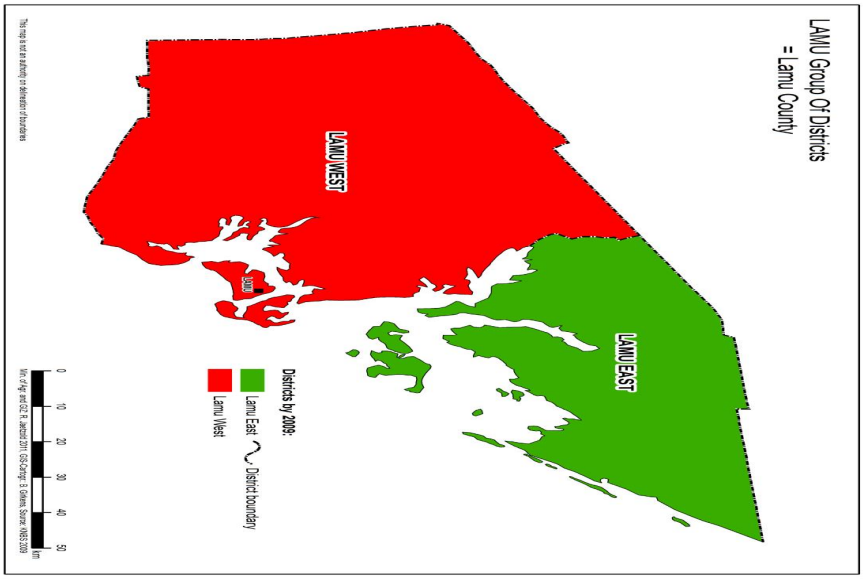
Inter-Governmental Authority on Development (IGAD)

The Biodiversity Management Programme (BMP)in the Horn of Africa

Tana-Kipini LagaBadana Bush Bushle Land and Seascapes Project



Forestry, Agroforestry & Rainwater Harvesting for Biodiversity Management

World Agroforestry Centre

Baseline Report prepared by Wilfred Muriithi

Executive Summary

The Biodiversity Management Programme (BMP) is an IGAD initiative with the financial support of the European Union (EU) aiming to contribute to poverty reduction by improving the social and economic wellbeing of the populations in IGAD region, through a better regional integration in the environmental sector. *Its purpose is the conservation and sustainable management of the ecosystems in the IGAD region in order to contribute to lasting ecosystem goods and services.* ICRAF is one of the BMP implementing partners and is managing one of the three projects financed through the *IGAD Biodiversity Management Programme in the Horn of Africa to develop collaborative management in three cross-boundaries land and seascapes between Kenya-Somalia, Djibouti-Ethiopia and Ethiopia-South Sudan.* The ICRAF project started at the end of 2013 and will last till November 2017. It is being implemented in the cross-border area of North Eastern Kenya and Southern Somalia in an area extending from the Tana River delta in Kenya to the Laga Badana Bush Bushle National Reserve in Somalia.

One of the BMP Interventions is **Activity 7; *Forestry, Agroforestry and Rainwater Harvesting Programme for Re-greening the Environment*** *The activity aims at developing a program in forest restoration within and agroforestry outside the protected area systems in the intervention sites.* The activity forestry and agroforestry is led by KFS through ICRAF support while the Rainwater harvesting-RWH will be led by ICRAF and facilitated by ICRAF staff based in Lamu.

To implement the project activity, KFS and ICRAF developed a strategic plan to explore ways and means of conservation and management of the ecosystems in the IGAD BMP project site in Lamu County in order to contribute to lasting ecosystem goods and services through Integrated Water Management (IWM) with the objectives of providing training and support on tree planting and management, Rainwater harvesting for trees/crops, livestock production and human consumption to 1000 community members.

The strategic plan is based on BMP's Vision to linking its activities to Sustainable Development Goals (SDGs); Goal 1 -*Eradicate extreme poverty and hunger*, Goal 3 -Promote gender equality and empower women, Goal 7-*nsure environmental sustainability* and Kenya's Vision 2030-

improving economic development and cohesive society with social equity in a clean service environment besides alignment to Kenya's 2009-2020 *ASDSP*

Baseline survey

The objective of the survey was to establish a macro analysis of the main water features and associated information gathering related to biodiversity management including issues related to crop/livestock development, irrigation approaches as well as micro analysis that would include spatial mapping of water resources and water systems. Data collection on access to water sources based on individual, group and project level approaches with their associated abstraction, conveyance and application technologies was planned as described below;

2. Activities planned

- Desktop Literature review
    - LCIDP document ,Farm management Handbook-Coast, Agricultural Technical handbook
    - Participatory, consultative meetings (community informants, stakeholders, WUAs etc

2.1 Desktop Literature review (LCIDP, Farm management Handbook, Agricultural technical handbooks etc)

Copies of Farm management Handbook Coast/Lamu Vol ii and hard copies of technical handbooks for coast region were available and the following information was gathered;-

- Natural Conditions and Farm Management Information
- Atlas of Agro - Ecological Zones, Soils and Fertilizing requirements
    - Rainfall figures from selected typical stations in Lamu County having recently at least 16 years of record of records
    - Climate in the agro-ecological zones
    - **C**limatic yield potentials of seasonal crops **1)** in *cl 3 m i vs/s* (calc. for station 9240003 witu

- Diagram of growing periods in the coconut-cassava zone cl 3 with a reliable medium to short first rainy season and a very uncertain second rainy season
- **F**ertilizer and manure recommendations for the

  agro-ecological units of the coconut-cassava sub-zones cl 3 m i vs, cl 3 m i (vs), cl 3 m i and the cashew nut-cassava sub-zones cl 4 m/s i vu, cl 4 m/s i, cl 4 s/m i (vs), cl 4 s/m i, cl 4 s i (vs), and cl 4 s i; soils z 2, pc j6

2.2 Participatory, consultative meetings (community informants, stakeholders, WUAs etc)

Consultative, participatory meetings were held with KFS staff, Lamu county planning unit. Ministry of Agriculture staff, Lamu west, Lamu Conservation Trust (Witu) and farmer groups Representatives.

Data on water resources, availability and reliability, Suitability for domestic and crop production, abstraction technologies and use was gathered through discussion and field visits in Lamu west and Amu Island. It came out clearly that 100% of water supply in Amu Island is from ground water accessed by excavating shallow wells. The County governments collect water into huge storage systems and treat it before distributing to the consumers. Landlords are forced to equip their buildings with shallow wells to supplement the supply. It is common to find community wells next to street/path junction points. Rope and bucket is used to abstract water mainly for domestic use.

85% of Mpeketoni community solely depends on ground water for domestic and irrigation while about 2 % depend on roof caught rainwater stored in plastic tanks. In many instances, it was found that the capacity of the tank did not meet the family water demand over the dry period. 3 out of the 4 farms visited had shallow wells fitted with submersible pumps, motorized 5.5hp petrol pumps or wind powered lift pump. A deep well fitted with a wind operated pump supplied water to Mpeketoni trading center. In the farms, ground water is used for irrigation, fish ponds and watering the animals (poultry, cattle and goats).Commercial farming is practiced.

In Witu accessing water for domestic uses is quite a challenge; Witu Water Association (WIWA), the main water supplier sinks boreholes and distributes water to water kiosks for community to access. The distance covered by majority of the consumers is prohibitive. The assessment team witnessed men, women and children covering a distance of 10 km, one way, to a water kiosk with Jerri cans of water either on bicycles, backs or on their shoulders. A determined farmer was found irrigating a 20m x 20 m tomato plot using a 20litre Jerri can of water and a bicycle. Either infrequent or under watering could be suspected through the existence of blossom end rot in the tomato plot. A group of farmers (Back to Eden Youth and Women cooperative) was visited and found to be doing their best growing horticultural crops on a rain-fed system. Frequent within season water deficits hampered the areas production potential resulting in low gross margins. A group of farmers facilitated to pump water from Moa Ox-bow Lake into a plastic storage tank (8m ^{3}) situated in a well fenced 50 m x 60 m plot could not sufficiently manage a 3 mx 10 m tree nursery while planted kales could not feed a family of 5 persons due to technology gap in water conveyance and application efficiency. Transects taken across Soroko/TCN area revealed that most inhabitants are relying on ground water for domestic and irrigation purposes. Irrigation was limited by the depth to the water as compared to the abstraction mechanisms. Survey showed that the water was suitable for both domestic and crop production.

2.3 Identification of hotspot areas for demonstrations (5 sites)

Participatory and consultative approaches was applied to identify hot spot areas for demonstrations. Purposive sampling was adopted based on nearness to the protected areas

≤5km. Decision on adoption of an area/site for demonstration was based on suitability of the intervention and group member's participation. This resulted to selection of four demonstration sites; 1),Witu which comprised of Soroko TCN, a farmer block, Witu secondary school and Lamu conservation centre situated in Witu center the second site was located in Tangeni which had been established by the back to Eden group. The third and fourth site were in kakate and Maisha Masha respectively. The demonstration areas confirmed for action area are shown in annex iii below

2.3.1 Reconnaissance/feasibility and baseline survey for micro analysis

A team consisting staff from Ministry of Agriculture, Forest, ICRAF and NRT-Coast joined farmer groups and after brief meetings took transect walks traversing group member's areas of jurisdiction. All members of the group present took part in the transect walks. This gave those present time to do a micro-analysis of water situation on visited sites. Group members were keen to score and prioritize projects. Tangeni's Back to Eden group for instance gave runoff pond system priority no 1.

