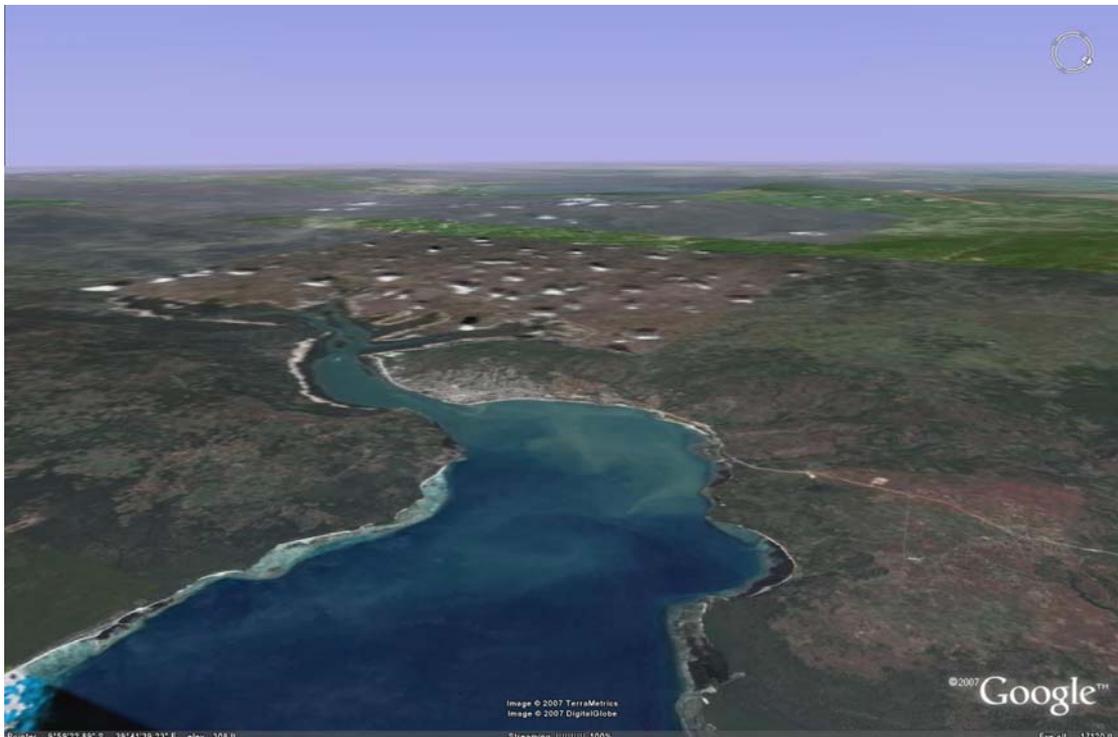


LAND SUITABILITY MAPPING

LINDI RURAL DISTRICT

FINAL REPORT



View of Lindi Bay, looking south-west. Image courtesy of Google Earth.

Report prepared by the Mpingo Conservation Project for the
National Land Use Planning Commission, Tanzania © 2007

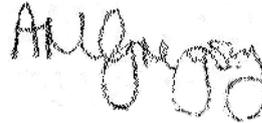
Steve Ball & Anne-Marie Gregory

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Our thanks to the District Executive Director, the District Land, Natural Resources and Environment Officer and the District Forestry Officer of Lindi Rural District for their support and for nominating an excellent fieldwork team: Godfrey Segesela (Land), Charles Mwaipopo (Forestry), Karim Wahedi (Livestock) and Mathew Kilua (Agriculture). Also thanks to Lawrence Emmanuel of GISIC Naliendele for help finding old reports and provision of GIS data.



Steve Ball



Anne-Marie Gregory



Figure 1. Survey team on the edge of the Makonde Plateau.

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Glossary of Terms

Africover	–	A large scale land cover mapping project of the FAO covering various African countries.
ArcView	–	The GIS software used by the MCP (version 3.2)
CSI	–	Consortium for Spatial Information, part of CGIAR
DEM	–	Digital Elevation Model
FAO	–	Food & Agriculture Organisation
FBD	–	Forestry and Beekeeping Division, part of MNRT
FR	–	Forest Reserve
GIS	–	Geographic Information System
GPS	–	Global Positioning System
ILRI	–	International Livestock Research Institute
LAFR	–	Local Authority Forest Reserve
MCP	–	Mpingo Conservation Project
MNRT	–	Ministry of Natural Resources and Tourism, Government of Tanzania
NLUPC	–	National Land Use Planning Commission, part of the Ministry of Lands
PFM	–	Participatory Forest Management (a programme of the FBD)
SACCOS	–	Savings and Credit Cooperatives
SMD	–	Surveys & Mapping Division, part of the Ministry of Lands
SOTERSAF	–	Soil & Terrain Database for Southern Africa, a joint project of ISRIC (the World Soil Information Centre) and the FAO
TanRIC	–	Tanzania Natural Resources Information Centre, part of the Institute of Resource Assessment, University of Dar es Salaam
VLC	–	Village Land Certificate
VLFR	–	Village Land Forest Reserve
WCST	–	Wildlife Conservation Society of Tanzania
WDPA	–	World Database of Protected Areas (maintained by UNEP-WCMC)

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Background

The Government of Tanzania is currently implementing the National Environment Conservation Strategy aimed at conserving land and water sources, threatened by over grazing and cultivation. Particular attention at this time is given to the conservation of Usangu Basin and its catchment. This basin is endowed with abundant natural resources and has a great potential for investment in agriculture, livestock keeping, mining, tourism, logging and hunting. Expansion of activities, coupled with the rapid population increase of both people and livestock have lead to unsustainable utilization of resources and subsequent environmental destruction currently experienced in the catchment.

Apart from loss of vital biodiversity, water sources in the catchment are drying up, thus reducing the water flow in the Great Ruaha River. This has lead to drying up of Mtera Dam and subsequent failure of hydropower generation at the dam. Tourism in the Usangu Game Reserve and Ruaha National Park has equally been affected. A number of initiatives have been and continue to be undertaken to control the situation in the Usangu catchment. Short term measures that the government has taken include the eviction by force of livestock keepers with their stocks from Ihefu Wetland in Usangu and smallholder irrigations. Medium and long term measures that will follow include the resettlement of livestock keepers and displaced farmers on permanent basis, both in Usangu Basin and its catchment, as well as other areas considered to have potential for resettlement of livestock keepers, based on the efficient, equitable and sustainable land resources utilization. This can best be achieved through land use planning and in particular through district land use plans.

The District level is an entry point for sustaining rural livelihoods. It provides the link between local interests and central government development priorities. As far as land and land resources management is concerned the district land use plan is an important tool for district councils. The plans take on board problems which transcend village level, provide the framework for the development of land use, and directs the land related developments and investments of government bodies, organizations, individuals and external development assistance. In addition they provide the district with guidance for village land use planning.

To this end, in September 2006 the National Land Use Planning Commission (NLUPC) put out a tender (Tender No. 1 / NLUPC for 2006/7) for consultancy services to undertake the development of land suitability mapping at district level for Chunya, Kisarawe, Mbeya, Mbarali, Makete, Njombe, Iringa, Chamwino, Manyoni, Kilombero, Ulanga, Kilosa, Lindi and Nachingwea Districts. The aim was to provide the district authorities with biophysical natural resources base line data (resource inventory) for district wide land use planning.

Following encouragement from the NLUPC, the Mpingo Conservation Project (MCP) expressed an interest in carrying out this work for Lindi and Nachingwea Districts. Initial expressions of interest were opened in public on 2nd October 2006, and the MCP was subsequently short-listed and, along with other short-listed providers, invited to submit a full bid with complete technical and financial proposals in the approved format by 25th November 2006. Appendix I details the precise terms of reference as specified by NLUPC. The MCP's detailed proposal was accepted and a contract for the consultancy services covering both Lindi and Nachingwea Districts was signed on 18th January 2007. See Appendix 1 for the complete terms of reference.

This report details how the consultants from MCP went about their work in Lindi District, and sets out the consultants' findings and makes recommendations of suitable land uses and for future land use planning in that district. A detailed itinerary and list of local stakeholders consulted is given in Appendix 2.

District Environmental Profile

Lindi Rural District comprises 132 villages surrounding Lindi Town (NBS 2005) and covers a total area of approximately 6,979km². Administratively it is divided into 10 divisions, totalling 28 wards, which are represented by the parliamentary constituencies of Mtama and Mchinga. The District is bordered by the Indian Ocean to the east, Kilwa District to the north, Ruangwa and Masasi to the west, Tandahimba and Newala to the south-east and Mtwara Rural to the south.

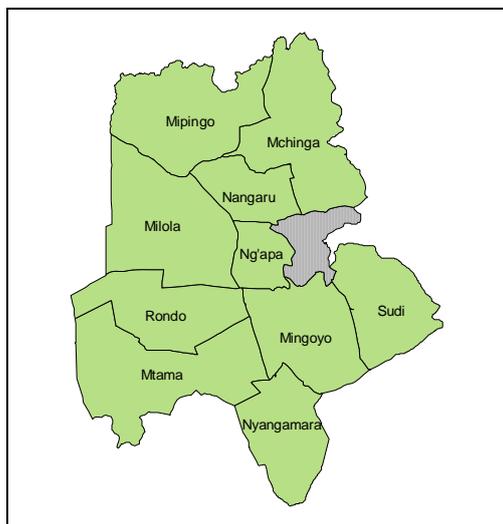


Figure 2. Divisions of Lindi Rural District.

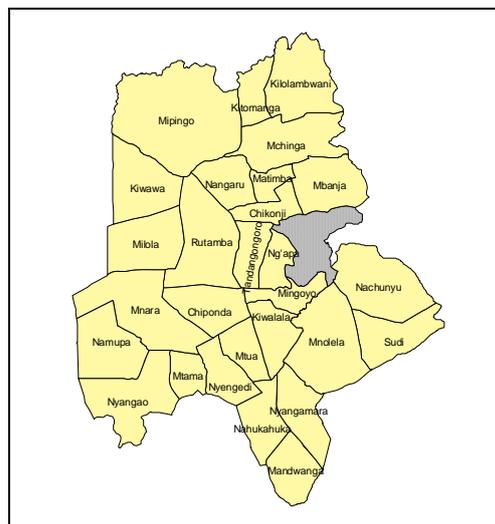


Figure 3. Wards of Lindi Rural District.

Lindi Rural has bimodal rainfall, with rains (*vuli*) between November and January, and the main rainy season (*masika*) from March to May. Overall it receives an average of about 1000mm per year, with considerable annual variation and slightly lower rainfall inland than on the coast (District Agriculture Office, *pers. comm.*). Proximity to the sea means that humidity remains quite high throughout the year, and the monthly average temperature only ranges from 24-28°C (RIPS, 2004).

Historically Lindi town was prosperous and an important centre of trade and administration, with sizable commercial plantations of cashew, sisal and coconut in what is now Lindi Rural. However the area has fallen into decline since 1952 when Mtwara, with its deep-water port, supplanted Lindi Town as the dominant urban centre in south-eastern Tanzania (Lerise *et al.*, 2001).

Lindi Region today is among the least developed parts of Tanzania owing to its relative isolation. Analysis of census data also shows net outward migration and an imbalance of men over women (Lerise *et al.*, 2001), both of which are indicative of a shortage of viable livelihood options. The District is still reliant on small-holder farmers practicing shifting cultivation; about 95% of the population is dependent on agriculture (RIPS, 2004). Fishing is also important for the livelihoods of coastal villages, but catches are small and traditional fishing gear predominates. When surfacing of the B2 road between Kibiti and Mingoyo (Mnazi Mmoja) is completed it will end the Region's backwater status, and act as a catalyst for land development (GoT, 2004a).

Most of the land is considered suitable for some form of farming (RIPS, 2004), although soil fertility is generally low. This, coupled with negligible usage of modern agricultural inputs, such as inorganic fertiliser, modern varieties and mechanisation, has led to Lindi Rural's agricultural sector stagnating (FAO, 2006). Staple food production meets local needs with very little surplus and cash crop production is not as profitable as it could be. About a fifth of the potentially cultivatable land is under crops in any given year, amounting to some 1000km² annually under arable production (RIPS, 2004). The main staples grown are maize, sorghum,

rice and cassava, while cashew, sesame and coconut are the principal cash crops. Only a very small area is irrigated and this irrigation is almost entirely for rice cultivation. Horticultural crops such as tomatoes and *mchicha* (Amaranthus) have a small market due to local food preferences and poor transport (District Agriculture Office *pers. comm.*).

Cashew production in Tanzania has a tumultuous history. Once it was the mainstay of the rural economy but since the early 1980s there has been a huge decline in the cashew industry. More remote villages in Lindi Rural even today have difficulty selling their harvest. As the wholesale market has improved in recent years with market liberalisation there has been limited planting of improved varieties, but not on the same scale as in Mtwara and Ruangwa. Lindi Rural's plantations are smaller in size and not as well maintained as those in Ruangwa and Nachingwea Districts.

Forest Cover in Lindi Rural is about 25%.¹ The District has six inland Forest Reserves (FR) under central government control (Rondo, Matapwa, Dimba², Ruawa, Litipo and Chitoo), Lindi District Mangrove FR (also under central government authority) and two reserves that are under district control; Makangala and Mtama. Their locations as recorded in the World Database of Protected Areas (WDPA) are depicted in Figure 4. However Matapwa FR is erroneously located; it should appear further to the north-west, beyond the Mchinjibi, the tributary of the Mbemkuru river that flows past Mipingo village (DFO Mahimbo *pers. comm.*), see Figure 23 for an estimate of its actual location. According to the WDPA data the eight inland FRs have a total area of 425km².

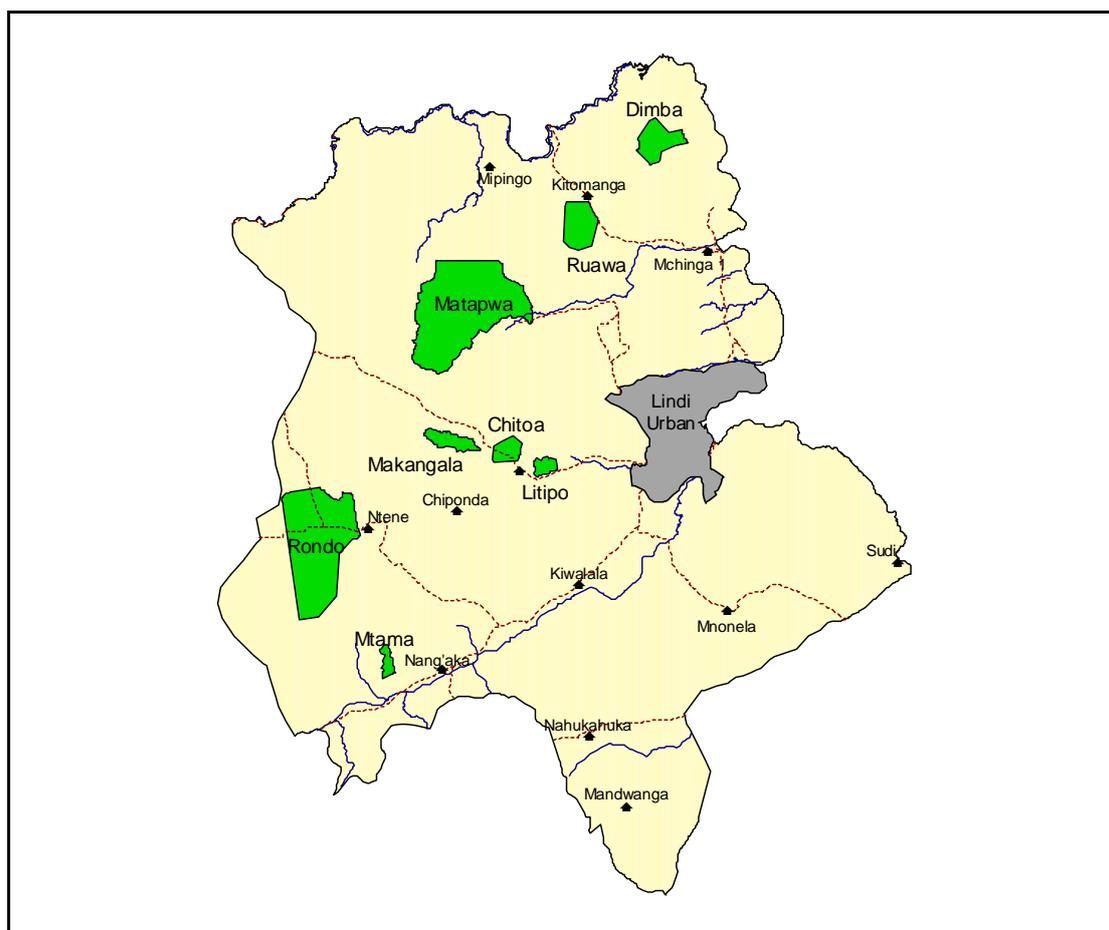


Figure 4. Forest Reserves of Lindi Rural District according to WDPA.

¹ According to TanRIC there are 2,052km² (29% of the district) of forest and woodland (but excluding large swathes with scattered cultivation), while Africover says 1,694km² (24% of the district) has 50%+ tree cover.

² Formerly this was called Ndimba Forest Reserve.

Makangara FR is in the process of being handed over to Joint Forest Management (JFM) involving a partnership between Lindi District Council and local communities. Five Village Land Forest Reserves (VLFRs) are close to being created under village management for a variety of purposes and Nyangamara LAFR is being established with the support of the Wildlife Conservation Society of Tanzania (WCST) for biodiversity protection.³

The District contains the Lindi Centre of Endemism in the Coastal Forest Biodiversity Hotspot (Burgess 2000, p.241). Patches of Coastal Forest are found within all of the central government forest reserves, most notably Rondo FR. Rondo FR contains over 100 endemic plant species and is where the Rondo Dwarf Galago (a small primate) was discovered (Briggs, 2002). Only a small area of coastal forest remains in the FR, and 1500ha is now planted with exotic timber species, including *Pinus caribea* that is currently being harvested and replanted.

Several wards have sizable timber stocks, including the commercially important Class I timber trees (GoT, 2004b) *Pterocarpus* spp. (*mninga*), *Dalbergia melanoxylon* (*mpingo*) and *Azelia quanzensis* (*mkongo*). Five divisions (Mchinga, Mipingo, Sudi, Mingoyo and Nyangamara) have had a logging ban in place for the past three years as a temporary conservation measure to prevent unsustainable logging. Logging is presently allowed in the other three divisions: Nangaru, Milola and Mtama.

Livestock production in the District is mostly based on traditional husbandry practices, with very few individuals or organizations rearing animals intensively or utilizing modern veterinary techniques such as improved feed, anthelmintics or improved housing. District records show that in 2005/6 some 6,944 cows, 19,255 goats and 3,445 sheep were kept in the District. Official records show 60 cows, 174 goats and 35 sheep slaughtered during the financial year, but many more were undoubtedly slaughtered for consumption by their owners. Livestock ownership is uneven and only a very few, for example around Lake Rutamba and in Mbanja Ward, having more than a dozen animals. Thus the imminent arrival of pastoralists will dramatically change patterns livestock rearing and land use in the villages where they will settle.

³ The WDPA also lists another FR in Lindi District: Mtama, although the actual status of this one is not clear.

Methodology

Initial Data Gathering

Digital GIS data was gathered covering the following spatial variables:

- Relief and Drainage (CGIAR-CSI)
- Geology (GISIC Naliendele)
- Soils (Sotersaf)
- Existing Land Use/Cover (FAO Africover, TanRIC)
- Protected Areas (WDPA)
- Existing Infrastructure (GISIC Naliendele, FAO Africover)

In addition paper copies of all 1:50,000 topographic maps from the Series Y742, Edition I-TSD (1965-6) covering the District were purchased from SMD for reference purposes and use in the field. Where colour versions were available⁴ boundary points of some of the large private estates were obtained and digitised. Supplementary statistical data were sourced from the 2002 census (NBS 2005).

Scoping Visits

An initial visit was made to Lindi District to discuss the proposed work, and to form the fieldwork team. This scoping visit also generated anecdotal information, particularly on infrastructure, development projects and existing land-use plans, all of which were fed into the fieldwork plan. Following on from the scoping visit District officials agreed to locate the following data so far as it was locally available:

- Known PFM and WMA project areas
- Recent participatory maps
- Major land holdings
- Existing land use zonings

Unfortunately data on mining concessions and potentially exploitable mineral deposits – held by the Southern Zone Mining Office in Mtwara – was not made available to the consultants. Where such concessions or deposits exist they will likely over-ride recommendations made within this report, even where they may be located on or below reserved areas.