2.3.2 Community/group mobilization meetings

Community/group mobilization meetings were held in Witu ward and were based on existing social and active groups present. Community at Soroko TCN and Tangeni's Back to Eden youth and Women group were met. Stakeholder versus group representative held a meeting at Witu centre(Agriculture office premises) . Witu Nyongoro bee keepers and Maish Masha New Kumekucha bee keepers were met separately on the same day.

2.3.3 Plan of operation

Program strategy (*Start Small, grow with Capacity*)	• *Development objectives*	*Immediate objectives*
Set 5 demonstration sites *Diversify technologies*	Improved biodiversity management and sustained productivity Improved living conditions	**Target group-** 1000 community members trained on integrated RWHM technique *all household members in the*

Work with existing groups *Link activities with the objectives of BMP*	Income generation and reduced poverty Environmental conservation	*programme area* initiate a process of RW management for production and sustained biodiversity conservation Increase awareness among the population of importance and impact of RWHM Improve access to water and introduce improved local water management

2.3.4 Action plan

General Activities	Detailed activities	Deliverable	Methodology	Assumptions
Assess current water situation in Witu and Awer communities	Desk top Literature review Facilitate 4 community mobilization tization meetings Facilitate stakeholder/group reps.meetings/workshops Organize participatory feasibility survey for hot spot areas and recommend intervention measures Develop training material On RWH Facilitate community	An assessment report on water status and hotspot farms in the intervention sites including recommendations on appropriate s/w conservation interventions Report on current RWH technologies and the need for WATER USE EFFICIENT TECHNOLOGIES Report-farmers trained in RWH technologies Report-RWH and S/W conservations designed, supported, adopted and impacts on livelihoods, including no of farms with interventions	Hold meetings with the community Hold meetings with stake holders Visit relevant offices Work with and through the farmer groups to implement the planned activities Organize farmer field day Organize a farmer exchange tour to a successful farmer Develop 5 demonstration sites and initiate and FFS approach	The population will maintain an interest in RWH The land tenure system will not affect the demonstration process Labour will be readily available whenever required Replication of introduced technologies will occur Financial flow and administrative procedures will operate smoothly

	training Support farmars for an exchange visit Facilitate Do a participatory demo site selectin Desgn and implement rainwater harvesting technologied	M&E report		The programme can benefit from relevant experiences from similar programmes in other areas or from programmes supportive to this programme.
Identify hotspot farms/sites and suggest appropriate interventions for S/W management Collect baseline on RWH technologies and identify alternative, sustainable, efficient RWH technologies for piloting on selected farms Support design and installation of identified RWH technologies in 5 demo sites (zai holes,				

trenches, contour beds, half moons, ponds, water pans, water tanks or roof catchment Support farmers field day within and without the focal area.				

2.3.5 Proposed demonstration sites

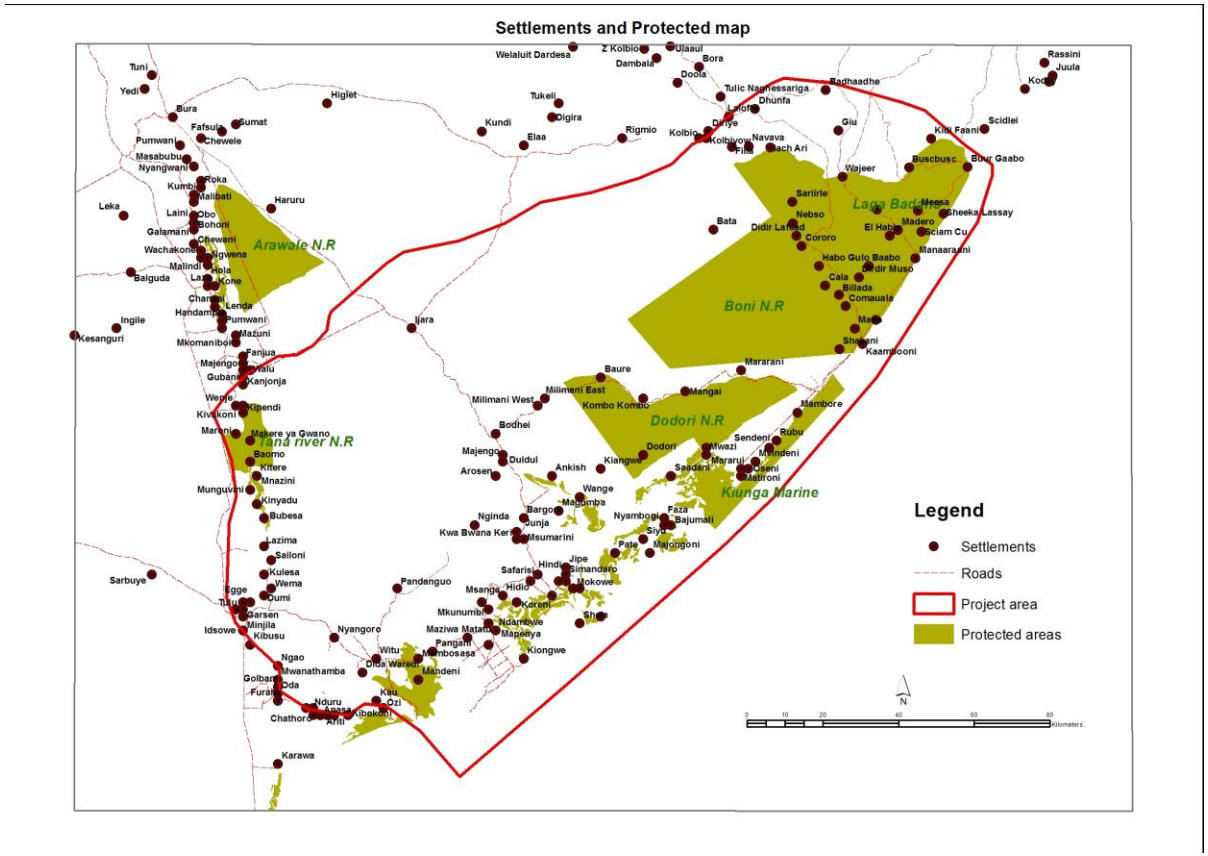
No	.	Project type	Activities(for discussion)	Remarks
1 a	Witu-Soroko/TCN Farm Witu Ward, Pandanguo Sublocation&Dide waride sublocation,Soroko&Hindiwa villages GPS- Lat. 2:24:4.59 Longi. 40:27:28.9988 Alt. 7m	Forestry, Agroforestry and RWH	i.Shallow well development ii.Central Nursery establishment iii.Communal nursery establishment iv. Demonstration on Agroforestry practices v.Road runoff management vi In situ /ex situ RWH Technologies	Main demonstration site a).Central and community nursery b).Agroforestry practices in farms neighboring TCN c).RWH for crop production and tree planting-In situ technologies/drip irrigation *Shallow well excavation started. .Hard rock slowed down excavation*
1 b	Witu-Witu Secondary Witu Ward,Soroko sublocation sublocation,Hindiwa village *GPS,Lat.2:52.126,* *Long,40:27.22.39,* *Alt.13 m*	Roof caught runoff mgt for BDM and capacity building	i.250m^{3}pond development ii.Installation of water collection /abstraction systems iii.Nursary establishment iv.Vegetable garden development Boundary tree planting	Cost sharing basis- 1.School=gutters,excavation,fencing posts land preparation nursery establishment/management,Vegetable stablishment and management 2.ICRAF-Plastic liner,fence, abstraction mechanism,capacity building
1c	Lamu Conservation Trust Witu Ward,Witu	RWH for Nursary re-establishment/management	I .Construction of a plastic lined tank	LCT-Gutters,conveyance pipes. Nursery re-establishment

	Sublocation,Witu Centre		ii.revival of nursery iii Capacity building(technicians)	ICRAF-Plastic liner,Hand pump On-the -job training for technicians Technicians to be drawn from groups.Only those with knowledge on masonry work
2	Tangeni/Back to Eden Youth and Womenn Organization (*Witu Ward,Pandaguo sublocation,Sendemke village-GPS,Lat.2:22.922, Long,40:25.17.32, Alt.12m*	a. Runoff management for crop pdn b. RWH for domestic uses C. Shallow well development for BDM/Plastic lined tank	i.Runoff pond system development-excavation/lining, abstruction and application on nursery/vegetable garden ii.Demonstration on In situ rwh technologies iii. Site fencing off iv.Plastic lined tank construction	Same group will have 3 sites spread over 2km on diferent technologies .Site between 2-4 km from Witu forest *Group have completed excavation of a 120m3 runoff pond and is ready to harvest and use runoff during the next elnino rains*
3.				
4	HVC Groups a)New Kumekucha Maisha Masha Bee Keeping cooperative Witu Ward,Pandanguo location,Maisha Masha Sublocation,Maisha Masha Villge	Bee Keeping	Apiary establishment. RWH for Nursary establishment/management Tree/shrubs establishment(bee forage enrichment) RWH for bees,tree/forage establishment Fencing out apiary site	Livestock technician to work with the groups to have the apiary ready for placement of hives Shallow well found to be the most ideal in the site.Technology on Plastic lined tank required Group to provide labour,sand ballast, (stones)

	GPS Lat.-2:23:47.6232 Longi 40:32:21.624 Alti 16m asl			ICRAF-cement, roofing material,(stones)
5	b)Witu Nyongoro Bee Keeping and Ecosystem Conservation Witu Ward Dide Warinde Sublocation Kakate GPS—Lat. 2:20:5.7012 Longi. 40:23:45.764 Alt 14m asl	Bee keeping	Apiary establishment RWH for bee keeping and tree planting Tree nursery establishment	Apiary site preparation Plastic lined Plastic lined tank easier to start with ICRAF –Lining,roofing material Pump, Cement ,Capacity building Group-provide labour

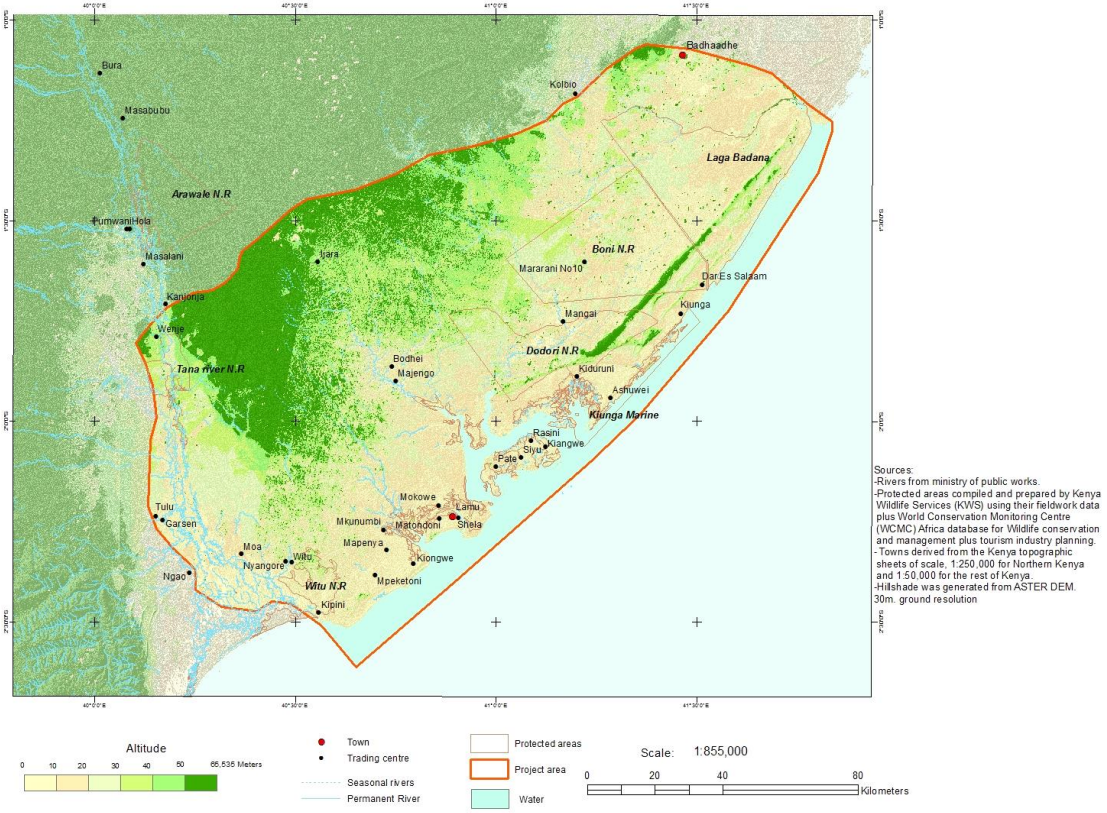
Annex 1

Settlements and Protected areas



Annex 2

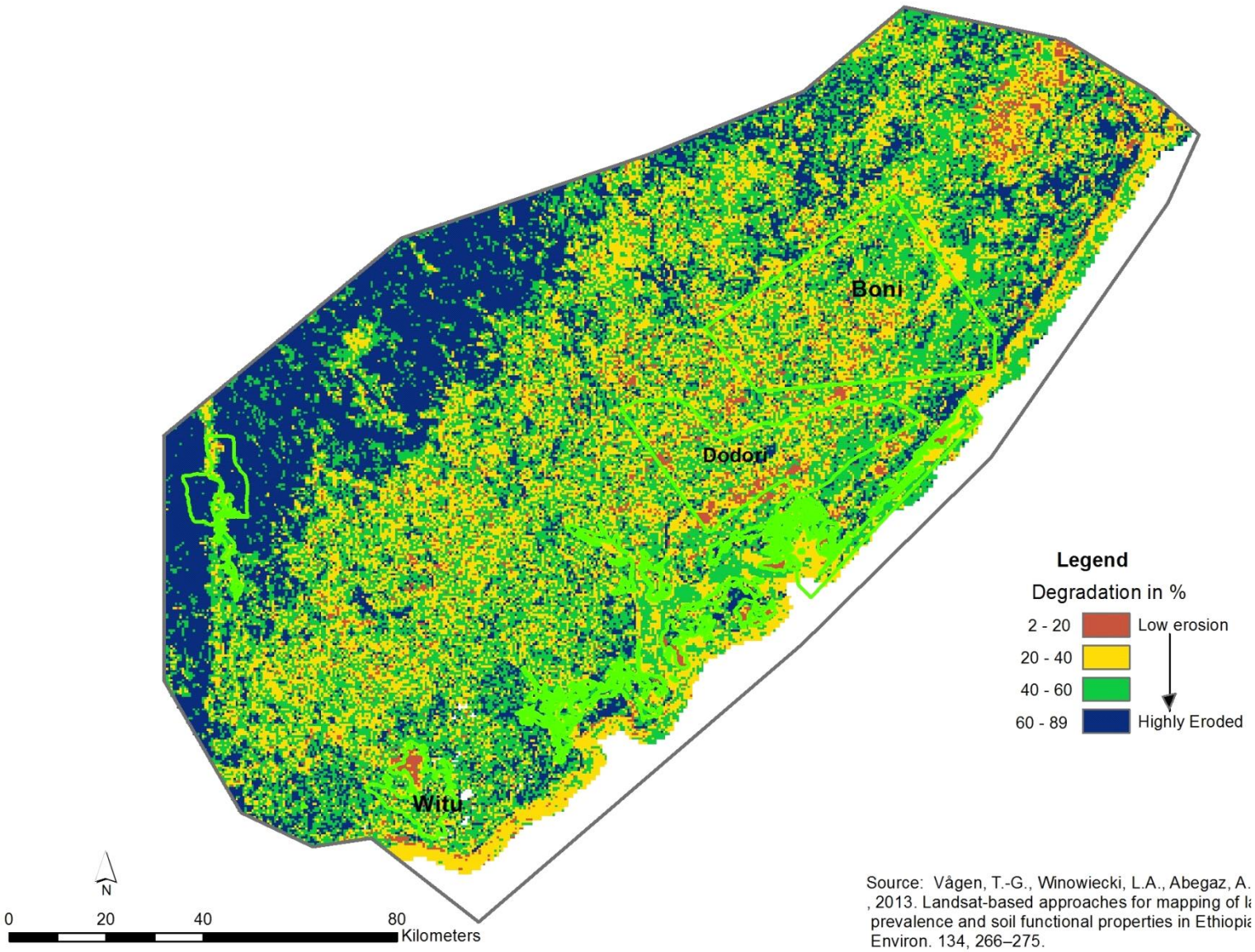
Altitude



Sources:
-Rivers from ministry of public works.
-Protected areas compiled and prepared by Kenya Wildlife Services (KWS) using their fieldwork data plus World Conservation Monitoring Centre (WCMC) Africa database for Wildlife conservation and management plus tourism industry planning.
- Towns derived from the Kenya topographic sheets of scale, 1:250,000 for Northern Kenya and 1:50,000 for the rest of Kenya.
-Hillshade was generated from ASTER DEM. 30m. ground resolution