Fieldwork

The timeframe for the contract (see appendices 1 and 2) allowed for only three weeks of fieldwork. This was carried out by a survey team consisting of one representative from each of the Land, Agriculture, Livestock and Natural Resources (Forestry) departments, and was led by an MCP consultant. The fieldwork had two principle aims:

1. To verify existing data
2. To elicit local knowledge

The first objective was accomplished by visiting areas pinpointed from existing maps and other data sources as being of particular interest. Current land cover was then checked against that described on the previously collated data. This was particularly important with respect to

⁴ And hence the light green used for plantations visible. Some maps were only available as black and white photocopies.

forest resources due to the recent pace of change in coastal forest cover, charcoal production and population trends.

The second objective was achieved by talking to key informants in local communities (e.g. Village Chairmen, semi-commercial farmers and traders) to gain their knowledge of land suitability for different potential uses. Due to the diverse nature of the information that was required, the approach adopted was based on semi-structured interviews with one or more community representatives in preference to rigid questionnaires. Since this was purely an information gathering exercise, not a participatory planning programme, large formal meetings of village institutions were avoided. However a brief information sheet explaining in simple Kiswahili the purpose of the work was left at each village visited, see Appendix 4, as was a letter of introduction that was kindly written on behalf of the District Executive Director.

In conducting surveys for both objectives, time was a significant constraint (as determined by the client). The survey team therefore did not attempt to determine the entire boundary of each land classification. Instead close reference was made to existing maps (both the paper topographical maps from the 1960s and more up to date digital maps), and one or two points on the boundaries checked by taking GPS readings. From this the actual boundaries of any land classification were inferred as far as possible.

The fieldwork took place during the rainy season so accessibility by road was a significant constraint. The villages visited by the survey team are listed in Table 1; the roads between them were also traversed in the course of fieldwork and many observations made along these routes. See Appendix 3 for the guide list of questions.

Ward	Villages
Kilolambwani	Dimba
Kitomanga	Mjimwema
Kiwalala	Narunyu Convent
Mandwanga	Mandwanga
Matimba	Likwaya
Mbanja	Kela, Likong'o
Mchinga	Mchinga 1 & 2
Mingoyo	Mingoyo, Mkwaya, Ruaha
Mipingo	Matapwa, Mipingo
Mnolela	Simana
Mtama	Makonde, Mtama, Nang'aka
Nachunyu	Nachunyu
Nahukahuka	Nahukuhuka
Nangaru	Nangaru
Ng'apa	Mbuyuni
Nyangamara	Nyangamara
Nyangao	Chiwere
Nyengedi	Mtumbya
Rutamba	Kinyope, Rutamba ya Sasa, Rutamba ya Zamani
Sudi	Sudi

Table 1. Wards and Villages visited during fieldwork.

Analysis & Map Generation

Data collected and the results of fieldwork were analysed using the ArcView 3.2 GIS software package, and statistics computed using Microsoft Excel. Maps accompanying this

report were prepared at a scale of 1:250,000. Maps were provided in ArcView Shape file format, and in printer-ready Adobe Portable Document Format (PDF).

Ill-defined boundaries

Almost all villages in Lindi Region lack a Village Land Certificate (VLC). For this reason ward, and hence district boundaries are often not precisely known except where they follow a well-defined natural feature such as a major river, e.g. the Mbwemkuru River which divides Kilwa and Lindi districts. We obtained district boundary data from two sources:

1. ILRI – based on ward boundaries
2. FAO Africover

However as Figure 5 makes clear, these two sources of data do not perfectly match. It is relatively easy to exclude the area of Lindi Urban municipality (which Africover include in a unified Lindi District), but on other borders there is no clear reason to believe one source over the other. Following consultations with the NLUPC this report and accompanying maps use a Maximal District Coverage which is so defined so as to include the whole of the district as depicted by both sources.

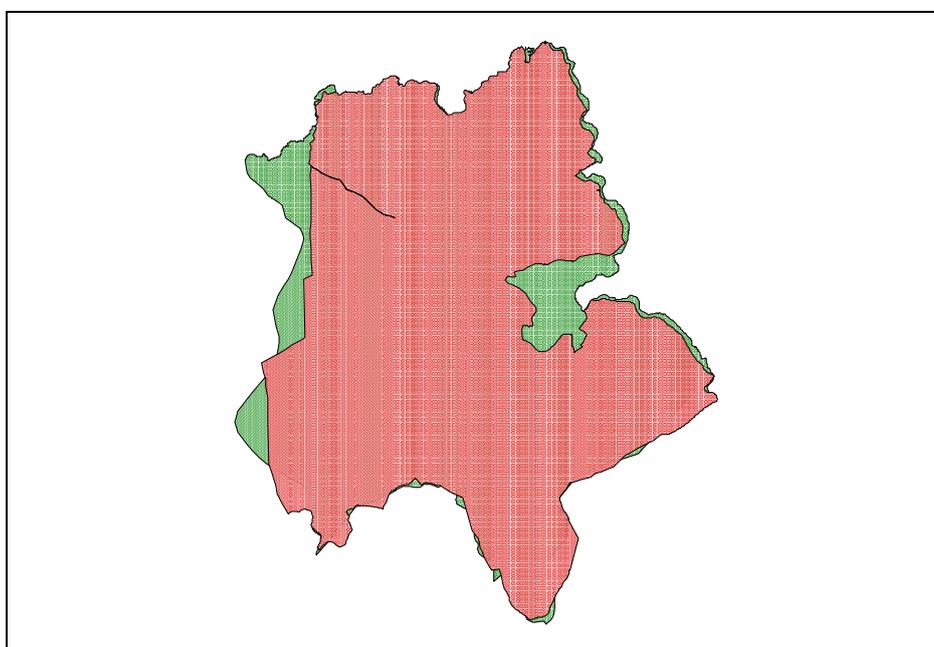


Figure 5. Inconsistent boundaries of Lindi Rural District (ILRI = red, Africover = green).

Extrapolating Land Capabilities

As noted above, the survey team could not visit all areas of the district in the three weeks set aside for fieldwork. Land suitability recommendations made concerning those areas visited should be generally applicable. Conversely recommendations for areas some distance from those visited had to be extrapolated by utilising *proxies*. That is to say one or more spatial data layers were selected which in the judgement of the consultants appeared to be most closely aligned with the situation in areas visited, and for which plausible cause-and-effect explanations could be construed. For example, the field surveys highlighted the need for catchment protection in Sudi Division, and so the elevation data layer was used to select some hill-tops⁵ and these were zoned for catchment protection in the final Recommended Land Suitability map.

⁵ The elevations used to select these hill-tops were somewhat arbitrary, and not even constant from one hill to another, the aim instead being to select a reasonably small proportion (again arbitrarily assessed) of the Division for this purpose.

A more complex example can be seen in the land suitability recommendations around Mipingo village, see Figure 6. Two different land uses are recommended along the rivers (the larger Mbwemkuru River which forms the northern boundary of the district runs along the top). Areas suitable for irrigation (shown in blue) were determined using the Africover Land Form data layer. Areas for high-intensity rain-fed (i.e. non-irrigated) agriculture were recommended using a combination of soil type, and distance from the river whereby all land within 1km of a large watercourse was deemed potentially suitable. This assumes that the river is flowing close to the centre-line of its floodplain, and that the floodplain is 2km wide. In many cases this will not be true and the high intensity agriculture zone will need to be narrowed or widened, and shifted to one side or the other accordingly.

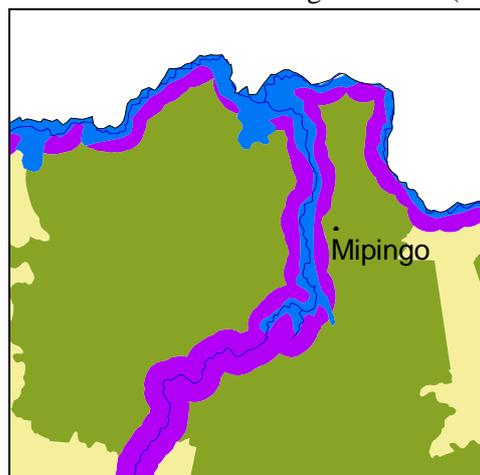


Figure 6. Land suitability recommendations around Mipingo village.

Hence recommendations made for areas some distance from the visited villages should be treated with caution, and adapted as required to the actual situation on the ground. For instance not all the hill tops in Sudi Division zoned for catchment protection may have significant remaining tree cover, while other smaller hills retain theirs, and which may therefore be better suited for protection under PFM. It is also important to note that the greater the distance from a visited site the greater will be the likelihood that the proxies used were inappropriate. For example in carrying out the same exercise in Nachingwea District, different proxies were used to derive land suitability recommendations, i.e. an approach that was appropriate in Lindi Rural District was not always deemed most appropriate in Nachingwea.

Prioritising Land Use Options

Many areas will be capable of supporting several different land uses. Dealing with this required a method to choose which land use option was most appropriate in any given situation. This was resolved by adopting a simple order of priorities, as listed below. Thus any area which is gazetted as a forest reserve cannot be used for any other land use, while, as in the case, discussed above, of land around the rivers, irrigation took priority over high intensity agriculture. However this list was not always followed slavishly. For instance around Kitomanga a large area was found to be potentially suitable for irrigation but this was reduced because without significant capital investment it would not be feasible to irrigate such a large area.

1. Forest Reserves
2. Estates
3. PFM Mangroves
4. PFM for Catchment Protection
5. Irrigable Valleys
6. High Intensity Agriculture – *valley bottoms and/or on black cotton soil, includes maize, sorghum, sesame, sugar cane and plantain (as appropriate to the soil type and water table height)*
7. PFM for Timber & Beekeeping
8. Coconut Plantations
9. Livestock Keeping – *extensive grazing*
10. PFM for Rehabilitation – *includes tree planting for conservation, and for firewood and charcoal production*
11. Moderate Intensity Agriculture – *mixed farming with arable and tree crops*

Stakeholder Consultation

Key stakeholders in the District were provide draft copies of this report and the land suitability map. At a meeting (the full list of attendees is given in Table 5 in Appendix 2) to solicit their feedback, the following comments were received:

- Colours on map are confusing; it is hard to differentiate between green for FRs and other related colours e.g. for PFM catchment protection and PFM timber/beekeeping.
- *The carrying capacity of each livestock grazing should be indicated, and followed when the central government directs herders to the District.*
- Matapwa FR is incorrectly located.
- Other FRs should also appear on the map; Dimba, Chitoa, Ruhaha (sic).
- *There should be beacons to demarcate the boundaries of livestock grazing areas.*
- *Areas proposed as suitable for livestock grazing lack social services (livestock keepers will suffer from lack of such services).*

Some of the comments (highlighted in italics) were not so much concerned with the land suitability map, but central government authorities and are duly reported here for their attention.

Available Spatial Data

Relief & Drainage

The Relief map is derived from Digital Elevation Model (DEM) data provided by CGIAR-CSI. It is based on the DEMs generated by the NASA Shuttle Radar Topographic Mission (SRTM), but also filled in the "no-data" holes where water or heavy shadow hindered the measurement of elevation (Jarvis *et al.* 2006). The SRTM data, and hence this DEM, is available as 3 arc second (approx. 90m at the equator) resolution, with a vertical error of less than 16m. Lindi District ranges from sea level to 920m asl.

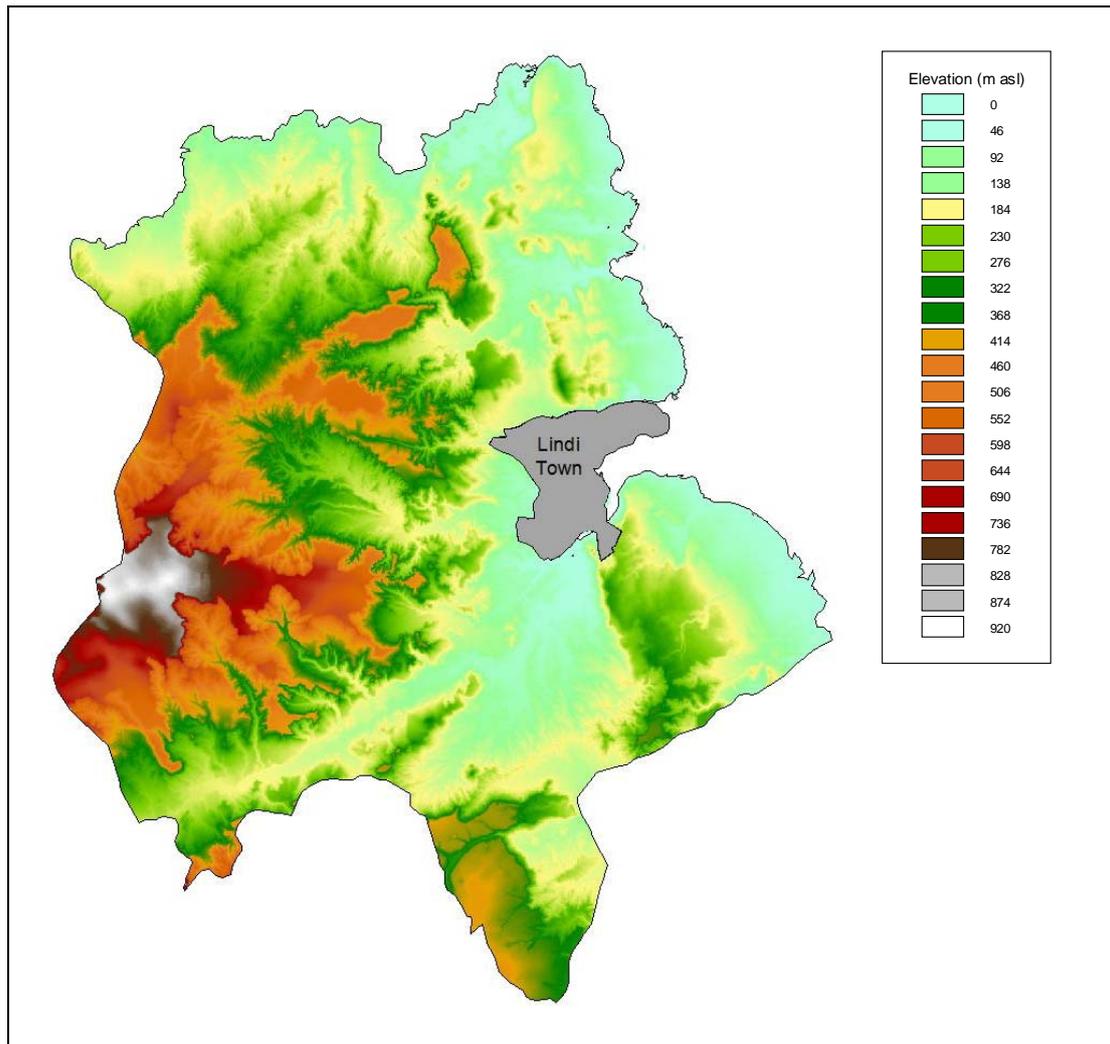


Figure 7. Elevation map of Lindi Rural District from DEM data from CGIAR-CSI.

The drainage map (see Figure 8) was generated from the DEM using freely obtainable ArcView scripts (Engel 2004). Streams were determined using a minimum threshold of 1,000 grid cells (approx. 810ha) draining to that cell.

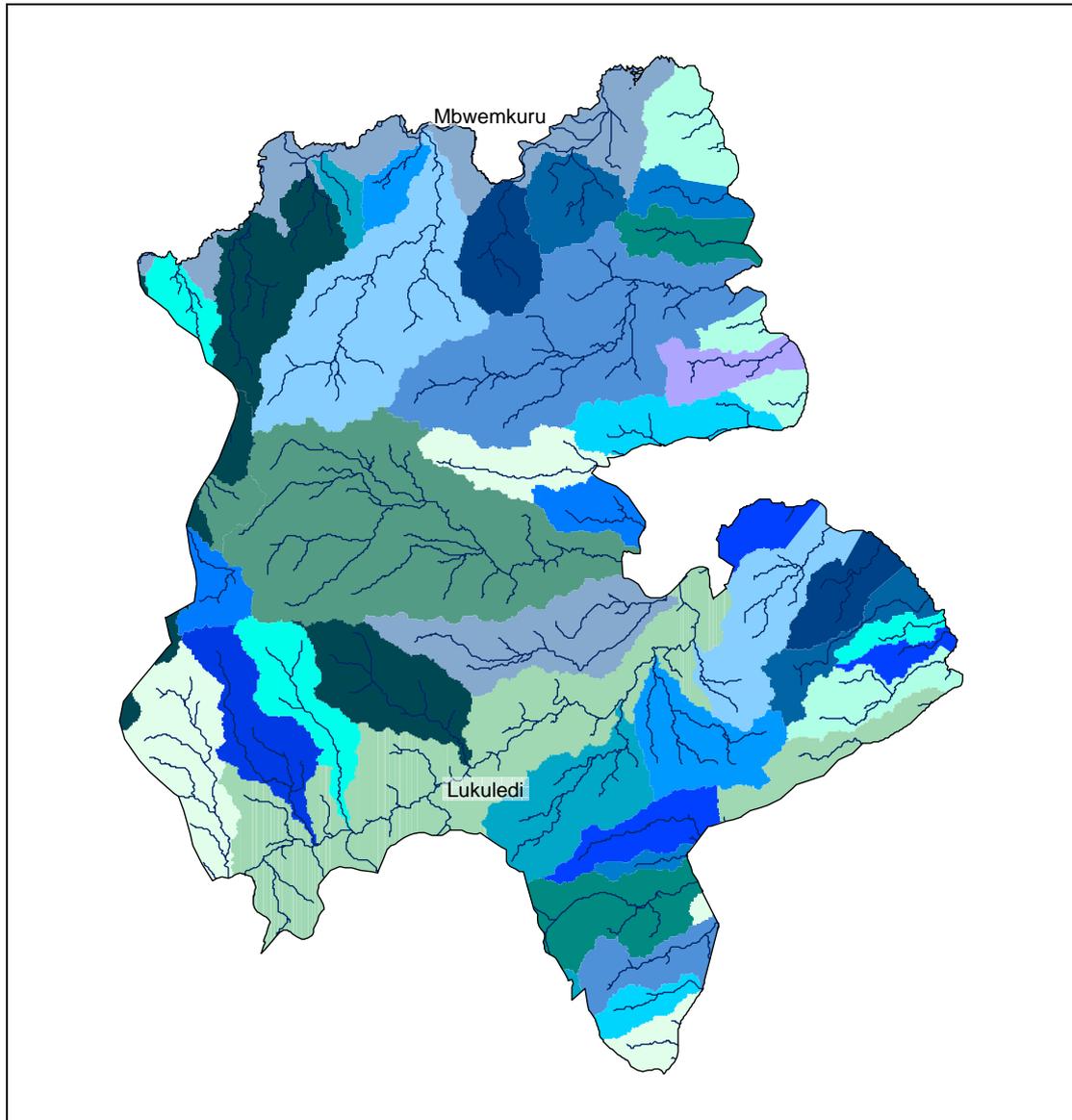


Figure 8. Sub-watersheds in Lindi Rural District.

Geology

Geological data provided by GISIC Naliendele data based on Bennett *et al.*'s work (1979) covers most of the district, omitting only some southern areas. For these we were dependent on the less-detailed data from FAO Africover (Lithology layer), and these areas are classified as Unknown Sedimentary in Figure 9 below.