Annex 3

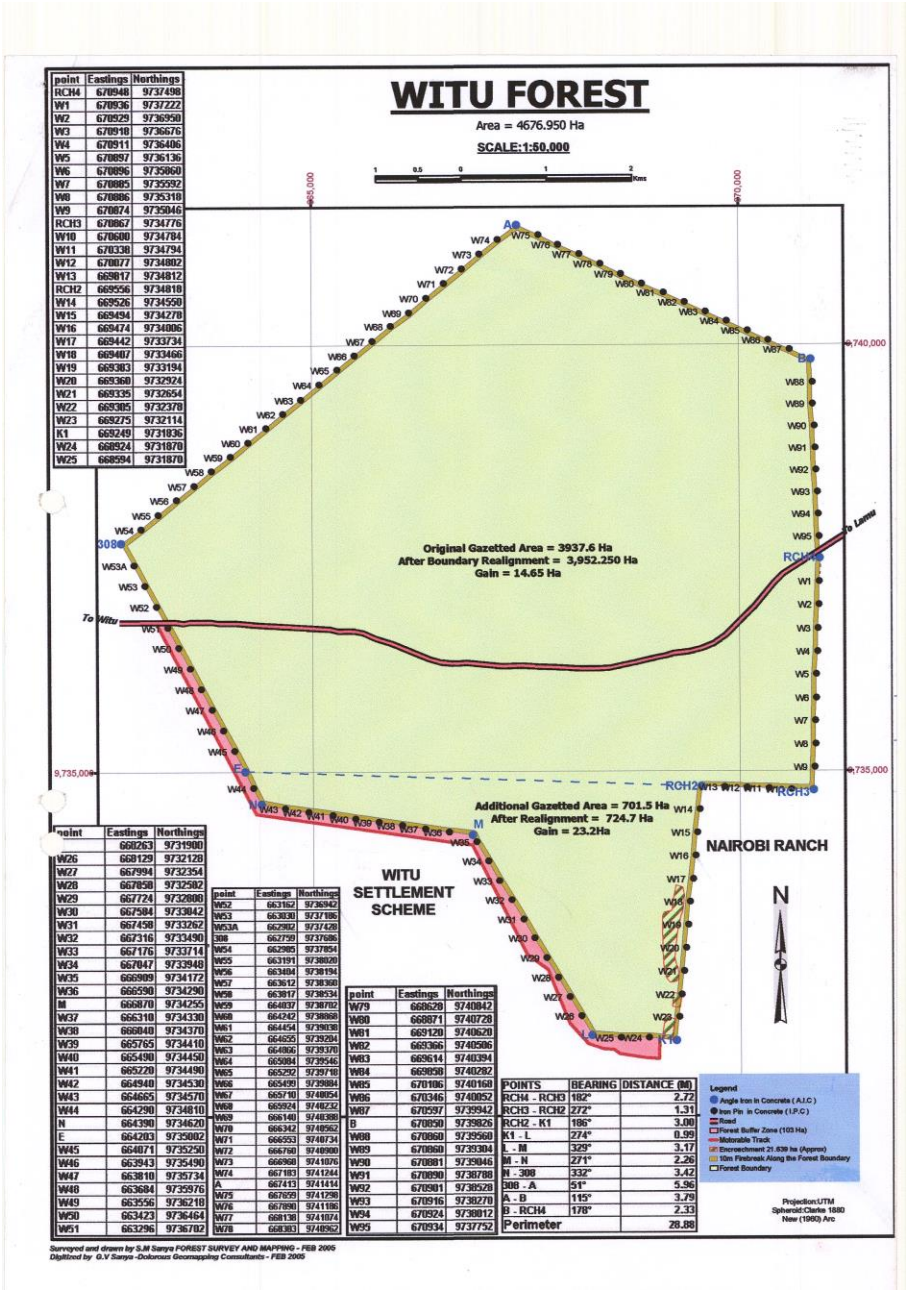
Erosion Prevalence



Source: Vågen, T.-G., Winowiecki, L.A., Abegaz, A. , 2013. Landsat-based approaches for mapping of l prevalence and soil functional properties in Ethiopi Environ. 134, 266–275.

Annex 4

Witu Forest



point	Eastings	Northings
RCH4	670948	9737498
W1	670936	9737222
W2	670929	9736950
W3	670918	9736676
W4	670911	9736406
W5	670897	9736136
W6	670896	9735860
W7	670885	9735592
W8	670886	9735318
W9	670874	9735046
RCH3	670867	9734776
W10	670600	9734784
W11	670338	9734794
W12	670077	9734802
W13	669817	9734812
RCH2	669556	9734818
W14	669526	9734550
W15	669494	9734270
W16	669474	9734006
W17	669442	9733734
W18	669407	9733466
W19	669383	9733194
W20	669360	9732924
W21	669335	9732654
W22	669305	9732378
W23	669275	9732114
K1	669249	9731836
W24	668924	9731870
W25	668594	9731870

point	Eastings	Northings
668263	9731980	
W26	668129	9732128
W27	667994	9732354
W28	667858	9732582
W29	667724	9732808
W30	667584	9733042
W31	667458	9733262
W32	667316	9733490
W33	667176	9733714
W34	667047	9733948
W35	666909	9734172
W36	666590	9734290
M	666870	9734255
W37	666310	9734330
W38	666048	9734370
W39	665765	9734410
W40	665498	9734450
W41	665220	9734490
W42	664948	9734530
W43	664665	9734570
W44	664290	9734810
N	664390	9734620
E	664203	9735002
W45	664071	9735250
W46	663943	9735490
W47	663810	9735734
W48	663684	9735976
W49	663556	9736218
W50	663423	9736464
W51	663296	9736702

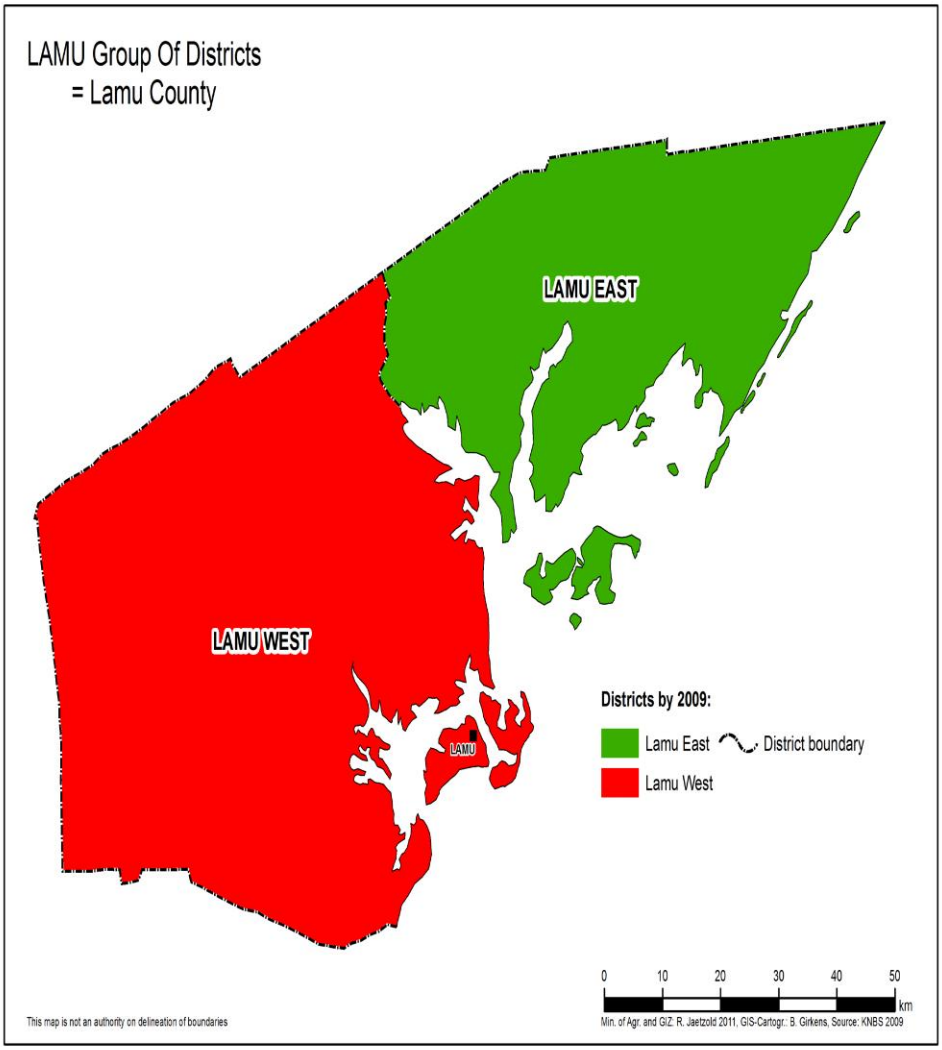
point	Eastings	Northings
W52	663162	9736942
W53	663030	9737186
W53A	662902	9737428
308	662759	9737686
W54	662985	9737854
W55	663191	9738020
W56	663494	9738194
W57	663612	9738360
W58	663817	9738534
W59	664037	9738702
W60	664242	9738868
W61	664454	9739038
W62	664655	9739204
W63	664866	9739370
W64	665084	9739546
W65	665292	9739710
W66	665499	9739884
W67	665710	9740054
W68	665924	9740232
W69	666140	9740388
W70	666342	9740562
W71	666553	9740734
W72	666760	9740900
W73	666968	9741076
W74	667183	9741244
A	667413	9741414
W75	667659	9741298
W76	667890	9741186
W77	668138	9741074
W78	668383	9740962

point	Eastings	Northings
W79	668628	9740842
W80	668871	9740728
W81	669120	9740620
W82	669366	9740506
W83	669614	9740394
W84	669858	9740282
W85	670106	9740168
W86	670346	9740052
W87	670597	9739942
B	670850	9739826
W88	670860	9739560
W89	670860	9739304
W90	670881	9739046
W91	670890	9738788
W92	670901	9738528
W93	670916	9738270
W94	670924	9738012
W95	670934	9737752

POINTS	BEARING	DISTANCE (M)
RCH4 - RCH3	182°	2.72
RCH3 - RCH2	272°	1.31
RCH2 - K1	186°	3.00
K1 - L	274°	8.99
L - M	329°	3.17
M - N	271°	2.26
N - 308	332°	3.42
308 - A	51°	5.96
A - B	115°	3.79
B - RCH4	178°	2.33
Perimeter		28.88

Annex 5

Lamu County Districts

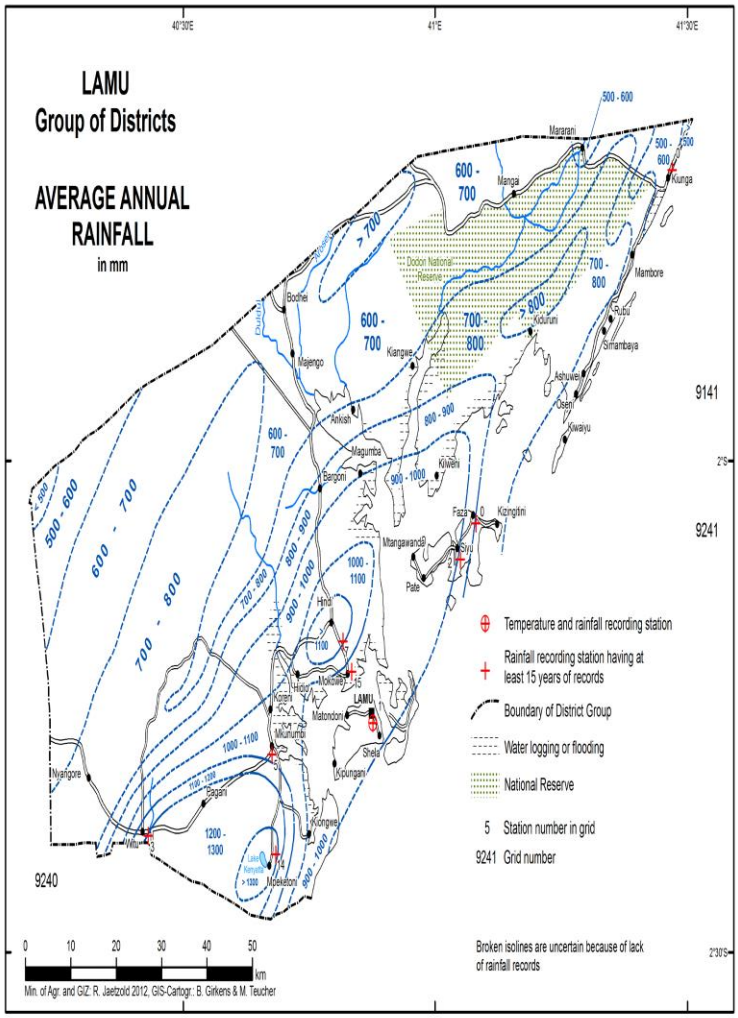

LAMU Group Of Districts
= Lamu County
LAMU EAST
LAMU WEST
LAMU
Districts by 2009:
Lamu East
District boundary
Lamu West
0
10
20
30
40
50
km
This map is not an authority on delineation of boundaries
Min. of Agr. and GIZ: R. Jaetzold 2011, GIS-Cartogr.: B. Girkens, Source: KNBS 2009

Annex 6

RAINFALL FIGURES FROM SELECTED TYPICAL STATIONS IN LAMU

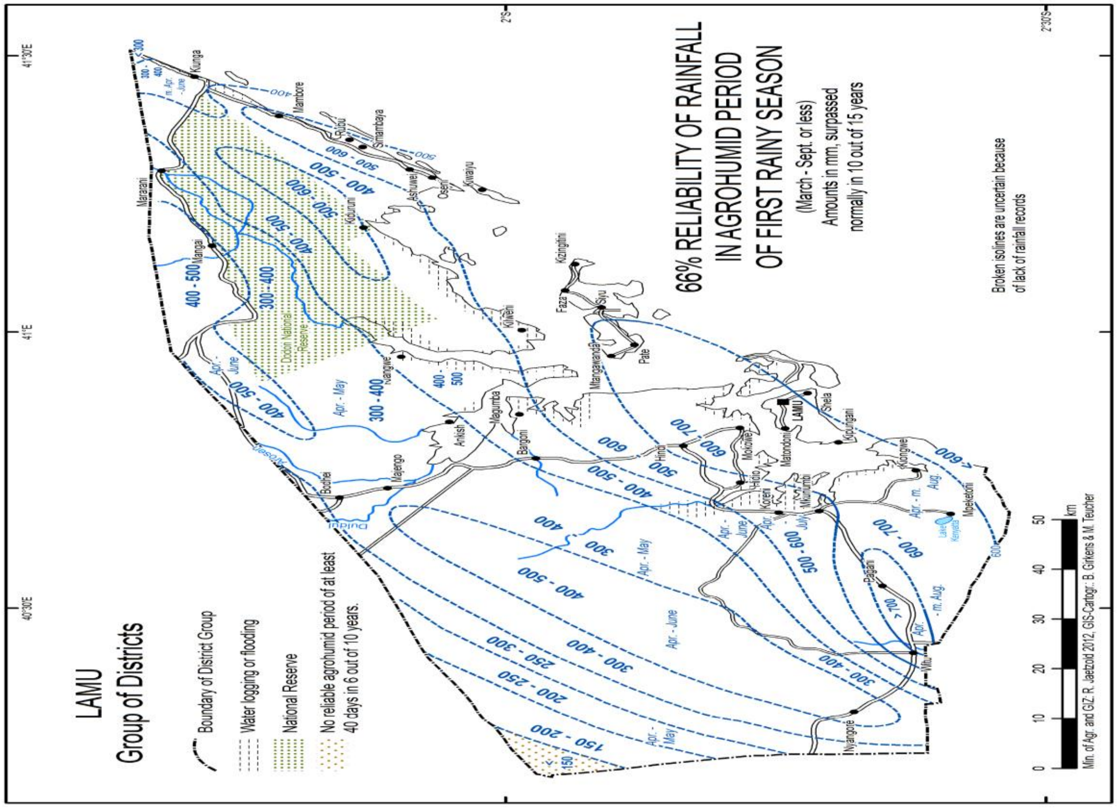
GROUP OF DISTRICTS HAVING RECENTLY AT LEAST 16 YEARS

OF RECORDS


LAMU
Group of Districts
AVERAGE ANNUAL RAINFALL
in mm
40°30'E
41°E
41°30'E
2°S
2°30'S
9141
9241
9240
Temperature and rainfall recording station
Rainfall recording station having at least 15 years of records
Boundary of District Group
Water logging or flooding
National Reserve
5 Station number in grid
9241 Grid number
Broken isolines are uncertain because of lack of rainfall records
0 10 20 30 40 50 km
Min. of Agr. and GIZ: R. Jaetzold 2012, GIS-Cartogr.: B. Girkens & M. Teucher

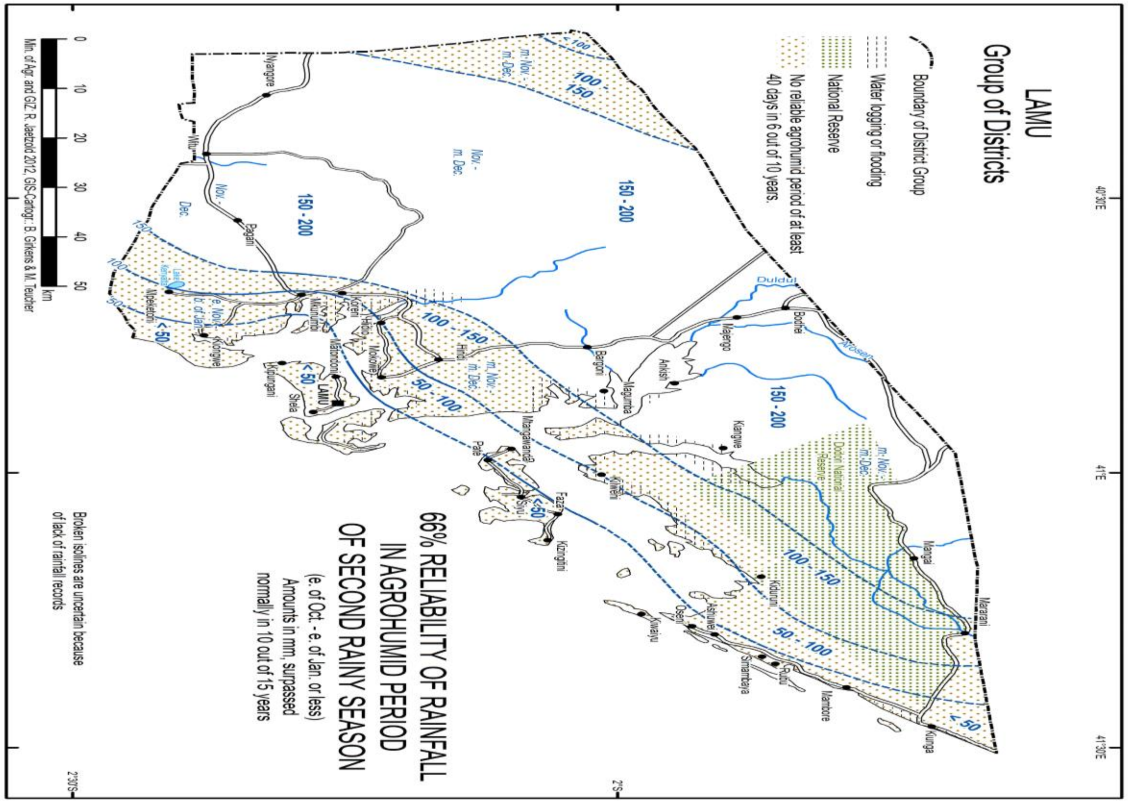
Annex 7

Reliability of rainfall-long rains


66% RELIABILITY OF RAINFALL
IN AGROHUMID PERIOD
OF FIRST RAINY SEASON
(March - Sept. or less)
Amounts in mm, surpassed
normally in 10 out of 15 years
LAMU
Group of Districts
Boundary of District Group
Water logging or flooding
National Reserve
No reliable agrohumid period of at least
40 days in 6 out of 10 years.
Broken isolines are uncertain because
of lack of rainfall records
Min. of Agr. and GIZ: R. Jaetzold 2012, GIS-Cartogr.: B. Girkens & M. Teucher