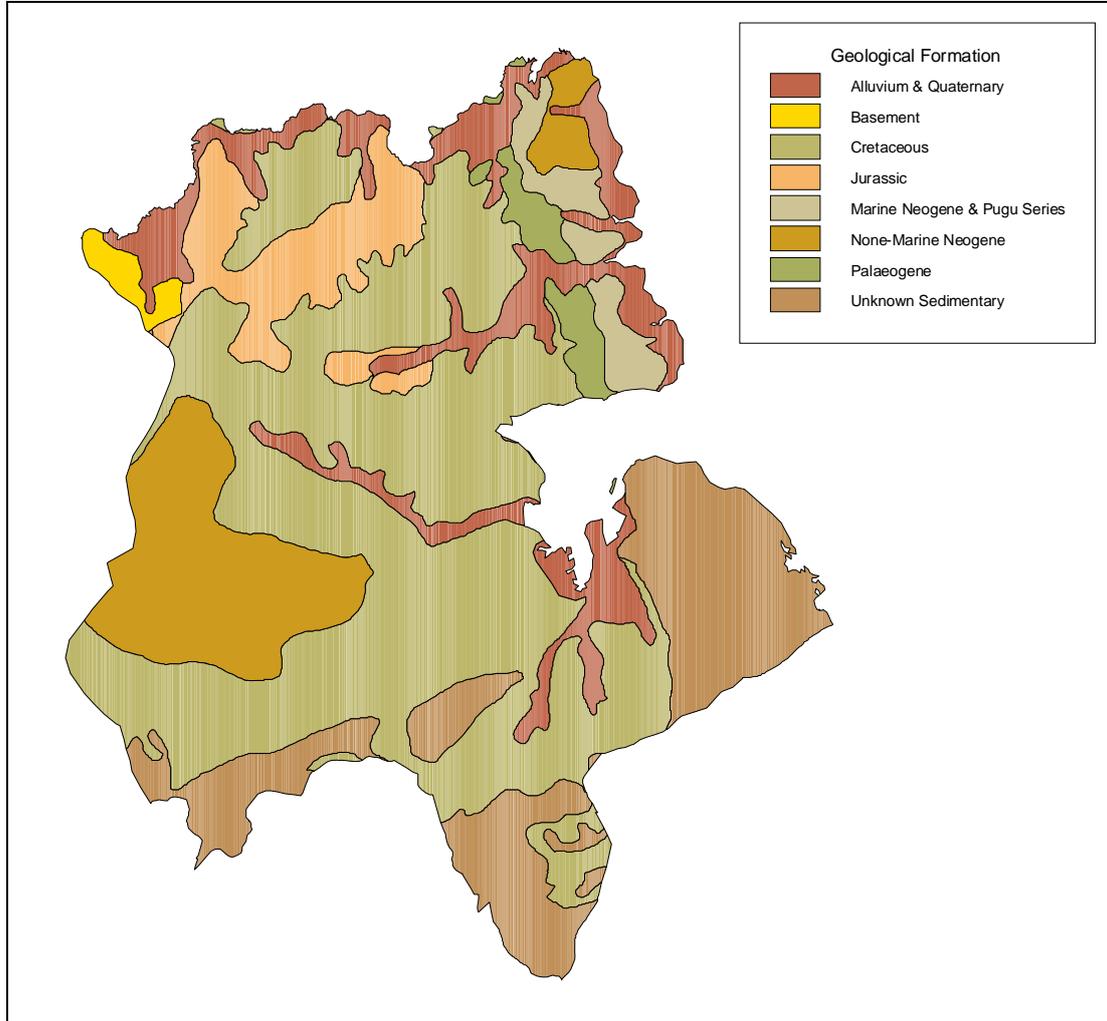


Figure 9. Geological formations underlying Lindi Rural District.

Soils

Sotersaf is the main source of soils data for Tanzania. The map of soils for Lindi Rural District is shown in Figure 10.

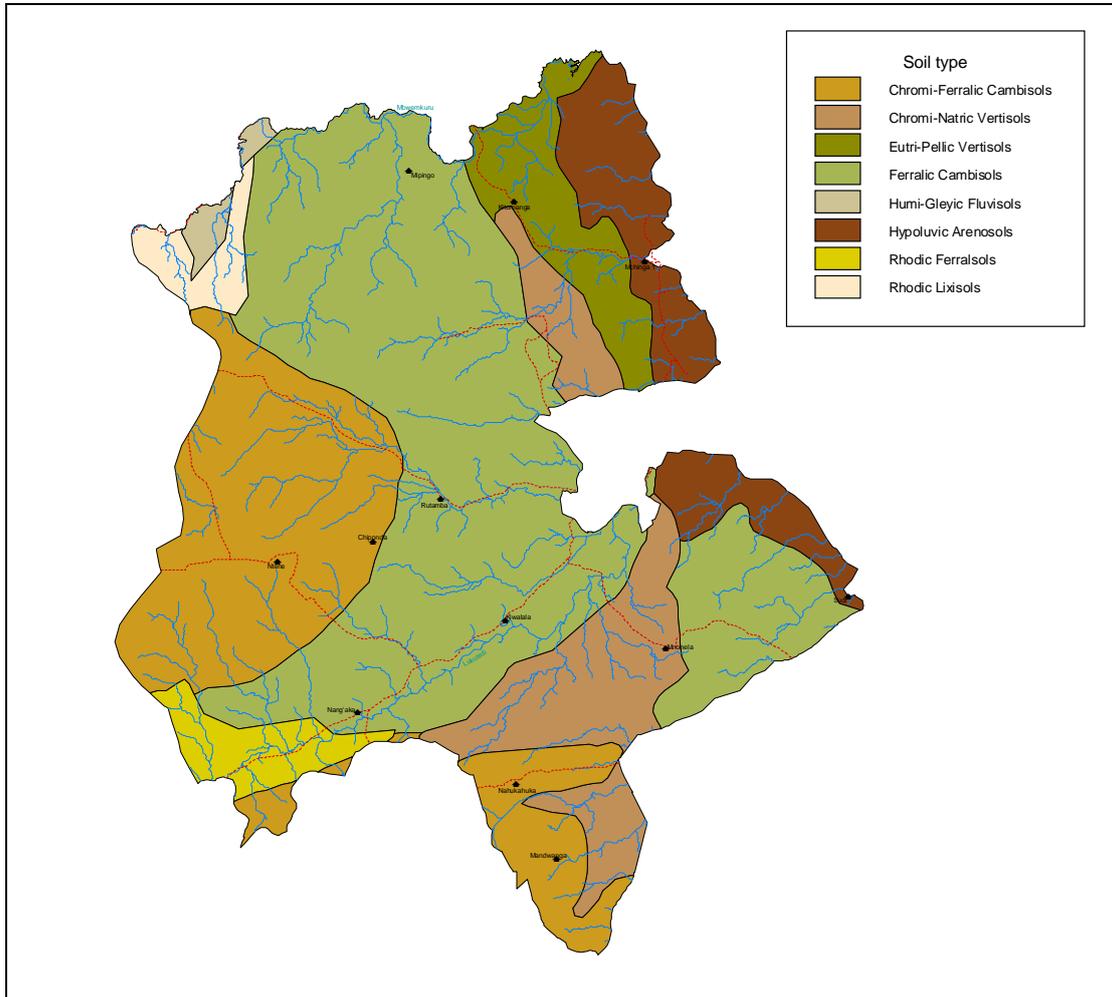
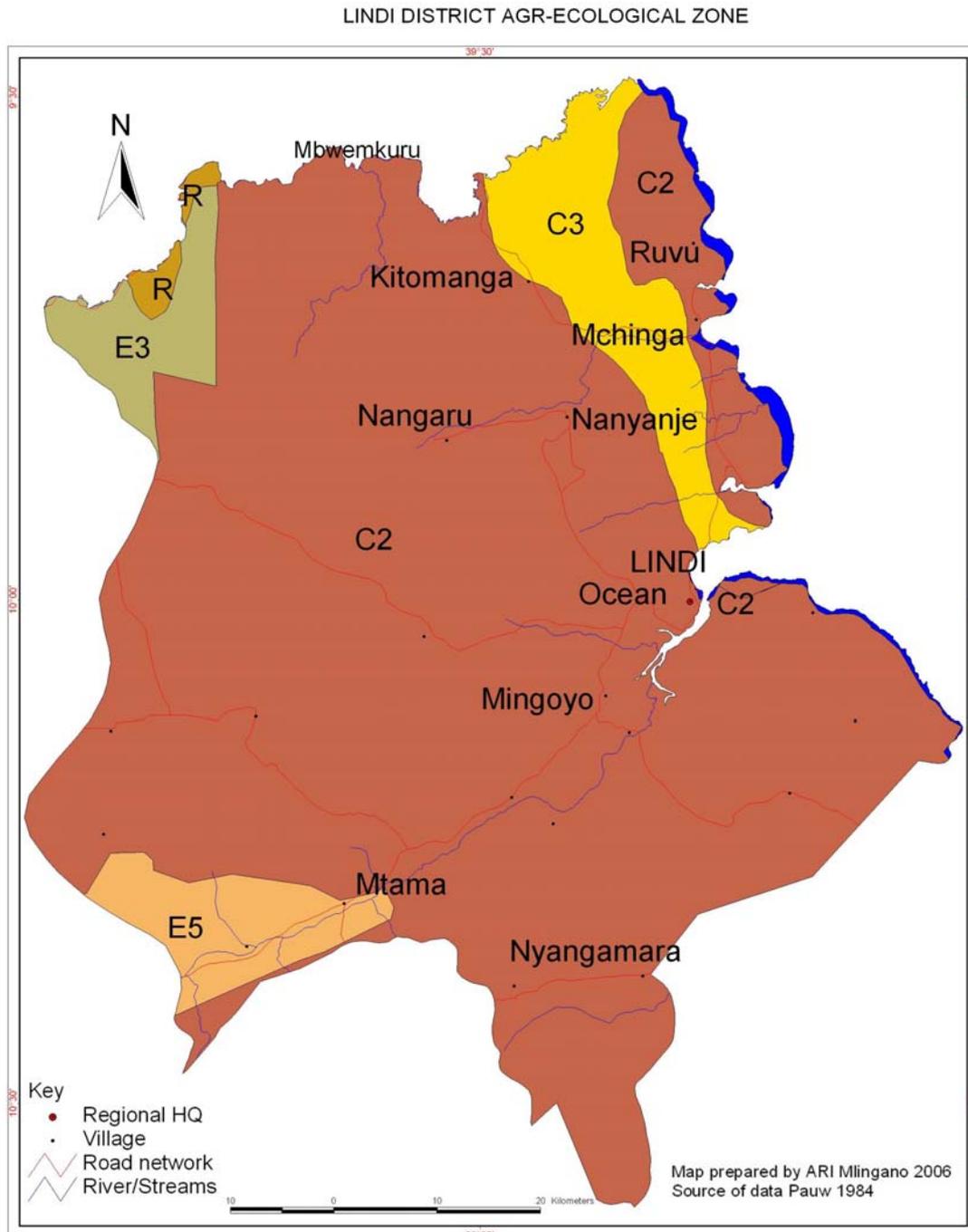


Figure 10. Soil classification of Lindi Rural District (Sotersaf).

Land Units

ARI Mlingano analysed De Pauw’s work to produce agro-ecological zone and rain-fed crop suitability maps for every district in Tanzania. Those for Lindi Rural are shown below.



Aez_code	Altitude (masl)	Rainfall(mm/year)	Physiography
C2	<500	800 - 1000	Nearly level to gently rolling plains and plateaux (0-10%) developed on quaterna
C3	<500	800 - 1000	Strongly dissected uplands to rolling to steep hills derived from Jurassic sands
C5	<200	1000 - 1200	Flat to gently undulating plains developed on old alluvial terraces not flooded
E3	200-750	800 - 1000	Flat to rolling plains low altit developed on intermediate metamorphic rocks
Ocean	Not applicable	Not applicable	Not applicable
R	Not applicable	Not applicable	Rocky terrain

Figure 11. Agro-ecological zones of Lindi Rural District (ARI Mlingano).

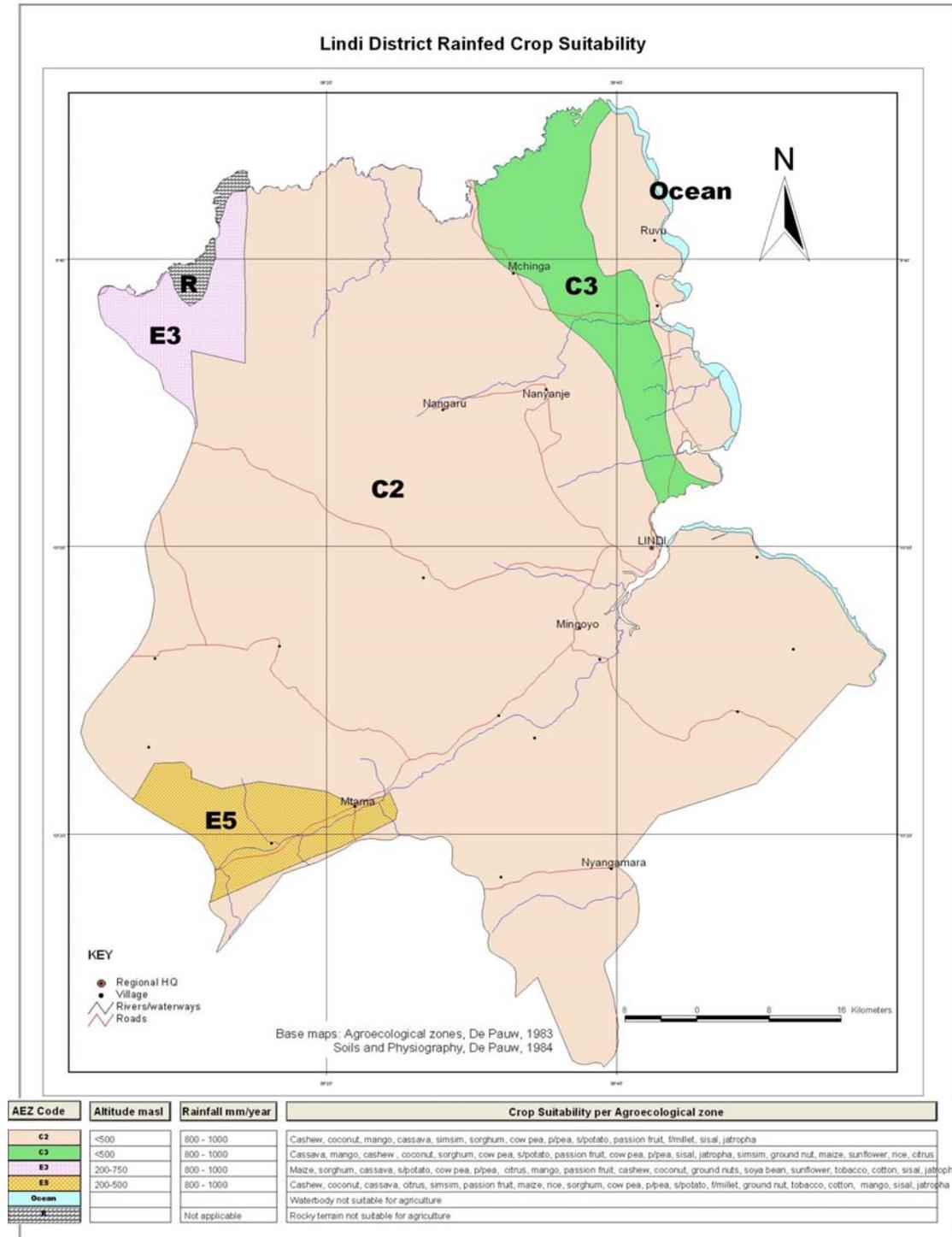


Figure 12. Rain-fed crop suitability zones for Lindi Rural District (ARI Mlingano).

Land Use / Cover

There are two sources of Land Use / Cover data available for Tanzania, both approximately a decade old. The TanRIC data is based on Landsat images captured in 1994-5, the FAO Africover data from Landsat images captured in 1996.

TanRIC

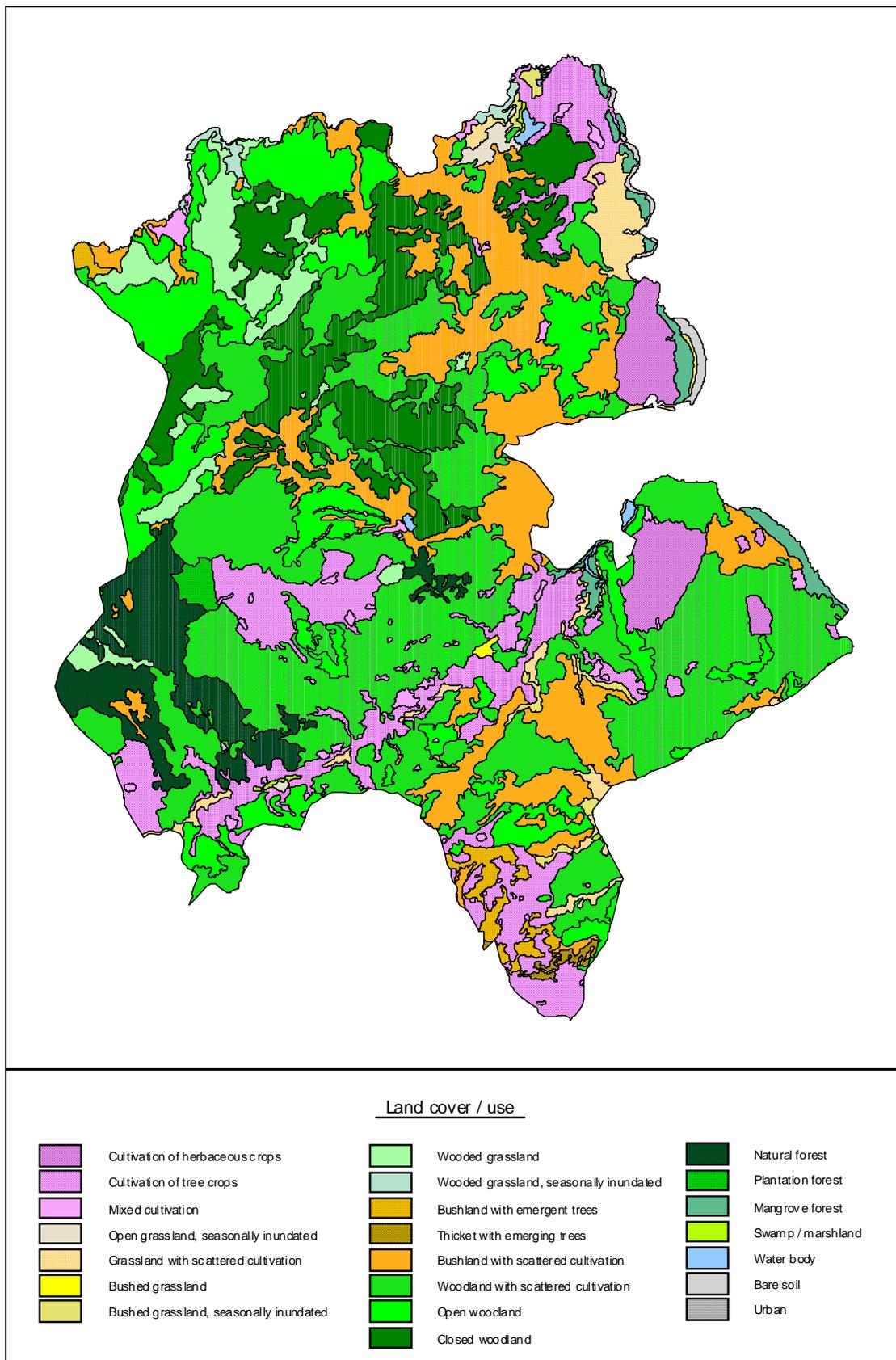


Figure 13. Land Use / Cover in Lindi District in 1995 according to TanRIC.

The map of land use / cover for Lindi District according to TanRIC is given in Figure 13. The main cultivated areas along the Lukuledi River, around Chiponda in the centre of the district, and in the east and south of the district are clearly visible, as is the forest on the Rondo Plateau. Some of the land cover categories barely figure in the district, for instance the only bushed grassland is just north-east of Kiwalala, and the only thicket appears right in the far south of the district. Woodland with scattered cultivation is the dominant land cover over much of the district (or at least was in 1995 when the satellite images were taken).