Annex 8

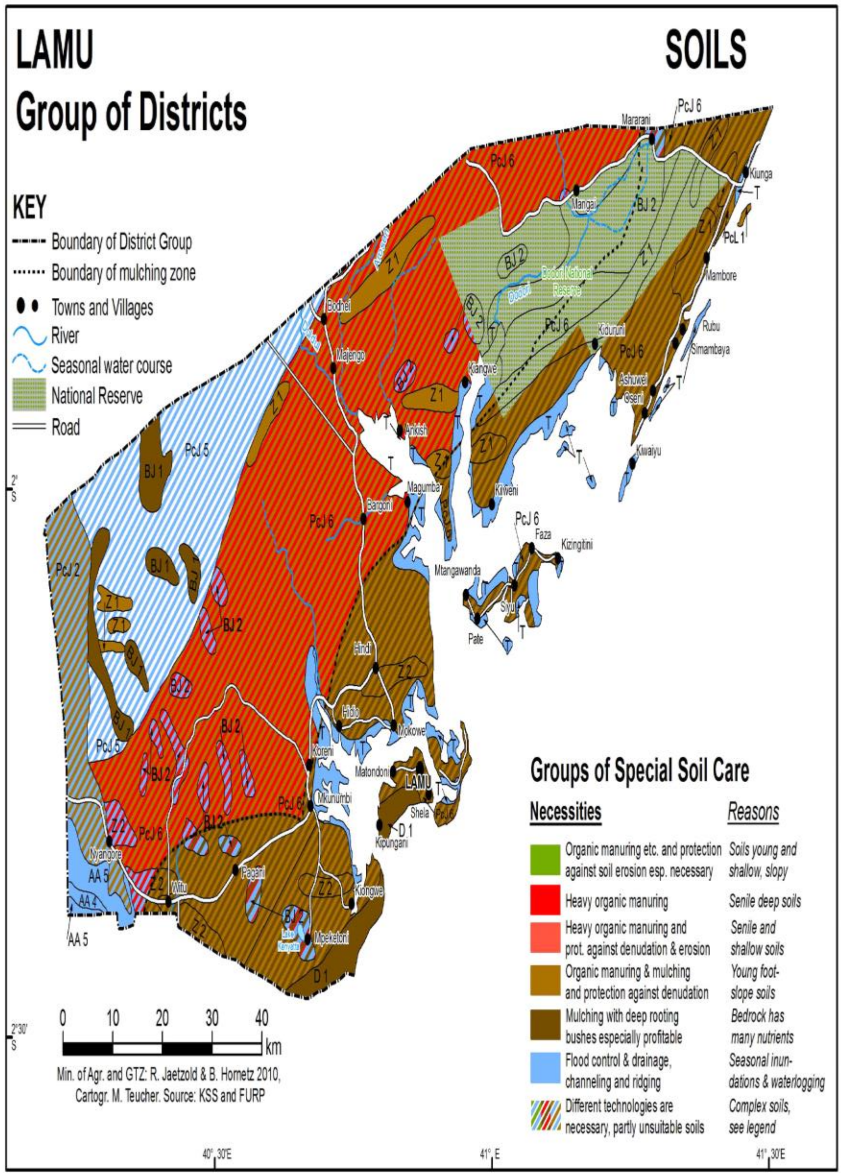
Rainfall reliability-short rains



LAMU
Group of Districts
Boundary of District Group
Water logging or flooding
National Reserve
No reliable agrohumid period of at least 40 days in 6 out of 10 years.
66% RELIABILITY OF RAINFALL
IN AGROHUMID PERIOD
OF SECOND RAINY SEASON
(e. of Oct. - e. of Jan. or less)
Amounts in mm, surpassed normally in 10 out of 15 years
Broken isolines are uncertain because of lack of rainfall records
Min. of Agr. and GIZ: R. Jaetzold 2012, GIS-Cartogr.: B. Girkens & M. Teucher
40°30'E
41°E
41°30'E
2°S
2°30'S
0 10 20 30 40 50 km
150 - 200
100 - 150
50 - 100
< 50
Nov. - m. Dec.
m. Nov. - m. Dec.
Dodori National Reserve
Mararani
Kiunga
Mangai
Mambore
Rubu
Simambaya
Kiduruni
Ashuwei
Oseni
Kiwaiyu
Bodhei
Majengo
Kiangwe
Ankish
Magumba
Bargoni
Kiliweni
Faza
Kizingitini
Mtangawanda
Siyu
Pate
Hindi
Mokowe
Hidio
Koreni
Matondoni
LAMU
Mkunumbi
Shela
Kipungani
Nyangore
Pangani
Witu
Kiongwe
Mpeketoni
Dulduli

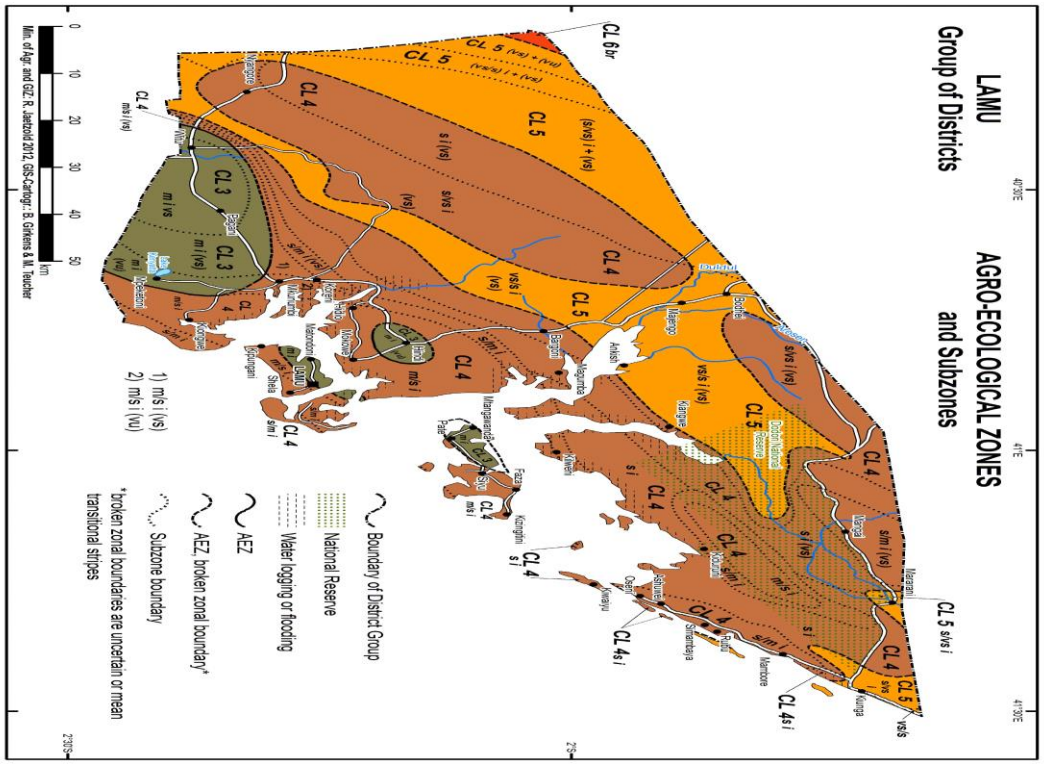
Annex 9

Soils


LAMU
Group of Districts
SOILS
KEY
Boundary of District Group
Boundary of mulching zone
Towns and Villages
River
Seasonal water course
National Reserve
Road
Groups of Special Soil Care
Necessities
Reasons
Organic manuring etc. and protection against soil erosion esp. necessary
Soils young and shallow, slopy
Heavy organic manuring
Senile deep soils
Heavy organic manuring and prot. against denudation & erosion
Senile and shallow soils
Organic manuring & mulching and protection against denudation
Young foot-slope soils
Mulching with deep rooting bushes especially profitable
Bedrock has many nutrients
Flood control & drainage, channeling and ridging
Seasonal inundations & waterlogging
Different technologies are necessary, partly unsuitable soils
Complex soils, see legend
0 10 20 30 40 km
Min. of Agr. and GTZ: R. Jaetzold & B. Hornetz 2010,
Cartogr. M. Teucher. Source: KSS and FURP
Mararani
Kiunga
Mambore
Rubu
Simambaya
Kiwaiyu
Mangai
Kiduruni
Kiangwe
Bodhei
Majengo
Mokowe
Magumba
Bargoni
Kiwayuu
Faza
Kizingitini
Mtangawanda
Siyu
Pate
Hindi
Matondoni
LAMU
Shela
Kipungani
Mkunumbi
Witu
Nyangore
Pangani
Kiongwe
Mpeketoni
PcJ 6
PcJ 5
PcJ 2
BJ 1
BJ 2
Z 1
Z 2
PcL 1
AA 4
AA 5
D 1
40° 30'E
41° E
41° 30'E
2° S
2°30' S

Annex 10

Agro Ecological Zones



AGRO-ECOLOGICAL ZONES AND SUBZONES

Introduction

The yield potentials are calculated for the important annual crops with the programs WATBAL and MARCROP by B. Hornetz (see chapter 3.1 and Annex). The other crops are classified by estimates according to their temperature and water requirements. Not all suitable crops could be mentioned here because of limited space. More crops and the most suited varieties can be found in the crop list (Table IX) and in IRACC: Small Holder Farming Handbook for Self Employment, Nairobi 1997, when comparing both sources with

the climatic data of the AEZ and Subzones (Table 2) as well as considering the soil requirements (Table IV) and the soil map. The potentials require optimal fertilising and manuring as well as good crop husbandry to reach the given percentages.