Africover

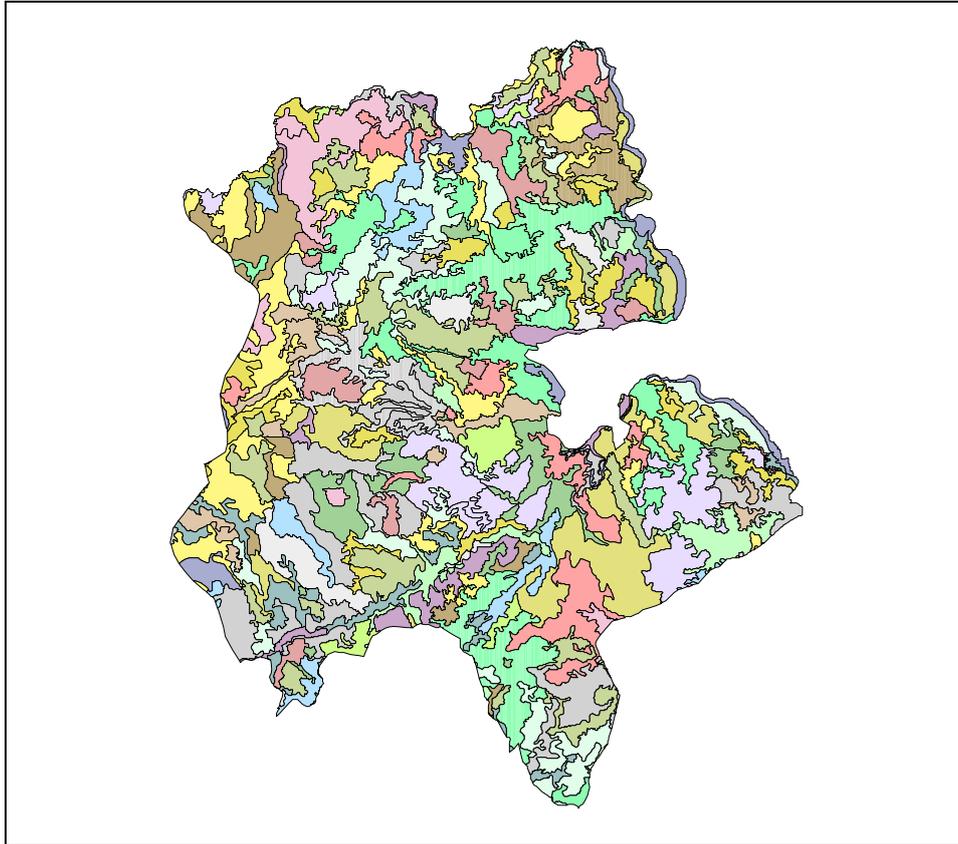


Figure 14. FAO Africover multi-purpose map of land use / cover for Lindi District.

The FAO Africover land cover data is also multi-purpose but more sophisticated than TanRIC in that it layers data on forest (tree & shrub) cover, savannah / grassland, and cultivation all together. This allows for more sophisticated analysis and for general land use planning and mapping to be based on the same general data across all sectors. The complete data set for Lindi District is shown in Figure 14. This is too complex for the sorts of simple analysis that was required for this exercise, but FAO also provide simpler aggregations of each of the sub-layers which are shown below.

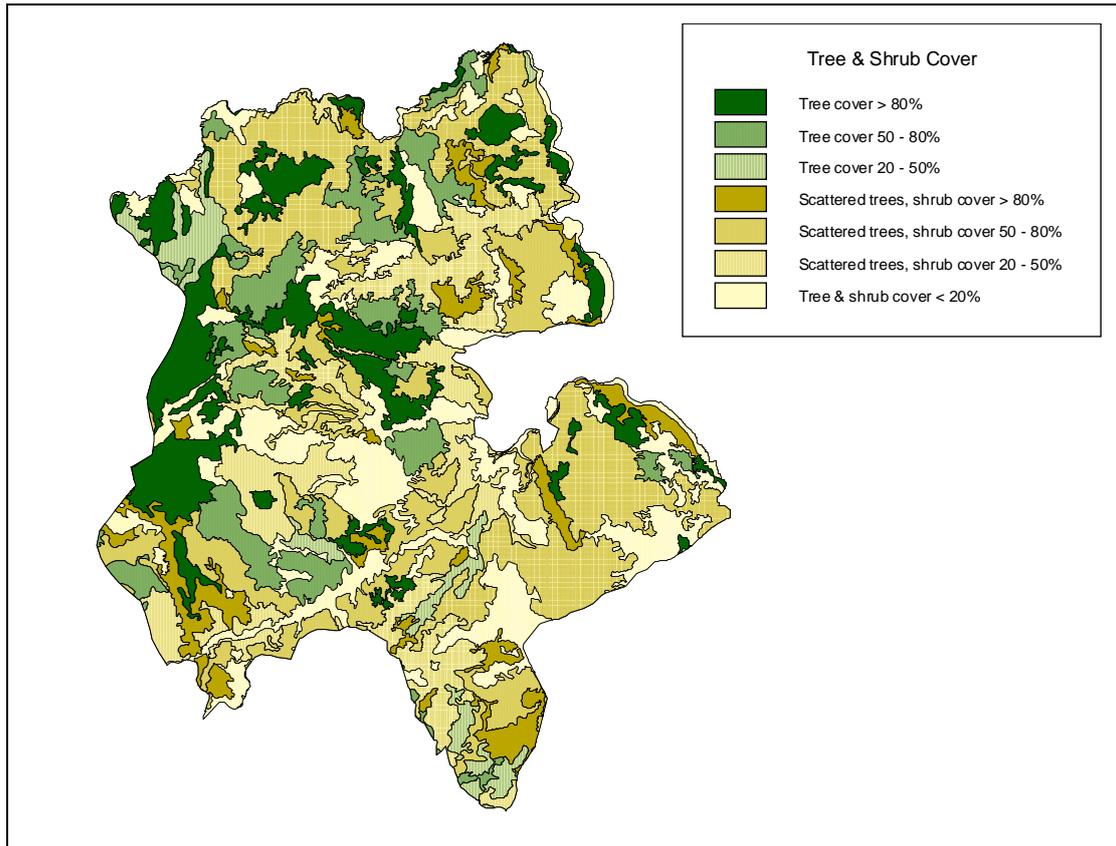


Figure 15. Tree and shrub cover in Lindi District (Source: Africover). Dominant cover only shown.

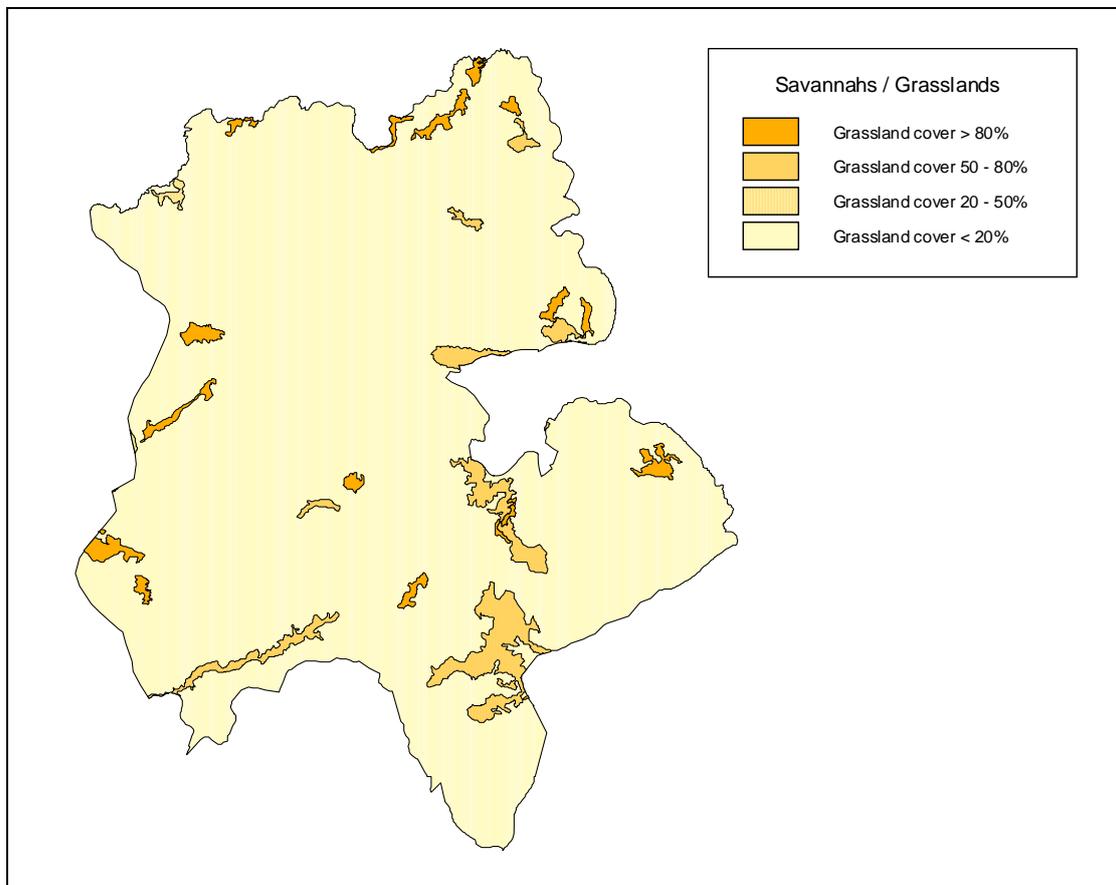


Figure 16. Grassland cover in Lindi District (Source: Africover).

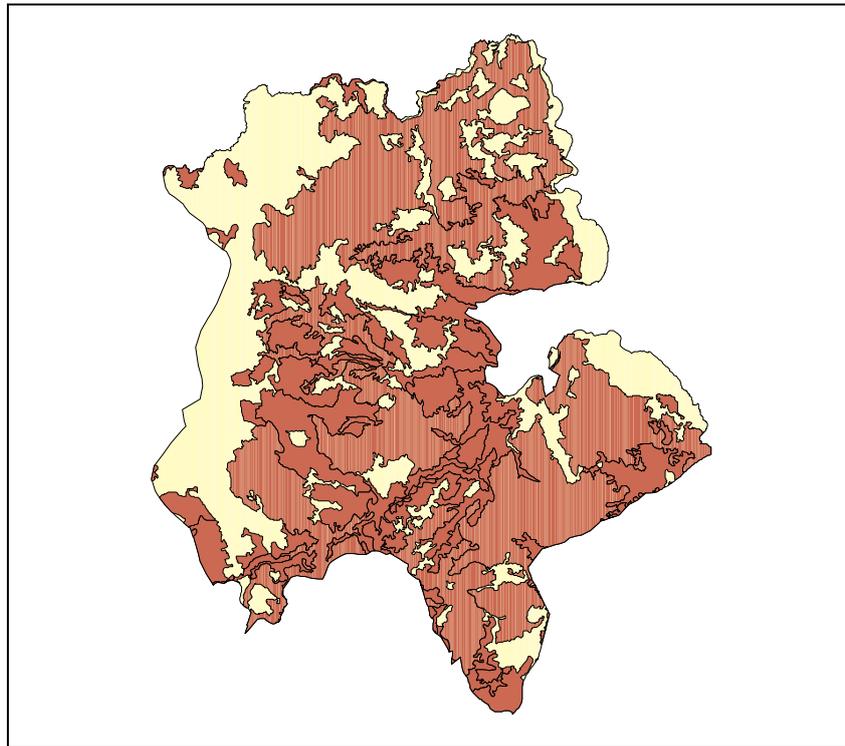


Figure 17. Areas where cultivation accounted for 20%+ of land cover (Source: Africover).

Unfortunately the ready prepared aggregation for cultivated land distributed by Africover is less useful as it conflates tree and arable crops. However careful analysis of the original multi-purpose data set allows for alternative views, which are shown in Figure 18 through Figure 20 below, although analysable data is not available for some of those areas identified in the main aggregation as being partly cultivated, and these show up as No Data in the figures.

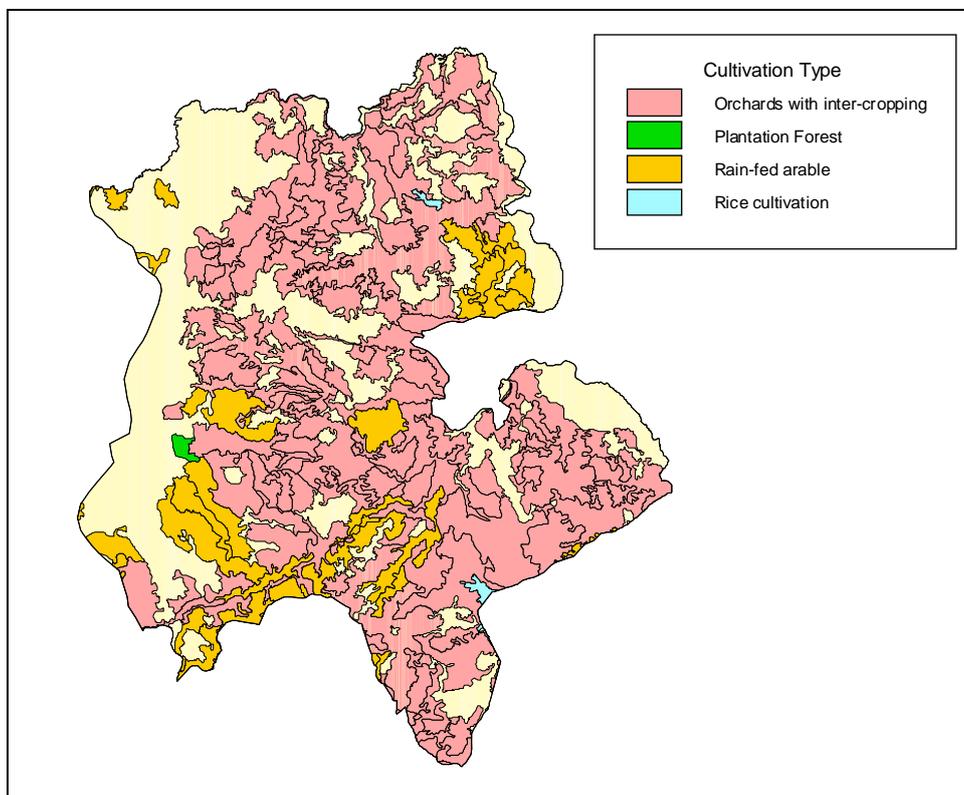


Figure 18. Cultivation by type in Lindi District (Source: Africover).

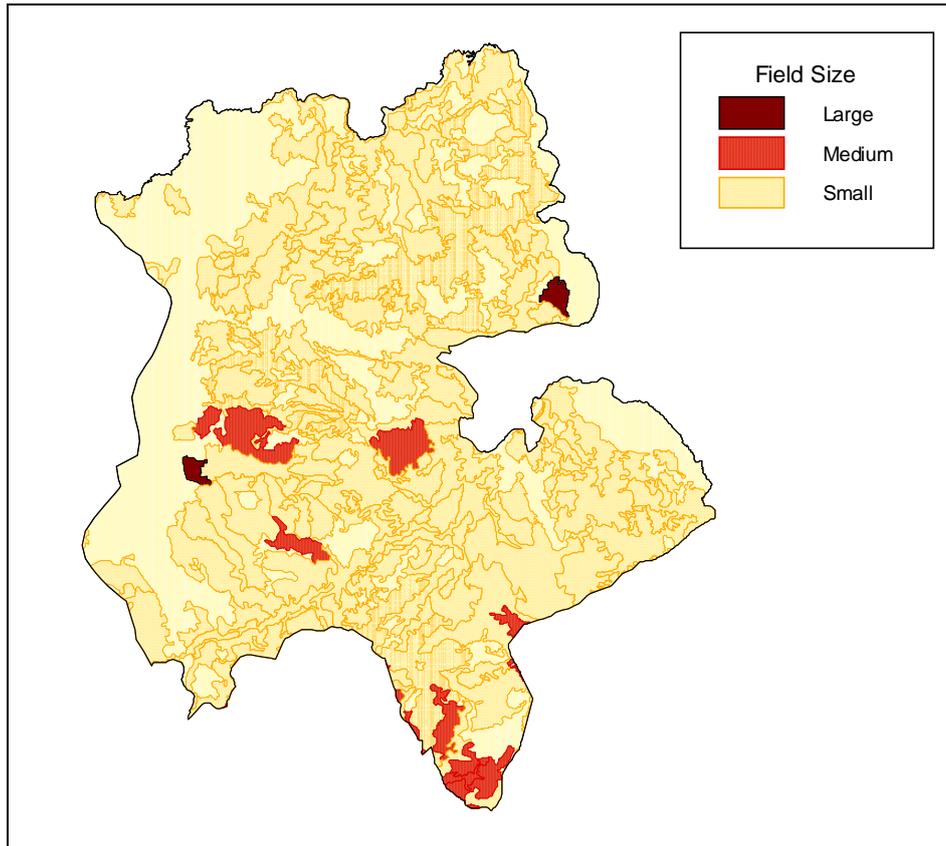


Figure 19. Cultivation by field size in Lindi District (Source: Africover).

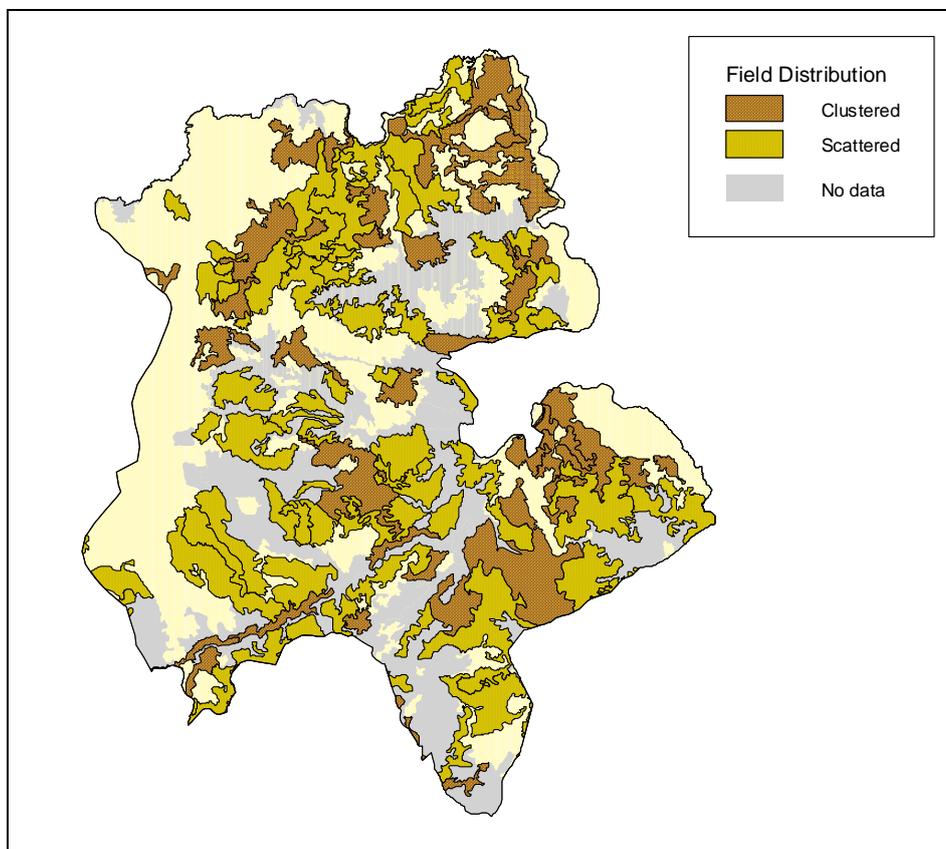


Figure 20. Cultivation by field distribution in Lindi District (Source: Africover).

Comparison

There are some disagreements between the TanRIC and Africover data, although not as great as for other districts. For instance, as discussed in the District Environmental Profile, they produce different figures for forest cover, and this discrepancy is magnified several times over if one includes the large swathes of land which TanRIC show as being woodland with scattered cultivation, but the overall pattern of distribution as shown is clearly the same. However the distribution of grasslands in the Africover data bears no resemblance to any of the land cover classes in the TanRIC data, appearing mostly as either cultivation of tree crops or bushland with scattered cultivation. The arable cropland just north of Lindi bay is identified as such in both data sets, but elsewhere there are significant inconsistencies.

Population

The spatial ward data set from ILRI includes basic census data, allowing graphical depiction of the spatial variations in population. Figure 21 summarises the distribution of population density throughout Lindi District. Wards are identified by an ID key⁶, which can be cross-referenced to Table 2. The strong concentration along the Lukuledi River is clearly visible, while the north-western part of the District is by contrast barely populated.