Recommended for checking in Table IX are the following crops resp. varieties if they have not been mentioned in the potentials: Some more maize and bean varieties; more vegetables like french beans, celery, brinjals and others; more fruits like grapefruit, mandarines, limes, lemons, tangerines and pineapples. It is important to compare the yields, f. i. a fair yield of med. mat. maize is higher than a good one of an early mat. maize but more risky. For fodder and forage many other plants than the mentioned ones are possible, classified by Agro-Ecological Zones in Table X.

The tables beneath the diagrams of growing periods may differ from other calculations because they do not include the drier grass growing periods which can give a minimum supply of moisture to low demanding crops. The gap between the number of sufficient growing periods and that of total crop failures is filled by fair to poor yields.

It must be kept in mind that the potentials are ecological zone based. What is economical depends on the present relation of costs-yields-prices and the marketing possibilities, of course.

AGRO-ECOLOGICAL ZONES AND SUBZONES (Legend to the Map)

CL = COASTAL LOWLAND ZONES

CL 3 = Coconut-Cassava Zone

CL 3 = Coconut-Cassava Zone with a medium cropping season,

m i vs/s intermediate rains, and a very short to short one

(See Diagrams Witu and Table 3)

Very good yield potential (av. more than 80 % of the optimum)1)

Whole year: Mangoes

Good yield potential (av. more than 60-80 % of the optimum)1)

1st rainy season, start norm. end of March: Coast comp. and Pwani Hybrid maize & 2KX 17, m. mat. white sorghum, m. mat. finger and pearl millet; dolichos beans (~ 60%)2), green grams (60-70 %)2), cowpeas (60-70 %)2), pigeon peas (1st-2nd r.), soya beans, *yam beans* (tubers), sweet potatoes; groundnuts (Makulu red)[3]), bambara groundnuts[3])6); cotton (with danger of rain in open bolls), roselle; tomatoes, egg plants/ brinjals, kales, Chinese cabbage, chillies, sweet pepper, pumpkins, onions, sweet and water melons, cucumbers, garlic, okra, *trop. Lima beans*9), guar11)

Whole year, best planting time b. of April: Sisal; cashew nuts[3]), bixa, pawpaws, West Indian avocadoes; cassava; guavas, senna, castor

Fair yield potential (av. 40-60 % of the optimum)1)

1st rainy season: Rice in seasonal flooded grasslands or semi-permanent swamps5); simsim (J./July- S.O.); cabbage, chick peas on heavy black soils after flooding (July - S.)

2nd rainy season, start indistinctly mid Oct.: V. e. mat. foxtail millet, Proso millet; green grams (fair-poor), cowpeas, black grams, Mung beans, Dolichos beans, chick peas

Whole year: Coconuts[3]) (danger of bollrot disease), bananas, lemons and limes, oranges and grapefruits4), pineapples4), curcuma

LAMU GROUP 11 Some marginal crops with poor yield potential (av. 20-40% of the optimum)

2nd rainy season: Sweet potatoes (necessary to continue from 1st r. to keep plant material for the next long rains); simsim; pearl millet (Kat/PM1, bristled var.), v. e. mat sorghum (IS 8595)

Pasture

1st rainy season: M. mat. rice NERICA 10 & 11 in seasonal flooded grasslands or semi- permanent swamps5); dolichos beans, green grams2), groundnuts3), bambara groundnuts (Apr-Aug.)3) 6) , simsim²); cotton; cabbage

Whole year: Coconuts3) (danger of bollrot disease), drought resistant bananas like Bocoboco and Zanzibarini, pineapples4), lemons, and limes, oranges and grapefruit (fair to poor)

Pasture and forage

More than 1 ha/LU on secondary high-grass savanna; feeding Napier and Bana grass, siratro, Stylosanthes hamata, and centro (legumes also to improve pasture and soil) and planting horse tamarind for browsing1) down to about 0.25 ha/LU

CL 4 = Coastal Lowland Cashewnut-Cassava Zone

CL 4 = Cashewnut-Cassava Zone with a medium to short cropping season

m/s i intermediate rains, and a (weak)

(vs) very short one

Very small and transitional. Potential in first rains see CL 4 m/s i but Lima and yam beans only fair, in second rains almost as CL 4 s/m i (vs)

CL 4 = Cashewnut-Cassava Zone with a medium to short cropping season

m/s i followed by intermediate rains

(see Diagram Lamu)

Good yield potential1)

1st rainy season, start norm. end of March/b. of April: Med. mat. maize like Coast comp. and Pwani Hybrid PH 4, m. mat. sorghum, m. mat. bulrush (pearl) and finger millet; cowpeas (~60 %)²), dolichos beans; m. mat. groundnuts3)6) (Apr.-Aug.); e. mat. *trop. Lima beans*9), *yam beans* (tubers), sweet potatoes; e. mat. sunflower like Kenya Almasi, m. mat. soya beans on h. and m. soils, e. mat. soya beans on light soils; kales, onions, pumpkins, chillies, sweet pepper, okra, egg plants, Chinese cabbage, garlic, water melons, cucumbers, *guar*11)

Whole year: Cashew nuts3), cassava3); sisal, mangoes

Fair yield potential1)

1st rainy season: E. mat. rice5) in semiperm. swamps; green grams (May/June-A./S.) and simsim2); cotton, safflor; cabbages, tomatoes; *trop. Lima beans*9)

Whole year: Pawpaws, senna, bixa

Some marginal crops with poor yield potential

Whole year: Bananas, coconuts

Pasture and forage

More than 1.5 ha/LU on secondary high-grass savanna; down to about 0.3 ha/LU feeding Bana grass, centro, siratro, Clitoria ternatea, Stylosanthes hamata, *Macrotyloma axillare* (legumes also to improve pasture and soil), and planting horse tamarind (Leucaena tricandria) for browsing. Mangrove leaf. Nat. vegetation: dry forest patches on free draining land, doum palm savanna on lower places; tsetse flies near forest

CL 4 = Cashewnut-Cassava Zone with a medium to short cropping season,

m/s i + (vu) intermeditate rains, and a (weak) very uncertain one

(see Diagram Mkunumbi)

Potential almost as CL 4 m/si but cowpeas and simsim planted towards the end of 1st rains give normally only poor yields; 2nd rains too weak or uncertain for crops

CL 4 = Cashewnut-Cassava Zone with a short to medium cropping season

s/m i followed by intermediate rains

Potential almost as CL 4 m/s i but Coast Comp. and Pwani Hybrid maize PH 4, finger millet, cowpeas[2]) give normally only f *CL 4 = Cashewnut-Cassava Zone with a short to medium cropping season,*

s/m i intermediate rains, and a (weak)

(vs) very short one

Good yield potential

1st rainy season, start norm. indistinctly end of March: E. mat. sorghum like Gadam; e. mat. pearl millet (*bristled variety*); dolichos beans, green grams, cowpeas, e. mat. groundnuts like Makulu Red, mung beans; e. mat. cassava

Whole year: Sisal, perennial castor

Fair yield potential

1st rainy season: M. mat. maize Coast composite or e. mat. maize PH 4; chick peas, black grams; e. mat. bambara groundnuts6), simsim, sweet potatoes; sunflower Almasi; e. mat. soya beans on h. and m. soils; luffa gourds, kales, cabbage, onions, tomatoes, chillies

2nd rainy season, start norm. e. of S.: V. e. mat. millets (proso, foxtail & *hog millet*); green grams (~40 %), chick peas (on h. bl. soils), cowpeas mainly for spinach

Whole year: L. mat. cassava like Kaleso (on light soils); cashew nuts, mangoes, pineapples

Poor yield potential

2nd rainy season: V. e. mat. sorghum IS 8595

Pasture and forage

Around 2 ha/LU in woodland, more than 3 ha in thickets: partly danger of tsetse if not cleared enough, feeding Bana grass and planting horse tamarind for browsing down to about 0.4 ha/LU. Cassava is an add. forage. More forage plants see Table X

Situation in 2nd rainy season is 10-20% better during an ENSO season (33% of the years)

CL 4 = Cashewnut-Cassava Zone with a short cropping season,

s i intermediate rains, and a (weak)

(vs) very short one

Good yield potential1)

1st rainy season, start norm. end of March: E. mat. sorghum, e. mat. pearl millet (bristled var. Kat/PM 1 above 250 m); chillies

Whole year: Mangoes, castor, sisal, jatropha

Fair yield potential1)

1st rainy season: E. mat. Pwani Hybrid PH 4 or WS 202, e. mat. rice NERICA 10 & 11 in mbugas, finger millet; cowpeas, dolichos beans, mung beans, green grams, e. mat. pigeon peas Kat/Mbaazi 3 and simsim[2]); sweet potatoes; e. mat. groundnuts[3]) and bambara groundnuts[3])6); kales, onions, tomatoes, red and green sweet pepper; e. mat. cassava like Nzalauka

2nd rainy season, start norm. O.: V. e. mat. foxtail millet (ISE 285) & proso millet

(Serere 1); green grams, cowpeas (for leaves), simsim (~40 %)

Whole year: Cashew nuts, ye-eb nuts

Some marginal crops with poor yield potential

2nd rainy season: Coast comp. maize1) (S.-D./J.), v. e. mat. sorghum like Gadam or KARI Mt. 1 (maize & sorghum fair yields in ENSO seasons), v. e. mat. sweet potatoes (to keep plant mat. for next long rains)

Whole year: Pawpaws1)

Pasture and forage

Around 2 ha/LU on short grass doum palm savanna on low, seasonally waterlogged land; feeding Bana grass and fodder legumes like siratro (med. soils on free draining land) and planting horse tamarinds (also on mbuga edges) down to about 0.35 ha/LU. Cassava is an add. forage. Sclerophytic dry forest on free draining land, tsetse flies near these forest patches

CL 4 = Cashewnut-Cassava Zone with a short cropping season

s i followed by intermediate rains

Good yield potential1)

1st rainy season, start norm. end of March: E. mat. sorghum, e. mat. (bristled) pearl millet Kat./PM 1; e. mat. pigeon peas Kat/Mbaazi 3

Whole year, best planting time b. of April: *Buffalo gourds* (on light soils)10)**LAMU GROUP 18**

)

Whole year, best planting time mid April: *Buffalo gourds* (on light soils)10), *Marama beans*10)

Fair yield potential

1st rainy season, start norm. b. of April: E. mat. sorghum Gadam (50-60 %), e. mat. pearl or bulrush millet (bristled var.)1); chick peas (on h. black soils), cowpeas, green and black grams (May-Aug., 50-60 %)1); e. mat. bambara groundnuts1)³)6); e. mat. onions1)

2nd rainy season, start norm. end of Oct.: Cowpeas for leaves, green grams1)

Whole year: Sisal (50-60 %)1), castor1), drought resistant cassava1), jatropha 7), ye-eb nuts

Poor yield potential

1st rainy season: E. mat. maize

2nd rainy season: E. mat. pearl millet (bristled var. Kat/PM 1), v. e. mat. proso & foxtail millet

Whole year: Mangoes

Pasture and forage

2-4 ha/LU on sclerophytic evergreen bushland (partly tsetse infested), about 2 ha/LU in mbugas; down to about 0.5 ha/LU on art. pasture of buffel grass (Cenchrus ciliaris) and feeding vines of *Mauritius or moth beans*, and planting fodder shrubs like saltbush (Atriplex nummularia) and Mesquite (Prosopis spec.)

CL 5 = Livestock-Millet Zone with a short to very short cropping season

s/vs i followed by intermediate rains

Good yield potential

1st rainy season, start normally mid April: E. mat. Gadam sorghum, e. mat. pearl millet (bristled var., ~60 %)1); chick peas (late planted on heavy black soils)

Whole year: *Buffalo gourds* (on light soils) 1)10), *Marama beans*1)10), physic nut (Jatropha)1)7)

Fair yield potential1)

1st rainy season: V. e. mat. maize PH 4 or WS 202; cowpeas and grams (May-Aug.); e. mat. groundnuts[3]), e. mat. bambara groundnuts[3])6); onions

Whole year: Drought resistant cassava (fair to poor), castor

Poor yield potential

1st rainy season: M. mat. maize like Coast Composite**LAMU GROUP 19** Fair yield potential1)

1st rainy season: E. mat. maize like Pwani Hybrid PH 4 or WS 202; cowpeas, dolichos beans like Kat DL 1, green grams and simsim (e. of May- e. of Aug.); e. mat. groundnuts[3]) and bambara groundnuts[3])6); onions, tomatoes, chillies

Whole year: Cashewnuts, mangoes, sisal, castor, jatropha 7)

Pasture and forage

Around 2.5 ha/LU on bushland with acacias, about 2 ha on short grass doum palm savanna in mbugas; horse tamarinds to plant on mbuga edges, saltbush (Atriplex nummularia) on higher land for browsing

CL 4 = Cashewnut-Cassava Zone

s with a short cropping season

Potential almost as CL 4 s i but cowpeas and simsim planted towards the end of 1st rains get poor yields only

CL 4 = Cashewnut-Cassava Zone

s/vs with a short to very short cropping season,

i (vs) intermediate rains, and a (weak) very short one

Potential almost as CL 4 s i (vs) but 1st rains start norm. b. of April

CL 5 = Coastal Lowland Livestock-Millet Zone

CL 5 = Livestock-Millet Zone with a (weak) short to very short

(s/vs) cropping season, intermediate rains, and a (weak)

i + (vs) very short one

Good yield potential1

Pasture and forage

More than 3 ha/LU on dry acacia bushland; down to about 0.6 ha/LU on art. pasture of buffel grass and feeding hay or silage of Mauritius and moth bean vines during dry season, and planting fodder shrubs like saltbush and Gao trees on good soils (Acacia albida) for pods

CL 5 = Livestock-Millet Zone with a very short to short

vs/s i cropping season, intermediate rains, followed by a (weak)

(vs) very short one

Good yield potential1)

1st rainy season, start norm. April: E. mat. foxtail millet, luffa gourds and *e. mat. water melons* (from West-Africa)

Whole year: *Buffalo gourds* (on light soils)10), *Marama beans*10) , ye-eb nuts

Fair yield potential

1st rainy season: E. mat. pearl millet (bristled var. Kat/PM 1)1), proso millet, v. e. mat. Gadam sorghum; chick peas (late pl. on heavy black soils), cowpeas1), green and black grams1), v. e. mat. bambara groundnuts1); simsim (May-Aug.)1)

2nd rainy season, start norm. end of Oct.: Cowpeas for leaves, green grams (fair to poor)

Whole year: Sisal1), castor1), drought resistant cassava (fair to poor) 1), jatropha

Pasture and forage

Almost the same as CL 5 (s/vs) i (vs)

CL 5 = Livestock-Millet Zone with a (weak) very short to short

(vs/s) cropping season, intermediate rains, and a (weak)

i + vs (vs) very short one

Potential almost as CL 5 vs/s i (vs) but good potential there is only fair here; stocking rates about 10 % lower

CL 5 = Lowland Livestock-Millet Zone with a (weak)

(vs)+(vu) very short cropping season and a very uncertain (weak) second one

Fair yield potential1)

1st rainy season, start norm. b. of April: V. e. mat. foxtail millet ISE 285 (40-50 %), v. e. mat. pearl millet (grain usable at dough stage)

Whole year: *Buffalo gourds* (on light soils); *Marama beans*10), ye-eb nuts8), sisal

Poor yield potential

1st rainy season: E. mat. pearl millet (bristled var.), v. e. mat. Gadam sorghum; green grams

Pasture and forage

3-5 ha/LU on small-leaved bushland; situation improvable by fodder plants as in CL 5 vs/s and by Opuntia spec.

IL 6 = Inner Lowland Ranching Zone

IL 6 = Inner Ranching Zone with

b r bimodal rainfall

No rainfed crops for good or fair results except desert plants like *buffalo gourds* or ye-eb nuts. More than 5 ha/LU on short grass savanna mixed with small-leaved bushland; improvable by fodder shrubs like saltbush and on good soils by Gao trees (Ac. albida)

1) Not in waterlogged areas or during times of waterlogging, except rice and partly sorghum, sweet potatoes

2) Relay-planted in maize during June/July, cowpeas and chick peas also on places where the waterlogging has just gone; cowpeas for leaves planted already in April.

3) Not on heavy soils

4) Not top quality

5) In deep water: floating rice varieties from Bangladesh, higher places NERICA

6) Gives reasonable yields also on poor soils

7) Jatropha curcas; shrub for hedging, gives medical or technical oil from seeds and blue colour or tannin from bark. Origin: NE-Brasil

8) Cordeauxia edulis, native in the medium bush and in thickets of the coastal hinterland.

9) Very sensitive to salinity

10) Still experimental. Plants produce edible seeds and, after some seasons, also tubers. Bitterness may be washed out in salty water

11) Cyamopsis tetragonolobus (Leguminosae) from India; vegetable or fodder, seeds contain gum; N collectorair yields, cashew nuts good to fair

ANNEX X1

November 2015 and November 2016 Lamu Dought Manangement report by MICA Madoya