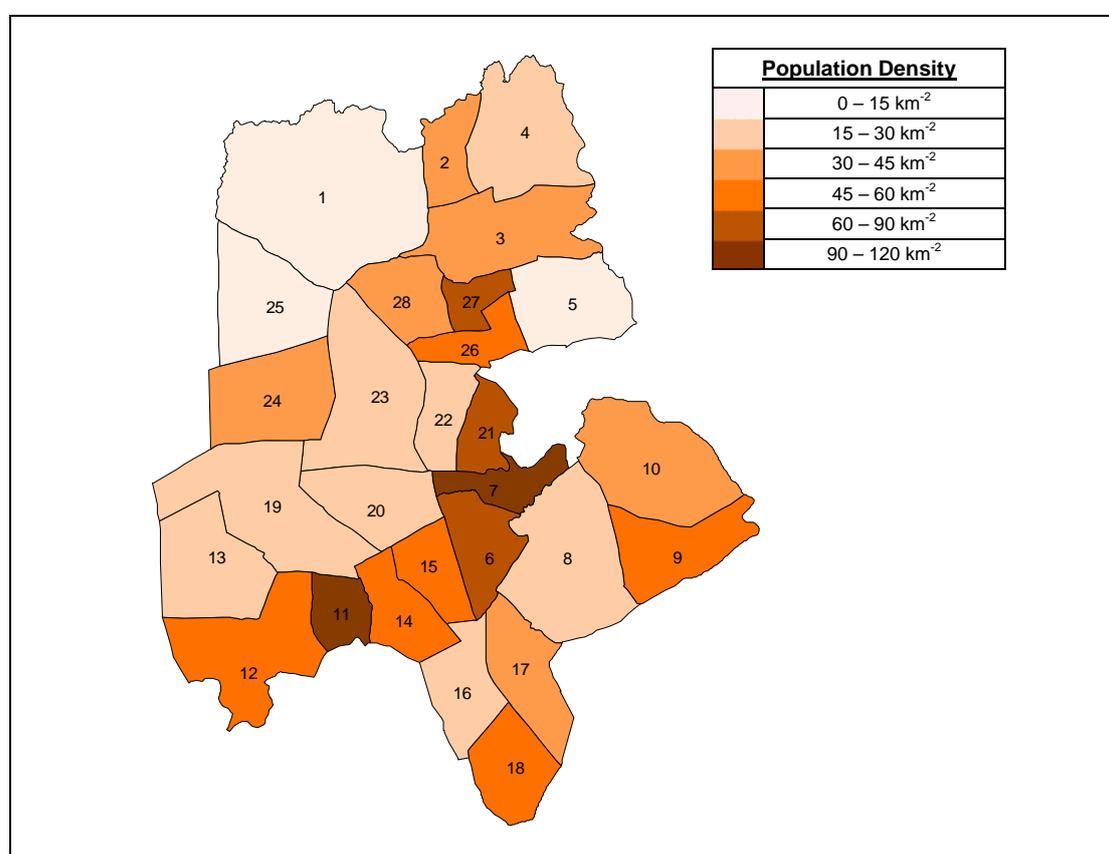


Figure 21. Population density of wards in Lindi District. See Table 2 for key to ward IDs.

ID	Ward	Type	Area (km ²)	Total Pop ⁿ	# HHs	Mean HH Size	Pop ⁿ Density
1	Mipingo	Rural	717.9	5,836	1,439	4.1	8.1
2	Kitomanga	Rural	115.4	4,002	932	4.3	34.7
3	Mchinga	Rural	307.3	11,568	2,913	4.0	37.7
4	Kilolambwani	Rural	314.7	6,777	1,668	4.1	21.5

⁶ This is provided by ILRI. It does not appear to follow any particular pattern.

ID	Ward	Type	Area (km ²)	Total Pop ^a	# HHs	Mean HH Size	Pop ^a Density
5	Mbanja	Rural	234.7	3,362	880	3.8	14.3
6	Kiwalala	Mixed	157.8	12,439	3,460	3.6	78.8
7	Mingoyo	Mixed	107.1	10,154	2,779	3.7	94.8
8	Mnolela	Rural	394.3	11,023	2,914	3.8	28.0
9	Sudi	Rural	212.4	11,068	2,649	4.2	52.1
10	Nachunyu	Rural	350.5	11,122	2,559	4.3	31.7
11	Mtama	Mixed	97.7	11,557	3,242	3.6	118.3
12	Nyangao	Mixed	325.2	15,834	3,898	4.1	48.7
13	Namupa	Rural	266.4	5,324	1,324	4.0	20.0
14	Nyengedi	Rural	149.7	6,747	1,817	3.7	45.1
15	Mtua	Rural	124.2	6,963	1,725	4.0	56.1
16	Nahukahuka	Rural	170.7	4,076	1,089	3.7	23.9
17	Nyangamara	Rural	198.0	6,347	1,685	3.8	32.1
18	Mandwanga	Rural	171.3	8,390	2,095	4.0	49.0
19	Mnara	Rural	399.5	8,899	2,024	4.4	22.3
20	Chiponda	Rural	204.4	5,300	1,273	4.2	25.9
21	Ng'apa	Rural	100.9	7,330	2,176	3.4	72.7
22	Tandangongoro	Rural	126.0	3,296	933	3.5	26.2
23	Rutamba	Rural	370.2	10,442	2,861	3.6	28.2
24	Milola	Rural	270.7	9,584	2,509	3.8	35.4
25	Kiwawa	Rural	276.1	2,964	747	4.0	10.7
26	Chlkonji	Rural	104.6	5,618	1,406	4.0	53.7
27	Matimba	Rural	69.4	4,710	1,259	3.7	67.8
28	Nangaru	Rural	156.1	5,032	1,321	3.8	32.2

**Table 2. Population of Lindi District by ward in 2002. HH = household.
Source: 2002 census data (NBS 2005) and ILRI.**

Infrastructure

There is little spatial data available on infrastructure. The map in Figure 22 below is composed from information from FAO Africover and GISIC Naliendele plus GPS waypoints collected during fieldwork.

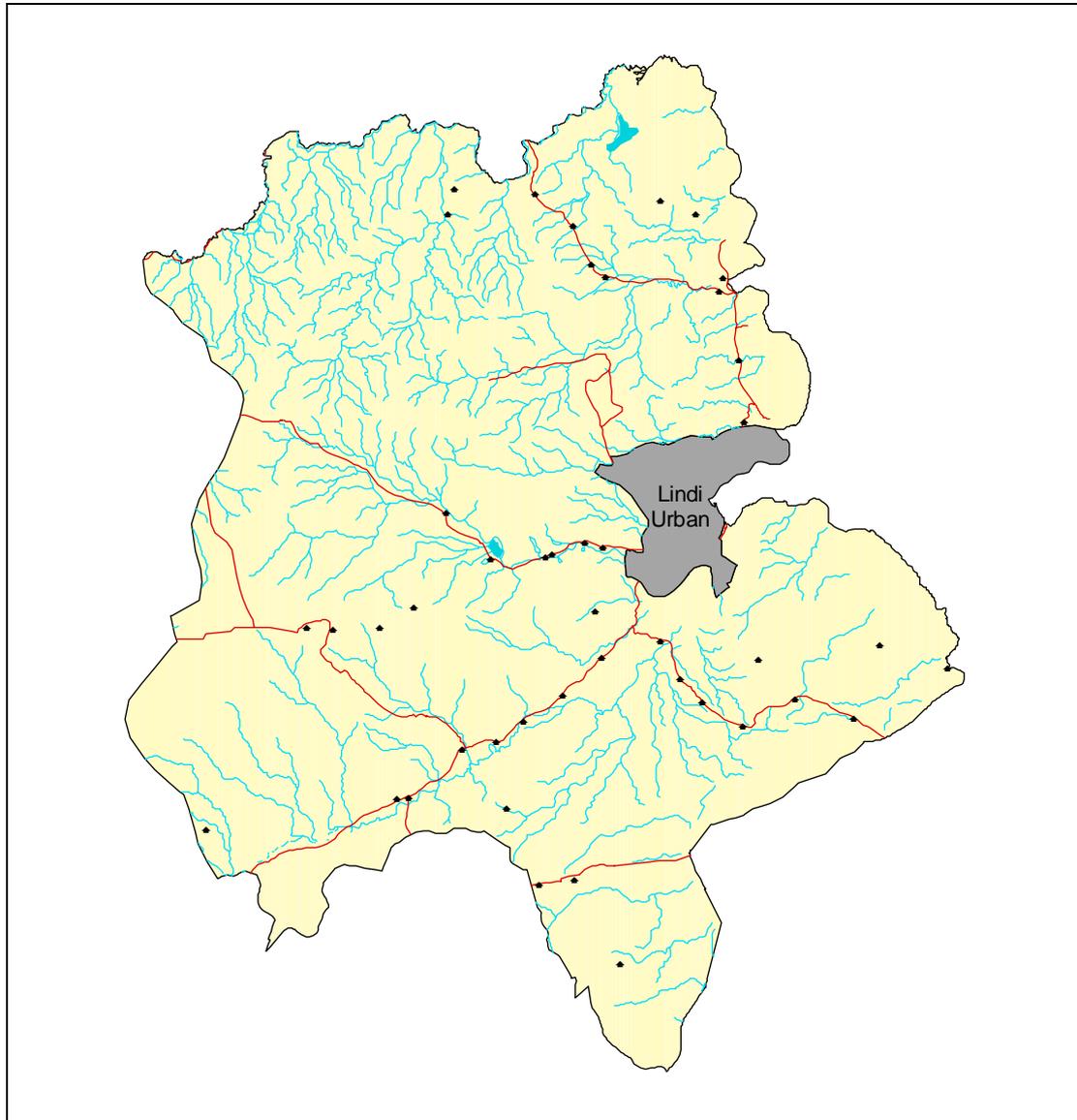


Figure 22. Known village locations, roads and rivers in Lindi District.

Areas of Special Interest

Biodiversity and Ecologically Sensitive Areas

Lindi Rural has a several ecologically sensitive habitats that the District Forestry Office and its civil society partners have active programmes to conserve. However, the District does not have any National Parks, Game Reserves or World Heritage Sites. The erroneous placement of Matapwa FR was based on data from the WDPA, and presented something of a problem. The District Forestry Officer was able to indicate on a map roughly where he thought it should be, and then the course of the Mchinjibi River (as determined from the CSI DEM data) was used to amend the south-eastern boundary. However the path of the rest of the reserve's boundaries (relative to the centre) were unaltered for lack of any more detailed guidance.

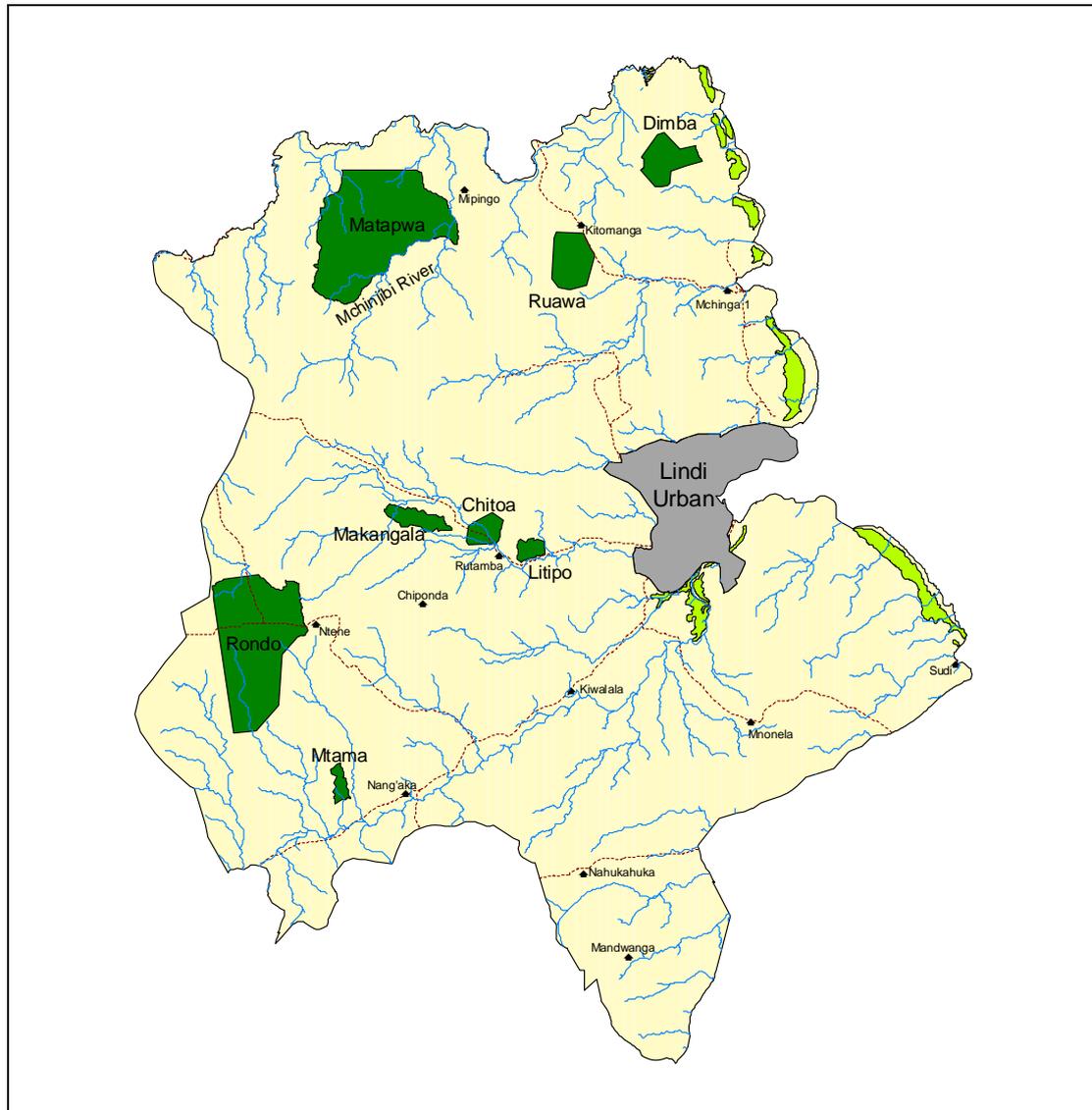


Figure 23. Forest Reserves (dark green) and mangroves (light green) of Lindi Rural, location of Matapwa FR shifted from that shown in WDPA based on advice from District Forestry Officer, see note on p10.

As the spotlight of this work is terrestrial resources, the fieldwork and data collection only briefly looked at mangroves and fisheries, which are not discussed in detail in this report. However, much of the coast is fringed with mangrove. The largest patch is along the Lukuledi Estuary, which is the breeding ground for many species and support prawn and fin fish harvesting. The District Forest Office has been involved in successful replanting activities at several sites in Lindi Urban and Rural Districts and has facilitated the establishment of salt pans in areas of very high salinity in order to improve the livelihoods of coastal communities. Under the national Participatory Forest Management (PFM) programme illegal harvesting of red mangrove poles (*Rhizophora mangle*) for export to Zanzibar, and clearance for illegal salt pans have both dramatically reduced.



Figure 24. Coastal forest in Rondo FR.

As mentioned in the Introduction, Lindi Rural is noted for its coastal forest.⁷ It has been the focus of biologists' interest since the early 1990s. Rondo FR is particularly interesting because it is at altitude, and the flora – and consequently the fauna – has affinities with montane Eastern Arc rainforest. While carrying out this work the consultant saw patches of dense forest that is possibly coastal forest, on a hill to the west of the road linking Likwaya with Kikomolela. The area is thought to be protected by villagers' traditional conservation measures. There is also a ribbon of dense thicket in Likong'o village, near the coast, that could be of biological interest (UTM 584619E 8914715S).

Other ecologically sensitive habitats include the escarpments on the edges of the Makonde and Rondo Plateaux. To prevent serious gully erosion these areas need a permanent cover of vegetation. Trees are ideal for this as some cover is maintained throughout the dry season preventing droplet erosion, and their deep roots bind the soil together. Most of the Rondo Plateau escarpment has tree cover, as either natural miombo woodland or old planted cashew and mango trees so erosion here is a lesser concern. Addressing this, however, should be a priority along the escarpment edges of the Makonde Plateau.

⁷ Coastal forest is a diverse habitat so named because it forms a discontinuous band that runs parallel to the coast. It is a terrestrial habitat of high plant and animal diversity and should not be confused with mangrove forest. Mangrove is a completely different habitat found in the intertidal zone. It has low plant diversity and support high fish, crustacean and mollusc populations, several of which are of economic importance.

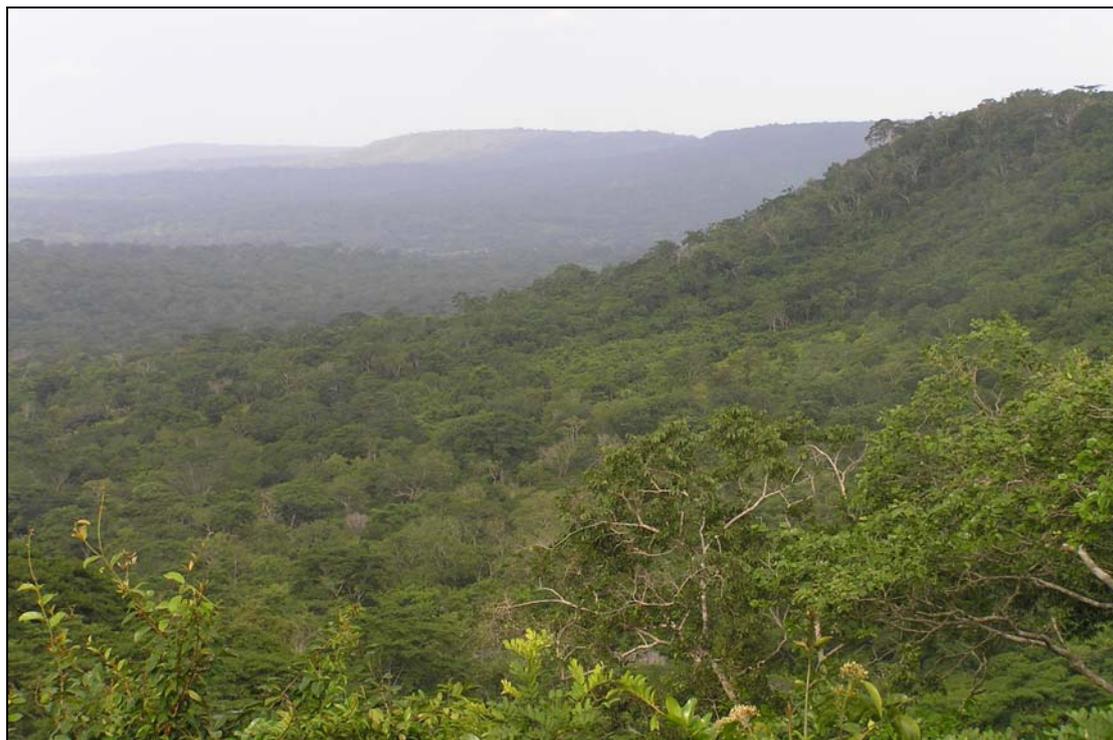


Figure 25. Escarpment forests along the edge of the Makonde Plateau,

Tourism development

Although Lindi has been on the sparsely-used south-east backpacker circuit for many years, it is only recently that the infrastructure has started to be developed to support larger-scale and upmarket tourism, e.g. twice-weekly scheduled flights. Tourism will further increase when the B2 road is surfaced and the Mnazi Bay electrification scheme reaches Mchinga. Accordingly there are plans for at least three tourist class hotels in the area (two in Lindi Urban and one in Lindi Rural). Occasionally traditional dhows (*jahazi*) carrying tourists to and from Mikindani (Mtwara) already stop along Lindi Rural's coast, at Sudi and the Mbwemkuru Estuary. The beaches and marine life are the District's main attractions, although it has a number of other sites of interest.

Sudi village has the remains of Omani settlements including a mosque, graveyard, well and pillar. These features themselves are not sufficient to keep tourists' attention for more than a couple of hours, but provide an excellent backdrop to appreciate the sandy beaches, good snorkelling and contemporary fishing village. Local leaders have a positive view of developing tourism and of the tourists who have already visited by boat and private 4WD.



Figure 26. Beach, graves and mihrab in mosque at Sudi.

Kela sub-village of Likong'o is hallmarked as the site of a hotel (approximately UTM 586639E 8914632S) aimed squarely at tourists. The site has a long sandy beach adjoining coastal scrub and perhaps Eastern African Coastal Scrub Forest *sensu* Burgess & Clarke (2000). At low tide a large area of sand is exposed and there is said to be reef beyond the low

water mark. Its proximity to Lindi Airport is said to be the reason for its situation, as the beach is not as attractive as others in the District.

Further north around Mchinga there are beautiful coconut-lined sandy beaches. However tourism is likely to be unpopular with sectors of the communities there, who have a long history of Islam, shown for example by Mchinga I's distinctive Ibadi style mosque.

Tendaguru in Mipingo Division has long been famous among palaeontologists. Each year scientists come to excavate dinosaur fossils, which even today are visible at ground level (Mipingo Division Secretary *pers. comm.*) However the site is close to the boundary with Kilwa District and vehicular access, via a long unsurfaced road, is only possible after a prolonged period of dry weather. Thus although this site would be of interest to tourists, it is difficult to fit into tourist itineraries (though it could be combined with Mto Nyange hippo pool in Kilwa District) and furthermore very difficult to reach.

Rondo Plateau is said to have ancient rock art (Briggs 2002) but we were not able to visit the site during the fieldwork. If the paintings have not deteriorated then they could easily be incorporated into a day trip from Lindi to include Rondo FR (not currently marketed at visitors) and the mission at Ntauna.

Lindi Rural's coastal forests and picturesque Lake Rutamba are known to ornithologists and even feature in the leading guide book to Tanzanian (Briggs 2002). As high end tourism develops in southern Tanzania more visitors will reach these sites by 4WD. However this is a very specialised sector of the market that is inherently limited in size.

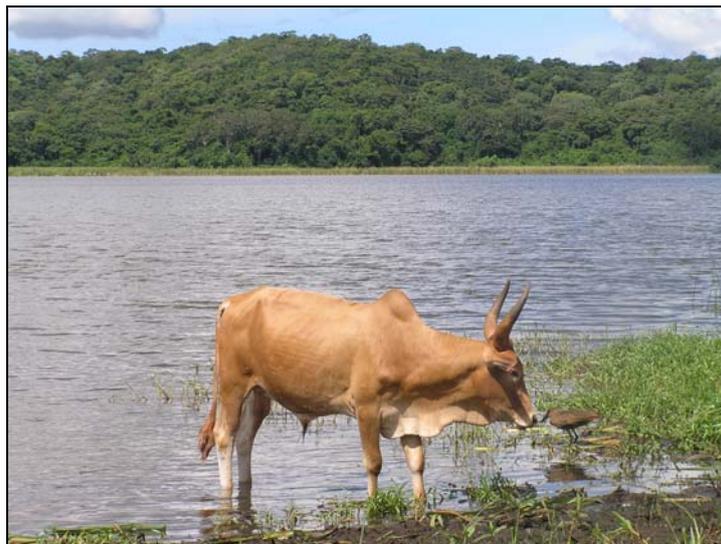


Figure 27. Lake Rutamba might attract the odd tourist.

Land Suitability: Agriculture

Irrigated Agriculture

The District Agriculture Office has been promoting the use of small-scale appropriate technology to help develop agriculture. At present there are five sites with surface-level irrigation e.g. diversions and canals, that are managed by local farmers, and pumps are in use at Mbalala. The best-known irrigation scheme, at Kinyope, dates back to the 1970s and is managed by a local CBO, *Chama cha Ushirika cha Umwagiliaji*. Some farmers in Kinyope are able to harvest three rice crops a year while others grow rice and then horticultural crops in the dry season. Kinyope is, by local standards, a prosperous village with numerous shops and iron roofing attesting to the income received from irrigated agriculture. Despite its success, a total area of only 300ha is irrigated in Kinyope. It is thought that the Land Bank figure of 2,089ha irrigated over the whole District is an overestimate. However, there are substantial opportunities to expand the irrigated area. At present only private individuals are expanding the area under irrigation at Kinyope. With sufficient capital and appropriate extension advice an area of 412km² could be irrigated.

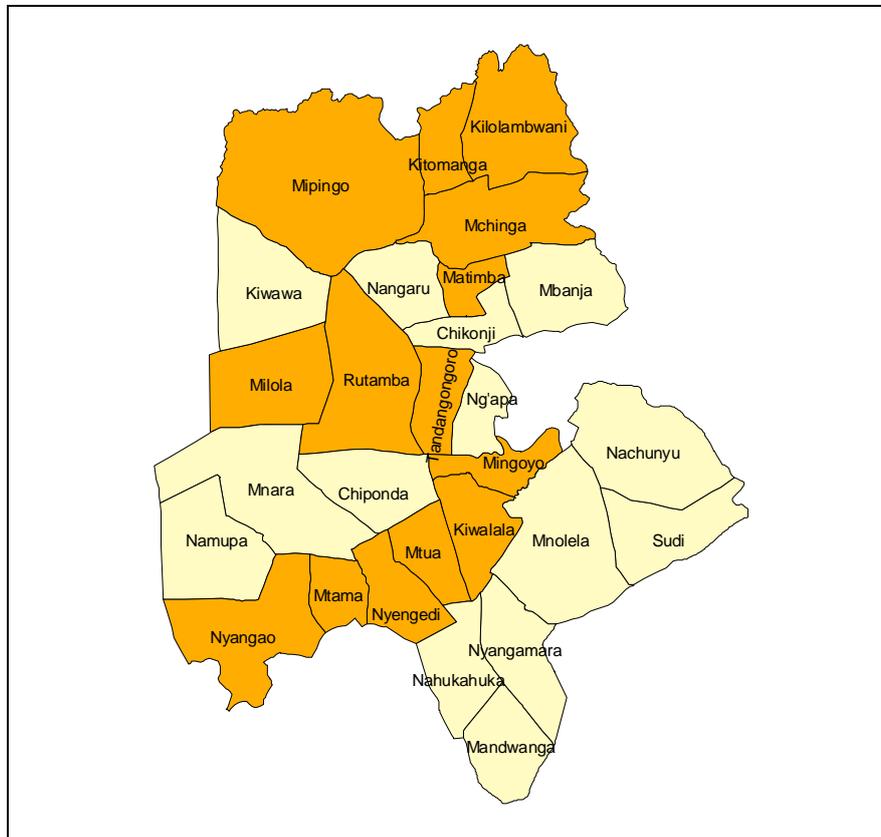


Figure 28. Main wards in Lindi Rural where irrigated agriculture would be appropriate.

Here, as elsewhere, as the irrigated area is expanded the communities should simultaneously be supported in developing catchment protection. Lake Rutamba already has some effective community-based catchment protection, as does Mtama Division. As populations and agriculture expand it is important that communities maintain as much tree cover as possible on slopes and higher altitude land, and Land Use Planning should be conducted at the catchment level, i.e. surrounding villages should coordinate their village level Land Use Plans, to ensure appropriate development options are pursued. This protection does not have to be in the form of natural forest; land with tree crops can be productively managed to fulfil the same hydrological function.

Much of the densely-settled Lukuledi River valley is already farmed and there is a small irrigation project at Nyengedi. We propose expanding irrigation along this valley to boost agricultural output. The situation here is different from the other river valleys in the District as market access is much better and there is a much greater level of awareness of development options. Foot and diesel pumps are currently very seldomly used in the District but should be promoted here to increase rainy season rice production and dry season horticulture production for wholesale marketing along the Masasi road (B5) and at Mnazi Mmoja. Elsewhere horticultural crops have limited area due to problems of market access (Lerise *et al.*, 2001). Increased availability of diesel pumps would also facilitate expansion of the area of sugar cane and plantain production.



Figure 29. Parts of Rutamba valley would be suitable for irrigation.

Already there is some mechanization of agriculture here. For example Narunyu Noviciated Sisters' Convent and Nyangao Benedictine Fathers have tractors and Mtama in the past used a tractor hired from Ndanda Mission. The wards of Mtama Division, notably Mtama itself, have CBOs and are well-organized, thus well-placed to manage a tractor if project funds were available for its purchase. On a smaller-scale, individuals could purchase power tillers, perhaps through targeted preferential loans or SACCOS-type schemes. Mechanized ploughing is no cheaper than the current cost of paying labourers to till large areas (1 acre costs TZS 20,000/- for both *kibarua* and tractor) but the deeper tilling enables crops to root deeper and thus higher yields to be obtained. The District Agricultural Development Scheme (DADEPS) is currently compiling a report that will include a section on mechanization. Care should be taken to include poorer villages, e.g. Chiwerere, in such programmes.

The Mbwemkuru valley also has potential for irrigation. When developing this valley advice should be sought to ensure that conflict with large mammals in Dimba FR and Lake Mkoie is minimized. This area is relatively poor and has low exposure to technology so needs external funding and technical advice to develop agriculture. Sukuma settlers at Mjimwema sub-village are pioneering "oxenization" (i.e. introduction of ox-pulled ploughs) in the District and have great potential to assist the surrounding villages. Already District officials have organised exchange visits to discuss the technology with Likong'o villagers, as this community is to receive pastoralists. The Sukumas' expertise should be utilized, rather than side-lined, by the Government's oxenization programme under DADEPS, which will be focused on Mchinga and Nangaru Wards.

Intensive agriculture

Sound development of rain-fed agriculture is key to ensuring rural prosperity in this district. With the exception of Rutamba Ward, the preferred staple food is maize. So despite the district only being climatically borderline suitable for widespread maize production, Land Use Planning needs to recognize that subsistence-level maize farming will dominate farmers'

plans for the foreseeable future. Maize tends to be grown on any patch of land where it might produce a yield if the rains are good. Unfortunately the rains cannot be relied upon to be good, and recent years have seen some of the wettest and driest years on record. Furthermore, increasing population pressure means lower water tables, less forested land and farmers are being forced to shorten rotation periods and return to recently farmed, depauperised land. Thus maize production is risky outside of the fertile black cotton soil of valleys and, although this would be unpopular with farmers, maize-based cropping should be discouraged elsewhere.

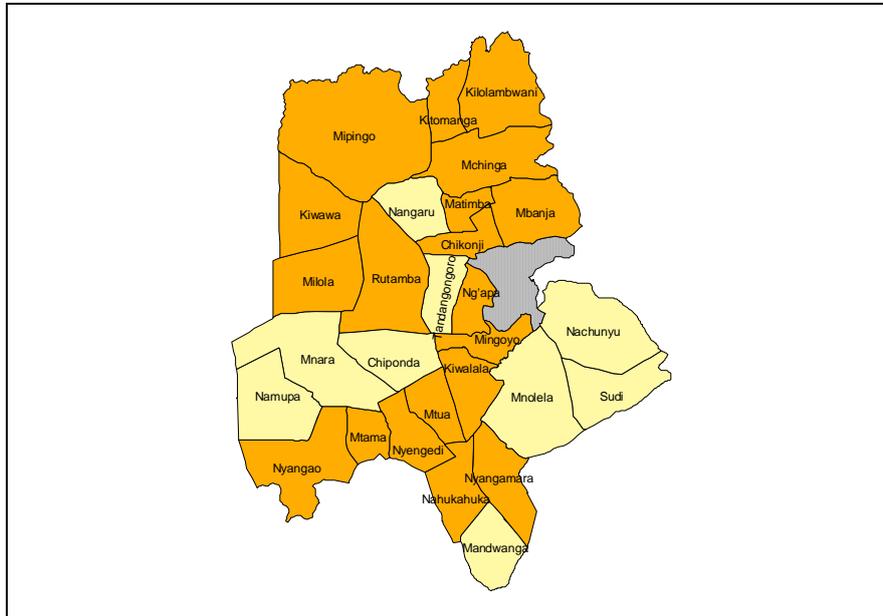


Figure 30. Main wards in Lindi Rural where intensive agriculture would be appropriate.

We anticipate that only a small fraction of the area suitable for irrigation will be irrigated. The remainder is suitable for intensive maize, sesame and plantain production as are the upper valleys and tributary valleys of the larger rivers, and the smaller valleys of more seasonal rivers e.g. the valley between Nahukahuka and Mandwanga. Only in the less densely settled north of the District will this result in deforestation; elsewhere the riverine *Acacia* woodland has already been almost entirely cleared.

Power tillers and ox ploughing should be promoted in these valleys to help farm a larger area and thus raise yields. The use of power tillers is at present restricted to the villages around Lindi Town, and the tillers are presumably owned by urban residents. However in several villages farmers obtain sufficient income from cash crops for private ownership of power tillers to be feasible. Poorer villages such as Matapwa would require external funding for purchase of power tillers but with mechanization or oxenization they will be able to greatly increase their standard of living, which at present is very low.

Moderately intensive agriculture: mixed cropping

Around two-thirds of the District has less fertile soil (we estimate some 4,046km²) that cannot sustainably support intensive agriculture. To safeguard future yields it is important that these areas are zoned as such during village level Land Use Planning. When miombo is cleared it will support a good crop of maize in the first year. Sloping land though is particularly vulnerable to erosion so if land is in short supply it should be protected by planting an understorey of groundcover e.g. pumpkin or legume crops. Ideally arable crops should not be grown on un-terraced sloping land. The current practice is to crop the land until the soil is exhausted, then shift to clear another plot. The rotation time depends on the population density, area farmed each year and soil fertility. The ferralic cambisols that cover much of the District are of low fertility with a very low cation exchange capacity (Mlingano 2006).

Shifting cultivation has served most of the District well in the past, but with population growth more attention needs to be paid to crop rotation.

Where soil fertility and water supply allow it, citrus and mango can be profitable. However cashews are a more obvious component of sustainable cropping systems in the less fertile parts of the District, and offer security in case of failure of the rains. Although they will thrive on sandy soil e.g. Nachunyuu, and the plateaux, they will not do well on the very shallow soils of some coastal areas e.g. parts of Mbanja. We recommend intercropping, planting cashew and/or mango trees with first maize then cassava and pigeon pea such that when staple crop production is no longer possible, the tree crops have established and weeding demands are low.

The closed cashew processing factory at Mtama is now owned by Lindi Farmers Ltd. (a district council partnership) and is scheduled to reopen. As the Government of Tanzania has put various incentives in place (World Bank, 2004) to promote the cashew industry the time is right for farmers once again to invest in cashew farming, for example by bringing abandoned plantations back to production. Good husbandry, including slashing and use of fungicide, is necessary to achieve good yields. It is notable that some of the poorest areas of the District with lowest cashew yields e.g. Kilolambwani, also have the worst crop husbandry.



Figure 31. Pigeon pea, maize and cassava intercropped.



Figure 32. Ward suitability for cashew plantations.



Figure 33. Ward suitability for fruit tree inter-cropping.

Land Suitability: Livestock

At present the Narunyu Noviciated Sisters' Convent has by far the most advanced animal production in the District, with 700 beef cattle being reared extensively on improved feedstock with modern veterinary care. They also have the only commercial-scale biogas electricity generation plant in the country, which uses cattle slurry, and they have ox carts and 2070 layers in an intensive poultry unit. However it is not appropriate to aspire to extending this level of technology throughout the District; the nuns had substantial capital to invest and have the high level of technical knowledge needed to maintain their farms.

A more appropriate model is found in the far north-east of the District. Three years ago 14 households of Sukuma agro-pastoralists settled in the Mbwemkuru Valley and legalized their tenure. Today they have 1,950 cows and many goats, sheep and some donkeys. The group introduced ox ploughing to the District and won local renown as 'serious farmers', growing maize, sorghum, groundnuts and sesame in the fertile valley soil (eutri-pellic vertisol). They have a very good relationship with the adjacent sub-village of Mjimwema, to whom they sell meat and milk and hire out their ploughing skills when the village can afford it. The potential benefits of 'oxenization' are very clear here; the Sukuma produce a food surplus, whereas the adjacent community does not. However, much of the difference could be attributable to the 'can do' entrepreneurial attitude of the Sukuma, who chose to travel across the country in search of new opportunities. It can be hoped that the arrival of Sukuma elsewhere in the District has a similarly positive effect.⁸

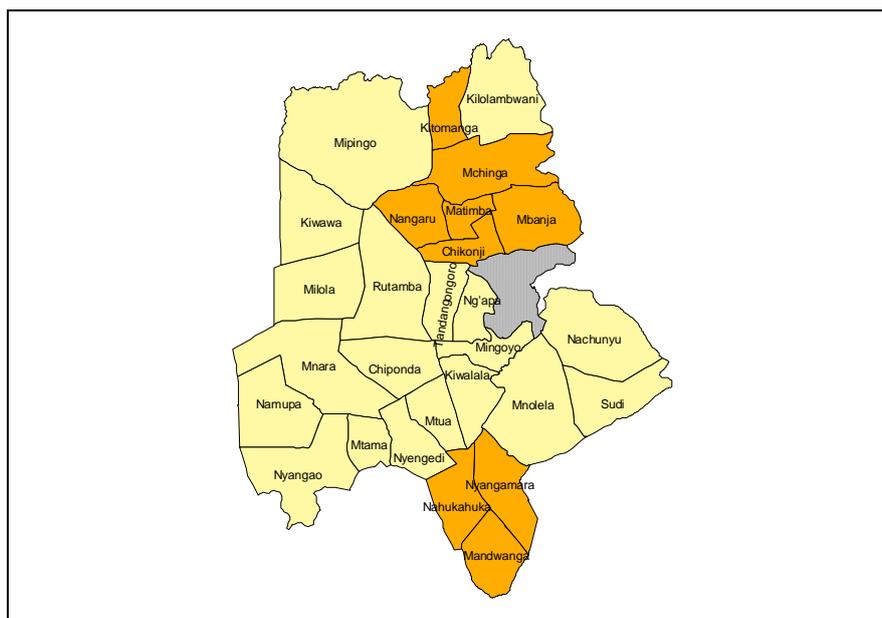


Figure 34. Main wards in Lindi Rural which would benefit from 'oxenization'.

Milk and meat are not sold in most villages and beef, in the few communities where it is sold, is TZS 2,800/- per kg (compared with 2-4,000/- for a chicken). In comparison the Sukuma at Mjimwema sell meat at 2,000/- per kg and milk at 350-400/- per litre. The milk in particular is very affordable as an occasional luxury even in poorer communities. Thus communities with more cash are excited about the arrival of large herds of cattle. However, they can foresee problems ahead. Firstly, there is the potential for trespassing and inadvertent crop damage from roaming cattle. Sufficient arable and grazing land and good relations between the pastoralists and farmers will minimize difficulties here; thus it is essential that the grazing areas are able to support the stocking density allocated, throughout the year. Having clearly

⁸ Contrarily Mang'ati pastoralists recently illegally settled at Mkwaya, in the centre of the District, and have a poor relationship with the established community.

designated areas with boundary markers, byelaws and joint meetings to discuss problems will help smooth the initial months.

Broadly-speaking, our findings support the choice of villages for designated grazing areas. We carried out fieldwork at the height of the rainy season, which meant that most of the villages selected for this programme were not accessible by vehicle, and many are indeed very remote and sparsely populated. Pastoralists require adequate grazing and water for their cattle throughout the year. This necessitates some variation in habitat. Under this scheme pastoralists are to be allocated to villages, and each household is to be allocated a fixed area. We understand that the people coming are mostly Sukuma, many of whom also farm. A water source for the cattle is to be provided, as is a dispensary and school, to each village receiving them. The community will also be surveyed and farmers will receive Customary Right of Occupancy.

In order to minimize conflicts the communities have mostly chosen sites for the designated grazing areas that are distant from their settlement, on the periphery of their village land. This strategy might however bring the pastoralists into conflict with the adjacent communities. If the pastoralists are of the same tribe they are likely to collaborate and having contiguous designated grazing areas in adjacent villages, as will be the situation at Likong'o and Likwaya, will help ensure good grazing throughout the year. In these villages, where some river valleys will be allocated for grazing, separating pastoralists from intensive farming will make easier the peaceful co-existence of the communities.

Communities are aware that much of the designated areas are forested, mostly in the form of open miombo woodland. They recognize that they are likely to lose forest cover following the arrival of the pastoralists, and that forest resources on the land will not be available to them. It seems that the host villages have carefully thought through the consequences of this programme, and despite their initial reservations, agreed to take the newcomers. For the programme to be successfully implemented it is essential that the promised infrastructure, e.g. charcoal dams and troughs, be put in place as soon as possible. Sukuma already arrived in the District have reported back to their fellows that the infrastructure is not in place to support them, and thus many are unwilling to make the trek to Lindi Rural knowing that they will face a water shortage in the approaching dry season.

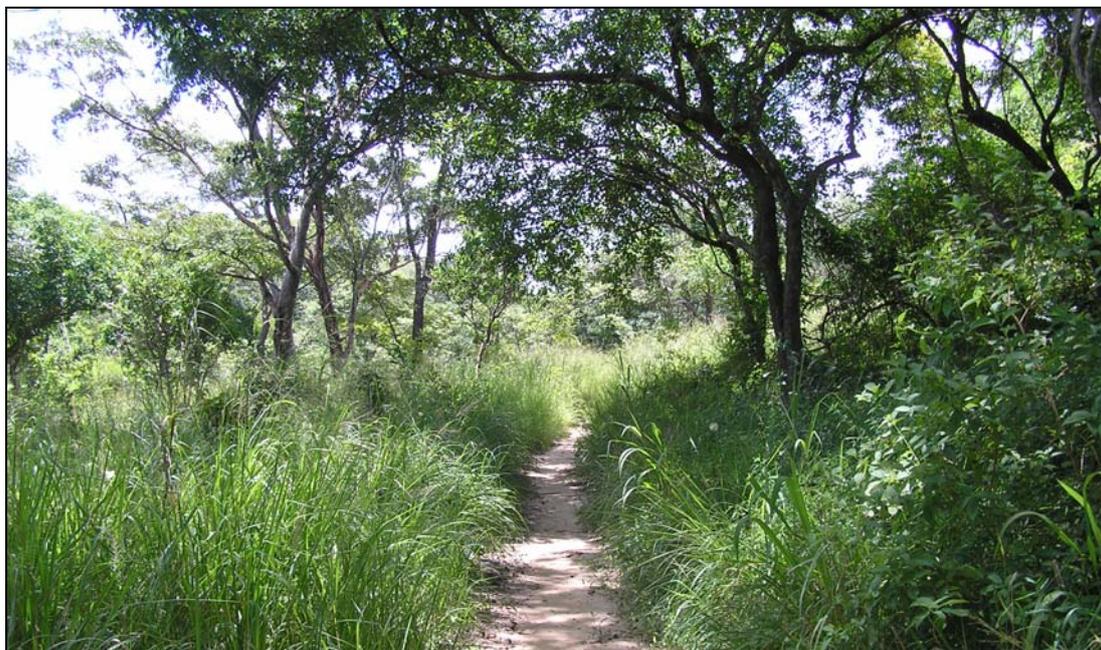


Figure 35. Designated grazing area at Mandwanga.

One of the villages that will receive pastoralists is Mandwanga. They are unusual in locating the boundary of the designated grazing area only a kilometre from their settlement; most

villages seem to keep a distance of 5km between themselves and the pastoralists. We were not able to visit other communities on the Makonde Plateau, due to transportation difficulties. However we are concerned about the likelihood of pastoralists inadvertently lowering the water table through clearing the existing miombo woodland to increase grass cover. Seven of the eleven villages in the District that presently experience severe water shortages are on the Makonde Plateau. Thus we believe that only a small area should be allocated for pastoralists on the Makonde Plateau.

Nangaru Division is also set to benefit from the programme. Take the villages of Muungano and Likwaya as examples. These are quite different settlements. Muungano is very remote, yet has fertile soil and is prosperous from sales of rice and other cash crops. Likwaya has better road access, less fertile soil and is poorer. Residents here are therefore anxious to have an active development project as they feel constrained by their current options. They will also benefit from having a primary school and dispensary to be built under this programme. Both villages have a relatively high population density yet plenty of farmland. If ox carts were introduced this division would greatly benefit. We saw for ourselves the extreme difficulties villages face getting their agricultural produce to market due to very poor transport options.



Figure 36. Landscape view of Ng'apa and Nangaru Divisions - typical rolling hills in the central valleys.

One area in which we have not recommended for introducing grazing is Milola Ward. We did not manage to cross the Milola River, so our thoughts on this area are tentative. One concern we have is that if a large area along the main river channel was allocated for grazing, and tree cover was reduced as a result of high stocking density (the division is heavily forested according to RIPS 2004), then many villages downstream would suffer.

Ward	Area (ha)	Stocking Capacity
Kilolambwani	2,485	1,243
Mandwanga	1,692	846
Nangaru - Matimba - Mbanja	20,444	10,222
Mipingo East	3,901	1,950
Mipingo West - Kiwawa	11,643	5,822

Table 3. Recommended grazing areas and stocking capacities at 0.5 head / ha.

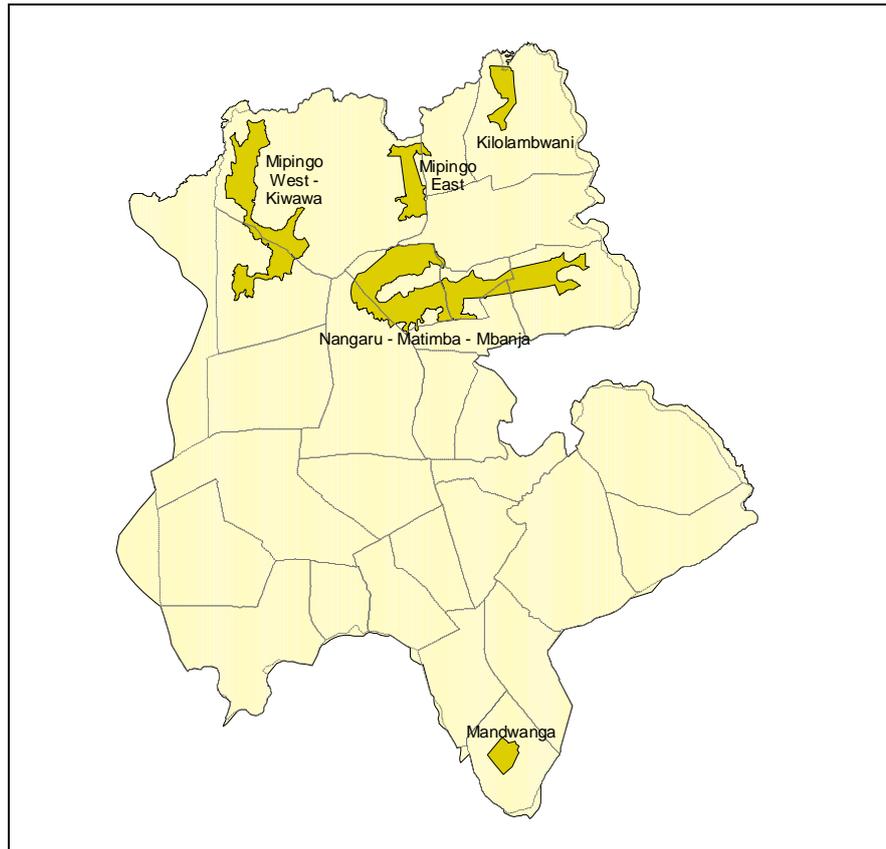


Figure 37. Location of recommended grazing areas, with ward boundaries for reference.

Intensive dairy goat production is already practiced in some villages, such as Ruaha, with the support of Heifer International, an international NGO. Heifer International also aided the creation of tilapia ponds in villages such as Makonde and Ruaha. These have mostly proved very successful and farmers have subsequently increased their number. These technologies will become increasingly suitable for the District, as land pressure grows and more people are able to purchase milk and fish. Suitable wards include those along the intensively settled Lukuledi River, Ng'apa and Tandangongoro.



Figure 38. Fish pond at Ruaha.

Land Suitability: Forestry

There are no plans for the reserves currently managed by the central government to change hands. With decentralization and the PFM there is less active management of these reserves than there once was. Rondo FR has by far the most activity due to its ongoing logging activities. It has a permanent staff of ten and contractors and labourers come in to work on extraction. The plantation has clearly helped to raise local living standards; many homes have a *mabati* roof, concrete water tank, goat shed made from timber off-cuts and have an attractive garden. Initial establishment of the plantations was highly destructive, but this work was undertaken by then foreign owners before the significance of the habitat was recognized. Now there are no plans to expand the area planted with exotics. The reserve's soil acidity is thought to be the reason why of the many plantation timber species raised, only three have been successfully grown: *Pinus caribea*, *Tectona grandis* and *Milicia excelsa*. The pine is being harvested and replanted. However marketing the softwood remains a problem; it is currently exported to Zanzibar or used within Lindi Region (Assistant Plantation Manager, *pers. comm.*). Teak plantations, though, could be established elsewhere in the District by investors.



Figure 39. Rondo FR: maize cultivation after pine harvest.

PFM for Timber Production

Lindi Rural leads the country in having what is believed to be the first private FR under PFM. Issa Ally Lipitako, an ordinary local farmer, was inspired to create his own FR. He has 6.54ha of miombo for conservation, catchment protection and timber production. The plot contains *mpingo* of harvestable size, plus juvenile *mninga jangwa*, *Spirostachys* for building and *Maerua* for brooms. Additionally he has planted over 2000 *mkongo* seedlings to enrich the woodland. His success, and the support of the local Game Scout and CBO have encouraged others to do the same.

Elsewhere progress on PFM has been slow recently. Mihima and Nndawa have their proposed VLFR management plans with FBD and Mtumbya, Namupa and Mnamba are part-way through the PFM process. Additionally Makonde and Chiwerere villages are just beginning PFM. The VLFRs are all multi-purpose, and may be divided up into smaller Forest Management Units (FMUs), e.g. for biodiversity protection, catchment protection, timber production, and the extraction of non-timber forest products (NTFP) by villagers.

Makangara FR has fine miombo woodland with valuable hardwood timber including *Pterocarpus angolensis*, *Milicia excelsa* and *Azelia quanzensis*, plus species used locally for building poles and large mammals including bush pig, lion and buffalo. It is to be managed

under JFM by the 4 adjacent villages, once the management plan has been approved. The PFM process was delayed by a dispute over cashew trees within the FR boundary, a problem which will doubtless be repeated elsewhere. This illustrates how thorough surveying, with the involvement of all stakeholders, is essential for Land Use Planning in the District.



Figure 40. PFM areas in Lindi Rural: Makangara VLFR and Mzee Lipitako's private forest area.

The north-west of the District has a vast area that is suitable for timber production under village management. Much of this land is short, open miombo with hardwood including *mpingo* (*Dalbergia melanoxylon*). Mipingo and Mchinga Divisions (along with 3 others elsewhere in the District) are currently closed to logging, thus making logging illegal. This ban is proving effective and we saw no signs of illegal felling while conducting the fieldwork. The remoteness of these areas and the ease with which logs could be removed from the District and transported to Dar es Salaam have precluded effective management by the District or central authorities. However, under PFM the communities will be empowered and incentivized to stop illegal logging, and income from sustainable logging will be able to make a substantial contribution to their livelihoods.

Milola Division's forest has thus far been protected by its remoteness and poor road access. However as nationally timber is becoming increasingly scarce the forests there will come under increasing pressure. Tree cover here is higher than in Mipingo and sustainable forest management in this watershed area is essential if the intensive cropping in the Rutamba Valley is to be maintained.

Elsewhere in Sudi, Mnolela, Nyengedi and Nyangamara Wards there are smaller patches of miombo with a mixture of timber species including *Pterocarpus* spp., *Azelia quanzensis*, *Albizia* spp. (*mtanga*) and *Bombax rhodognaphalon* (*msufi pori*). Introducing PFM could really help these less affluent villages. These patches of forest are mostly on cambisols, which are less fertile and so if cleared would not be able to support high yields. Thus there is a low opportunity cost of keeping them as natural vegetation, and the benefits will be apparent in coming decades.

PFM for Protection

Catchment and biodiversity protection often go hand-in-hand as coastal forest is frequently found on hills. All the existing central government forest reserves fulfil catchment protection functions, as will Nyangamara LAFR, once the villages have been surveyed and the management plan approved.

A surprisingly high percentage of the Makonde Plateau within Lindi Rural District is forested with a mixture of widespread and more restricted species, and the vast fields of cassava found elsewhere on the plateau are seldom seen. We propose setting aside additional forested areas

on the Makonde Plateau to serve the twin purposes of biodiversity and catchment protection. We hope that this provision will prevent dropping of the water table and thus benefit food security.

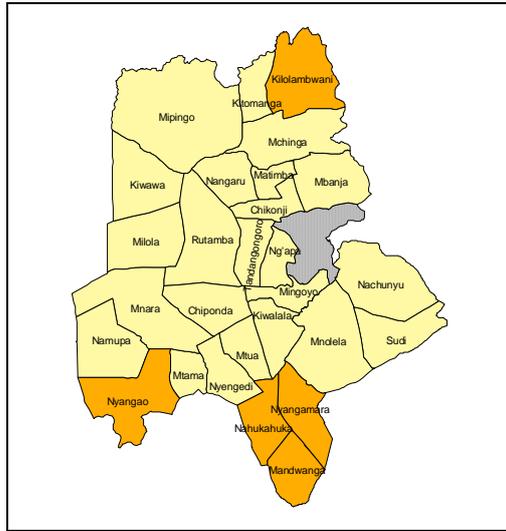


Figure 41. Main wards which need catchment protection.



Figure 42. Wards with high timber stocks for management under CBFM.

PFM for Rehabilitation

Simana is infamous for its lions. The village is quite poor, with substantial outward migration of young people. Simana receives few visitors, many of those who do come, come about the ‘lion problem’. Much of the surrounding land is abandoned sisal estate that has become mono-specific stands of *Lantana*. The village is also heavily involved in tree felling for charcoal production. Thus bush dominates the landscape and provides an ideal habitat for lions.

Reforestation here would make the habitat less suitable for lions. We suggest that the less fertile areas (village leaders report having plenty of fertile land) be set aside for tree planting using a mixture of native species including those that can be used for charcoal and favoured NTFP species.

Planning

The biggest problem facing the District at present is uncertainty about land ownership. Many former large estates have been abandoned or only a small fraction of their area is being productively used. Local farmers are encroaching on the estates to grow their crops. In some areas, such as along the Lukuledi River valley smallholder farmers are even planting tree crops on land over which they have no legal tenure. In order for the former owners to relinquish their rights they must be compensated. We urge this issue to be resolved, particularly in Mkwaya village, where it is causing substantial hardship.

Resolving the ownership of the estates is also likely to open up areas for investors. Conditions are right now for a rejuvenation of the economy with the improved road link to Dar es Salaam and the imminent arrival of a reliable electricity supply.⁹ Already several international investors are interested in developing commercial plantations of different species. So the land, which previously had very little value, is becoming an important resource. It is important that the different development plans are coordinated within the District Land Office to ensure that plans that are individually sound e.g. plantations and pastoralism, work together and do not compromise the livelihood options of the existing villagers. It is important that a cross section of villages are involved in planning decisions, as poverty alleviation goes hand-in-hand with sound, sustainable land management.

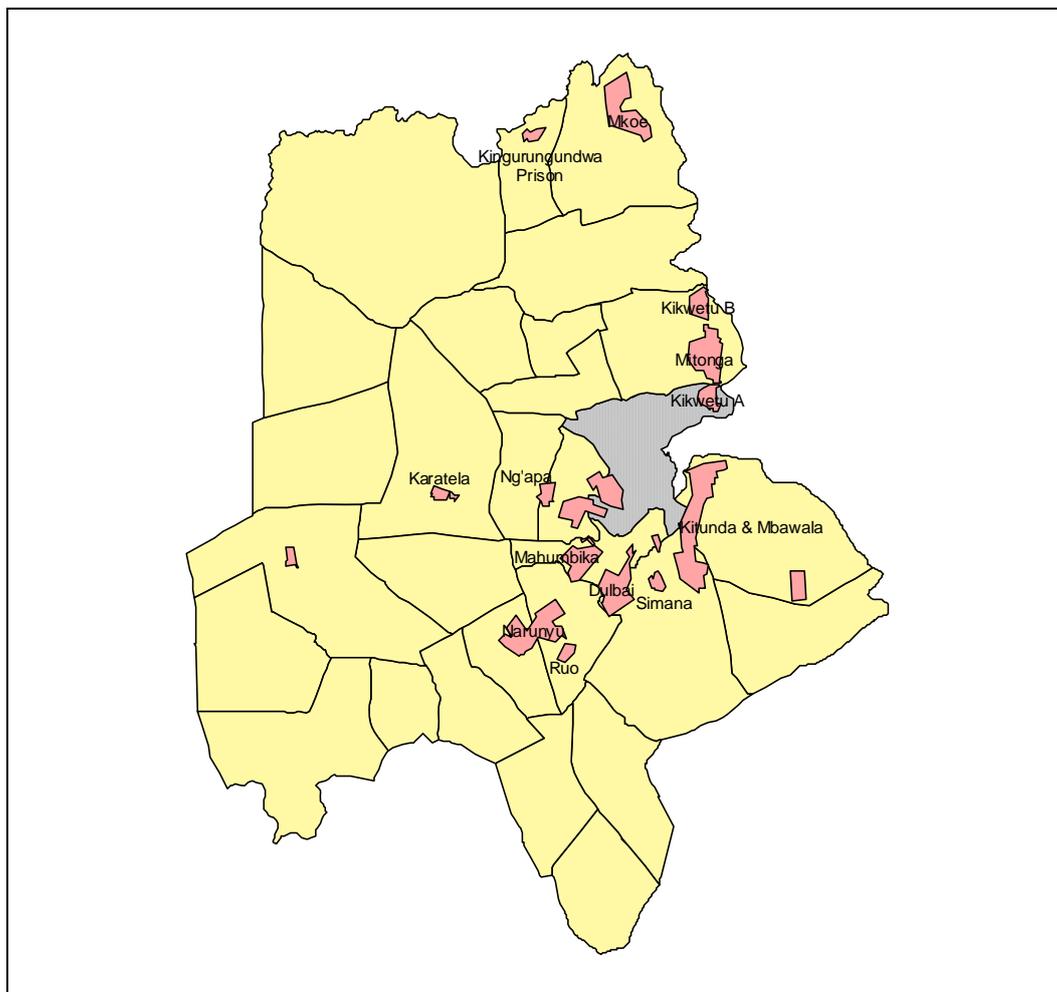


Figure 43. Some of the large estates in Lindi Rural District.

⁹ Mnazi Bay electricity reached Mingoyo while we were conducting fieldwork. Parts of the District are still reliant on the old generator and infrastructure, and suffered from a notoriously bad electricity supply, with daily power cuts due to rationing in Lindi Town and a transformer blow-out at Mtama.

Notes on Maps Prepared

The following maps were prepared at 1:250,000 to accompany this report:

- Relief
- Geology
- Soils
- Hydrology
- Protected Areas and ecologically sensitive areas
- Population distribution and density (by ward)
- Infrastructure
- Land use / cover
- Land Suitability classification

In using and interpreting these maps it is important to bear in mind some significant limitations. In particular scale is a major factor; these maps are appropriate to the district as a whole. Highly localised factors are often not represented, hence at larger scales, such as ward or village, there may be many apparent 'errors'. More finely detailed variations will be appropriate when conducting Participatory Land Use Planning in villages, and these variations will likely contradict the 'broad brush' recommendations of land suitability made in this report and on the accompanying maps.

Even when using for district level planning some care must be taken as to the accuracy of source data. Suspiciously straight lines are unlikely to be straight in real life. Often this will be because the source data maps were prepared for use at national level. A good example of this is the Land Cover/Use maps from TanRIC; the interpretation of the satellite imagery was based on ground truthing exercises carried out at a national level, and in Lindi Region, at least, only traversed the main roads. The MCP has found numerous examples of local inaccuracy in this data, but the same problems are also to be found in the Africover alternative. The only data set which can be utilised without any such concerns is the DEM from CGIAR-CSI as it does not require any ground-truthing to validate; this data is accurate to about 90m.

Finally it must be noted that we – the consultants – did not know Lindi District very well before starting the work, and had only limited time in which to complete it. The survey team did not visit every single ward or village, and some areas were entirely unreachable in the rainy season during which the work was carried out. We were thus highly dependent on local knowledge and expertise, but this could rarely be precisely geo-located. Many recommendations are therefore based on best guesses and extrapolating from proxy indicators, whose own accuracy, as discussed above, is variable.

The maps should therefore be interpreted as indicative only, for guidance in district-wide planning, and all decisions made on such a basis should be refined based on field visits.

Land Cover Map

In preparing a map of land cover of the district we were mindful of the fact that high quality 1:250,000 land use / cover maps based on the TanRIC data and analysis are at present readily available at a reasonable price from TanRIC. The only other comprehensive land cover data available were from FAO Africover, but reconciling these data with the TanRIC data is not always easy, and requires a high level of familiarity with the district which we lacked. However the FAO Africover data is currently only available in electronic form, and is not well purposed for use by the average lay person who does not have a high level of technical understanding as the various integrated classification systems used by Africover are complex and depend on databases of key codes. We therefore decided that there was some significant value in re-analysing the raw Africover data to produce a basic land use / cover map of the

district for use in future planning. A smaller version of this map is re-produced in Figure 44. Note that it suffers from the all the same problems listed above, most notably in that it depends on the Africover data which was ground-truthed at the national level, and is based on satellite images captured in 1995-6, so is now over ten years out of date.

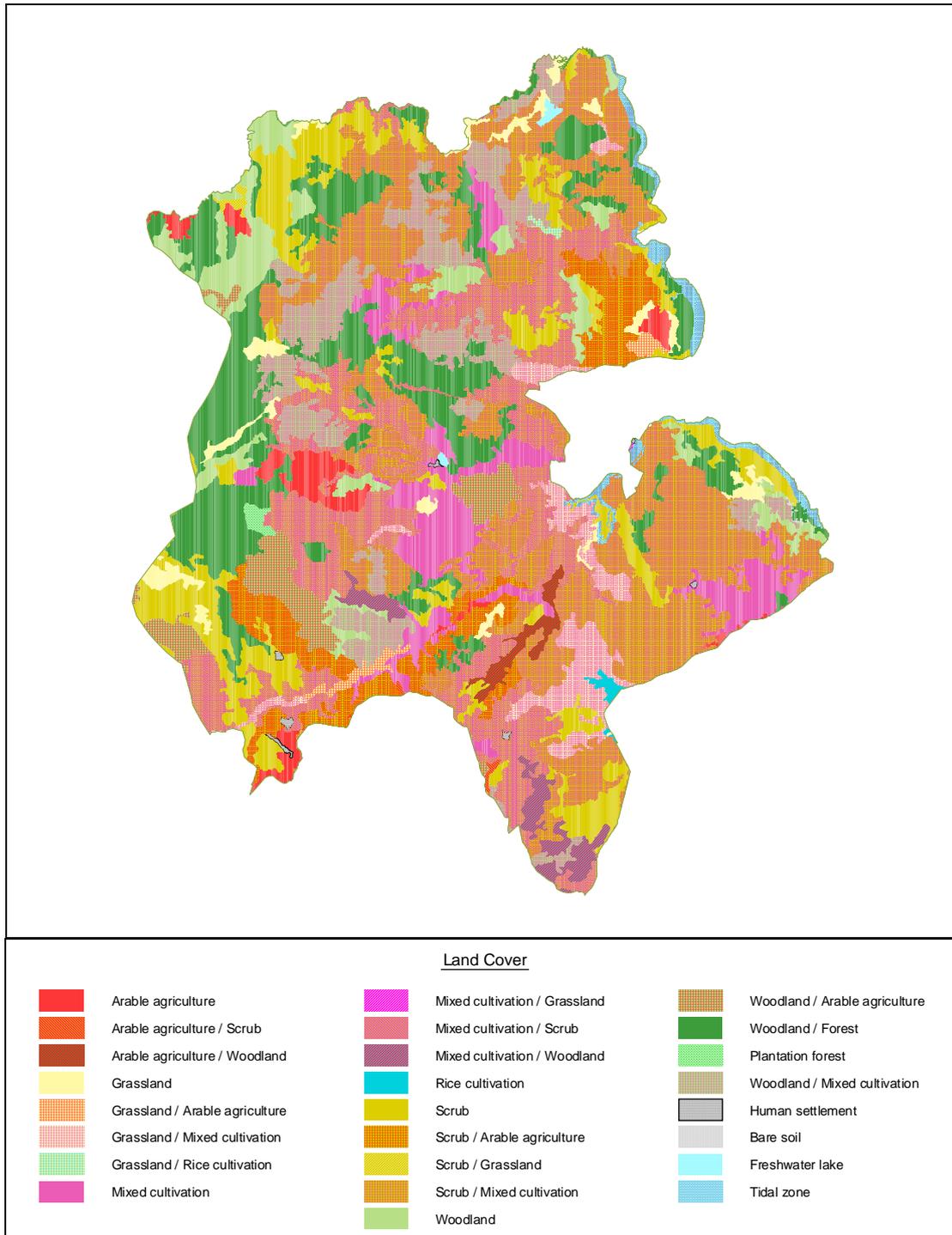


Figure 44. Land Use / Cover of Lindi Rural District in 1995-6.
(Source: MCP analysis of FAO Africover data.)

Land Suitability Map

For the sake of completeness a much reduced-size view of the land suitability map of the district is given below. Those wishing to make serious use of the recommendations are advised to refer to the full-size A1 version.

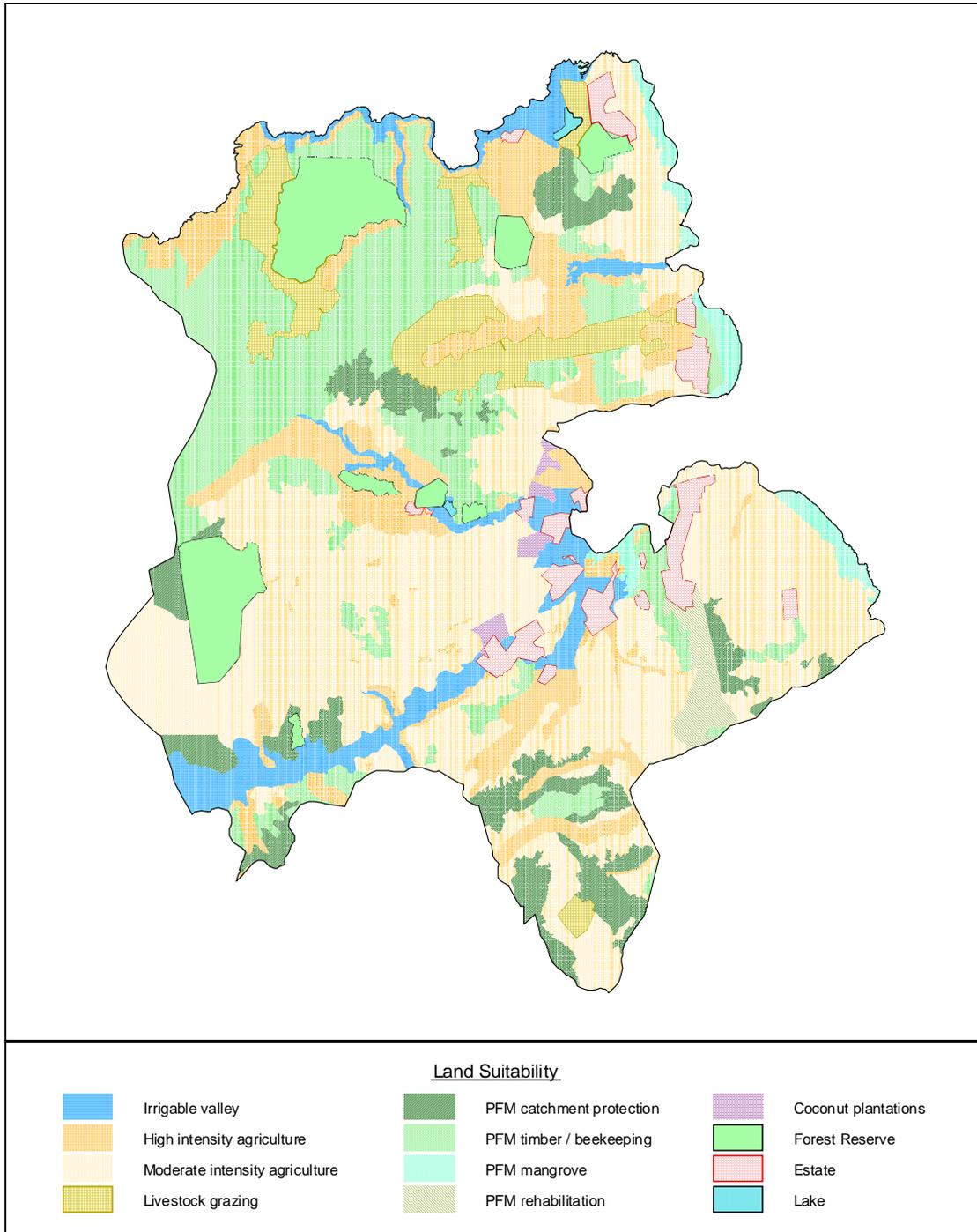


Figure 45. Map of land suitability recommendations for Lindi Rural District made in this report.

Appendix 1 : Terms of Reference

Objectives of the Consultancy

The objective is to provide the district with biophysical natural resources base line data (resource inventory) for district wide land use planning.

Specific Objectives

1. Production of a land capability map at a scale of 1: 100,000 – 250,000.
2. To assess and make recommendations on land capability and development and institutional framework for land use planning at district level.

Methodology

The task will be carried out in close collaboration with the client and the respective District Council. The consultancy will be done in two stages: an inception phase and the main stage.

During the inception stage, the consultant will:

3. Carry out a preliminary assessment of available data by doing desk reviews on existing empirical and situational literature to determine the type and amount of data to be collected.
4. Carry out preliminary field visits to key stakeholders, villages projects, and programmes relevant to the assignment; again to determine the type, amount and use of data to be collected.
5. Produce an inception report.

The purpose of the inception report will be threefold:

1. To test the understanding of the terms of reference by the consultant.
2. To state clearly how the consultancy will be carried out, in terms of both the methodology timelines, assignments of responsibilities to the key staff as well as the anticipated limitations/ constraints.
3. To state the progress which will have been made and problems/challenges if any.

During the main stage the main stage the consultant will:

1. Use appropriate approaches for the study, including baseline surveys, stakeholders participation, data collection, analysis and interpretation of key findings.
2. Produce the Draft Final capability maps and report and present to the stakeholders meetings.
3. Incorporation of comments to produce and submit a Final Report.

The consultant will collaborate closely with the NLUPC, District Council and the District Land use Planning Teams.

Work Plan

The consultant shall prepare appropriate time lines/framework outlining detailed schedule of activities.

Outputs and Deliverables

The outputs shall be:

1. Inception report

2. Draft final report
3. Final report

The draft final and final reports shall be well defined in terms of objectives, outputs, impacts (outcomes), and recommendations and shall be accompanied with the list of maps attached as appendix to the TOR

The final reports will be submitted in both hard and soft copies

Duration of the Assignment

The whole exercise shall be executed within a period of 5 months

Qualification of the Consultant

The consultant should have a minimum of master degree in land use planning / soil survey and mapping. Expertise in remote sensing and GIS application in land use planning is mandatory. The consultant should have minimum 10 years working experience in Rural land use Planning and related activities in Tanzania.

Responsibilities of the Client

The National Land Use Planning Commission will be responsible for:

- Providing and empowering a liaison officer who will be responsible for guidance, ensuring timely delivery of information and other logistics.
- The liaison officer shall work closely with the consultants, as well as with the respective District Council and The NLUPC for professional input.
- Facilitate introduction letters to the stakeholders

Maps to be Prepared by the Consultant

Physiographic

- Relief and Drainage
- Geology & Soils
- Hydrology (including catchment areas)
- Land use / cover
- Land Suitability classification for rain fed agriculture, irrigated agriculture, livestock keeping, forestry and wildlife.
- Recommended land use zoning scheme

Environmental

- Biodiversity and ecologically Sensitive areas
- Protected Areas (national parks, forest reserves, game reserves, world heritage sites, Historical sites etc)

Socio-Economic

- Population distribution, density
- Social services distribution
- Water supply
- Road network, railways, harbours and ports, airstrips and ports, pipelines etc
- Agriculture, livestock keeping areas and other economic activities
- Public land categories Village land, General Land, Reserved lands.

Appendix 2 : Logistics

Work Plan

DATE	TASK
Jan 2007	Scoping visits (1 week) & Data gathering (2 weeks)
31 Jan 2007	Inception report submitted
02 Feb 2007	Feedback from client provided to consultant
Feb 2007	Main surveys in Nachingwea District (3 weeks)
Late Feb 2007	Preliminary analysis of surveys from Nachingwea District (1 week)
Mar 2007	Main surveys in Lindi Rural District (3 weeks)
Late Mar 2007	Preliminary analysis of surveys from Lindi Rural District (1 week)
27 Apr 2007	Draft final reports submitted
May 2007	Stakeholder feedback (1 week)
11 May 2007	Feedback from client to consultant on draft final reports
31 May 2007	Final reports completed & submitted

Table 4. Work Plan for combined contract covering both Lindi Rural and Nachingwea Districts.

Survey Team Itinerary

Courtesy calls were made on the DED and DC at the beginning of the fieldwork. Then the District Natural Resource Officer and District Forest Officers' advice and data were sought. During the course of the work data was collected from the Agriculture and Water Offices.

Week 1: 5th – 9th March

Ward	Locations visited
Mbanja	Airport, Kikwetu estate, Kela sub-village and beach only
Mipingo	Matapwa village and FR Mipingo village
Mtama	Makonde village and SACCOS office Nang'aka private forested area, Chemchem Kubwa and catchment protection, Kwanjosi Chemchem
Nahukahuka	Nahukahuka village and Makonde escarpment
Ng'apa	Mbuyuni
Nyangao	Nyangao village Chiwerere village
Nyangamara	Nyangamara village and designated LAFR
Nyengedi	Mtumbya village
Rutamba	Kinyope village, farms, Makangara FR and irrigation scheme Rutamba ya Zamani village and Chitichiti chemchem Rutamba ya Sasa and lake

Week 2: 12th – 16th March

Ward	Locations visited
Mbanja	Likong'o village
Mchinga	Mchinga 1 village
Kitomanga	Mjimwema sub-village and farms
Mingoyo	Mkwaya village, estate and illegal grazing Ruaha village and fish ponds
Mnara	Rondo FR
Mnolela	Simana village and estate
Nachunyu	Nachunyu village
Sudi	Sudi village, beach and historic sites

Week 3: 19th – 23rd March

Ward	Locations visited
Kilolambwani	Dimba village
Kiwalala	Narunyu Sister's Convent and biogas electricity unit
Mandwanga	Mandwanga village and designated grazing area
Matimba	Likwaya village
Mchinga	Mchinga 2 beach
Mingoyo	Mingoyo village and jetty
Nangaru	Nangaru village

Key District Stakeholders Consulted

Name	Position
Hassan, Minduva M	DEO / Ag DED
Ngaweje, Selemani S	DNRO
Mwaipopo, Charles D	Forestry
Chenga, JL	DCDO
Kalalula, JM	DIA
Mwakabesa, Alphonse N	DPLO
Ndijuye, Joseph M	DHO / Ag DMO
Mannento, Elly J	Ag DT
Mahela, MJ	Ag DE
Matunda, BSF	DALDO
Mdanda, TI	Agric. & Livestock
Mahimbo, S	DFO
Segesela, GS	DLO
Mbwago, Salma	CC
Nnunduma, Abdallah A	PLO
Mkama, CJ	DWE
Mtira	Ag DHRO

Table 5. Key District stakeholders consulted for comments on draft report and land suitability map.

Appendix 3 : Interview Questions

Key informants in each community visited were interviewed in a semi-structured manner. Discussions were flexible and arising points of interest, such as economic activities and development projects, were discussed in some detail. Time constraints meant that priority areas for that community were focused on, and not all questions were asked to any one person or group. The list below was used as a guide when conducting the semi-structured interviews.

Where time allowed our key village contact (Village Chairman or Village Executive Officer) was asked to assemble a small group of knowledgeable long-term residents, including the Chairman of the Village Natural Resources Committee and the Ward Executive Officer, where possible. If few villagers were available, for example because of agricultural activities, then we spoke solely to our key contact. In order to encourage villagers to speak freely about sensitive issues, such as their income and problems, we specifically told them that their comments would not be attributable to them, and therefore did not take names, except when offered.

Village development

- What infrastructure and facilities do you have? (school, dispensary, borehole, electricity)
- Have you done any PRA exercises?
- Have you done any land use planning activities?
- Do you have a participatory map of the village?
- Do young people like to stay in this community, or do they prefer to go to the towns?
- What do dynamic, wealthier community members do to earn income?
- Which village committees, CBOs and projects are active?
- What development projects have you had in the past? How successful were they?
- How would you like the village to develop in the future?

Agriculture

- What are the main food crops?
- What are the main cash crops?
- Does the community produce a food surplus?
- Are there any commercial farmers or plantations here?
- What prices are obtained for produce sales?
- How important is cash cropping relative to production for home consumption?
- Does the village have a land shortage?
- Is there lots of fertile soil?
- Do any outsiders farm here?
- How long is the rotation period?
- What are the problems facing farmers?
- Is water supply a problem for farmers? (flooding, drought)
- What inputs are used in farming?
- Is there any mechanisation?
- Where do farmers sell their produce?
- What livestock are kept?

- How are the livestock raised?
- Does anyone rear livestock intensively?
- How would you like to develop agriculture here?

Natural resources

- Approximately how large is the village land?
- Which villages or estates do you have boundaries with?
- Are these boundaries well known and agreed?
- What resources are present? (forest, biodiversity, water, minerals, tourist sites)
- Which resources are being used?
- Where do you get your water from?
- How good is this supply? (seasonality, quantity, salinity, contamination, price)
- Do you have any protected areas? (FR, catchment protection, sacred sites)
- Is there any participatory management of natural resources?
- Do you have any byelaws or taboos to conserve the environment?
- Do you have timber trees? Which species? Do community members work in logging?
- Are there any forest-related enterprises here? (furniture-makers, sawmills, building supply merchants, charcoal sellers, NTFP sellers)
- Is there any charcoal production?
- How plentiful are building poles and bamboo?
- Does anyone keep bees?
- Which large mammal species are present?
- Do you have a problem with large animals?
- Are there any woodlots or plantations here?
- Do you have ponds or lakes with fish?
- Do you have any particularly interesting biodiversity or natural features?

Appendix 4 : Information Sheet for Communities

The following is the text of the information sheet which was given to each community visited.

MPANGO WA KUANDAA RAMANI YA UWEZO WA ARDHI WA WILAYA

UTANGULIZI

Ardhi ni rasilimali muhimu na nyeti kwa maisha ya binadamu. Ardhi inategemewa na watazania wengi waishio mijini na vijijini. Watazania wataweza kujikwama katika umasikini iwapo ardhi itatumiwa vizuri.

MADHUMUNI

Kutokana na sababu hizo, Serikali ya Tanzania kupitia Tume ya Matumizi Bora ya Ardhi imeamua kuweka mikakati ya kubaini uwezo wa ardhi kwa kuandaa Ramani zitakazoonyesha uwezo wa ardhi kwa matumizi mbalimbali. Asasi ya Mradi wa Kuhifadhi Mpingo au Mpingo Conservation Project (MCP) imepewa zabuni na Tume ya Taifa ya Matumizi Bora ya Ardhi kuandaa ramani za uwezo wa ardhi katika Wilaya ya Lindi vijijini na Nachingwea.

Shughuli hii inatekelezwa na wataalam wa Halmashauri za Wilaya wa idara mbalimbali wakiongozwa na mtalaam toka Mradi wa Kuhifadhi Mpingo.

Mpango wa utayarishaji wa ramani za uwezo wa ardhi katika Wilaya unalenga kutoa hali halisi ya eneo/sehemu husika ya ardhi kwa matumizi fulani yaliyotarajiwa. Pia mpango huu utatoa mfumo na taarifa kwa mpango wa mtumizi ya ardhi ngazi ya kijiji na Wilaya. (Ramani hizi za uwezo wa ardhi zitakuwa ni rasilimali nzuri katika uandaaji wa mipango ya matumizi bora ya ardhi) kama vile uandaaji wa mipango shirikishi ya matumizi bora ya ardhi.

Utasaia watoa maamuzi na watumiaji wa ardhi kutumia ardhi kwa mahitaji husika.

Ramani za uwezo wa ardhi zitasaidia kutambua maeneo yapi katika Wilaya yanafaa kwa matumizi yapi, kwa mfano hifadhi za misitu na wanyamapori, kilimo cha umwagiliaji, ufugaji, kilimo kinachotegemea mvua pamoja na matumizi mengine ya aina mbalimbali.

MIPANGO SHIRIKISHI YA MATUMIZI BORA YA ARDHI

Ni utaratibu wa kutathmini na kupendekeza namna mbalimbali za matumizi ya maliasili ya ardhi kwa kuwashirikisha wananchi kikamilifu katika kubuni, kupanga na kutekeleza mipango ya matumizi ya ardhi ili kuinua hali ya maisha kwa minajili ya kuondoa umasikini.

UMUHIMU WA MIPANGO SHIRIKISHI YA MATUMIZI YA ARDHI

Huweka utaratibu wa matumizi ya rasilimali za ardhi kwa:

- Kutatua migogoro
- Kuimarisha miliki za ardhi na matumizi
- Kugawa ardhi na kuboresha matumizi na hifadhi ya ardhi kulingana na mapendekezo na uwezo wa walengwa.

Mipango huzingatia na kuangalia matatizo ya pamoja ya wadau, fursa zao, udhaifu wao, nafasi zao na tishio ili kuweka mkakati utakaoleta mabadiliko.

Katika utaratibu huu mtalaam ni **MWEZESHAJI** na **MSHAURI** na siyo mtayarishaji wa mpango.

Mipango ya matumizi bora ya ardhi ni zana muhimu kwa usimamizi wa rasilimali hii kwa maendeleo endelevu na pasipo kuwa na ramani inayoonyesha uwezo halisi wa ardhi si rahisi kuwa na mipango madhubuti ya matumizi bora ya ardhi.

Appendix 5 : References

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