Coast Province

Coast Province

Socio Economy Prifiles

Coast Province has an total area of 83.6 thousand km^2 or 14% of the national total. Most of the land is of medium and poor potential and mainly of range potential. Of the total provincial area, 28.5 thousand km^2 or 34% is reserved area for uses such as national parks and reserved areas. The rest, 54.6 thousand km^2 or 66%, is habitable area where the people carry out their daily activities. The district population distribution was as follows:

Code District	Area (km^2)	Population in 1990 (1000)	Density (persons/km^2)
310 Kilifi	12,523	654	52
320 Kwale	8,322	409	49
330 Lamu	6,814	61	9
340 Mombasa	275	480	1,745
350 Taita Taveta	16,975	215	13
360 Tana River	38,694	138	4

In 1990, 1,956 thousand people or 8.6% of the national population were living in Coast Province. Its population distribution by district is shown in the above table.

The urban population numbered 607 thousand or 31% of the total provincial population. It was distributed into 16 towns in six Districts as follows: one municipality with 480 thousand of urban population in Mombasa; five towns, 62 thousand, in Kilifi; three towns, 15 thousand, in Kwale District; two towns, 12 thousand, in Lamu; three towns, 27 thousand, in Taita Taveta; and two towns, 12 thousand, in Tana River. Among these towns, the top 10 towns in terms of urban population were Mombasa, Malindi, Kilifi, Voi, Taveta, Lamu, Msambweni, Hola, Mariakani and Kwale in that order.

Mombasa is the largest town in the province, which functions as the provincial capital. It also functions as an international port and tourist centre for the whole coastline and has a well developed industrial and infrastructural base including an international airport. Besides, district headquarters of the other Districts are Kilifi in Kilifi District; Kwale in Kwale; Lamu in Lamu; and Wundanyi in Taita Taveta; and Hola in Tana River.

The main subsistence crop is maize, although the coast is not a good maize area. In the flood plains of the major rivers, rice is cultivated, often with rudimentary irrigation. The most notable cash crop along the coast is coconut and cashew nuts. They provide the greatest share of cash crop income in Kilifi and Kwale Districts. In the cooler environment of the Taita Hills coffee and vegetables are produced.

Mombasa ranks as the most industrialized town in the province. It is also the second largest industrialized town in the country, following Nairobi. Besides, Voi, Malindi Town, Lamu Town, Changamwe and Tezo are also listed up as industrialized towns in the province, although there are few major manufacturing establishments in these towns.

Coast Province recorded K£918 million at 1989 constant prices or 12% of GDP, according to the Study Team's estimation explained in Chapter 5 of Sectoral Report "A". Mombasa recorded the largest GRDP in the province. It was estimated at K£691 million or 8.9% of GDP. Mombasa also recorded the largest GRDP per capita in the province. It was estimated at K£1,441 in 1990, which was 4.2 times of the national average. GRDP per capita of the other Districts recorded were as follows: K£348 or 1.02 times in Lamu; K£217 or 0.54 in Taita Taveta; K£174 or 0.51 in Kilifi; K£85 or 0.25 in Kwale; and K£74 or 0.22 in Tana River.

Surface Water

In the Coast Province, a relatively wet and narrow tropical belt lies along the Indian Ocean coast. Along the coastline, south monsoon causes a maximum monthly rainfall and about 30% of annual mean rainfall occurs in May. Behind the coastline large areas of semi-arid and arid land stretch. In these areas, double maxima of monthly rainfall occur in April during the Long Rains and in November during the Short Rains. Annual mean rainfalls of semi-arid and arid lands were estimated at 600 mm and 350 mm, respectively.

Tana and Athi rivers flow through the semi-arid and arid land of the Province and discharge into the Indian Ocean. Streamflow losses from the rivers are generally caused by water abstraction, seepage along river channel and evaporation from river surface. The other perennial rivers in the Coast Province are the Tsavo River, the Lumi River, the Voi River, and small rivers along the coastline.

(1) Mombasa District

Water demand in the Mombasa District which is the second largest urban center in Kenya was estimated at 98,100 m^3/day (1.14 m^3/sec) in 1990 and 200,600 m^3/day (2.321 m^3/sec) in 2010. The present water sources are;

(Unit:m^3/day)

	Water Supply System	Supply	Ratio
1.	Mzima pipeline	34,560	(42%)
2.	Marere pipeline	9,150	(11%)
3.	Sabaki pipeline	35,000	(42%)
4.	Tiwi boreholes	3,890	(5%)
	Total	82,600	(100%)

Present water supply capacity is insufficient for the demand in 1990. To cope with such a serious problem, the second Mzima Pipeline is being studied by NWCPC. Two potential damsites, Mwachi and Pemba dams, were identified to supply additional domestic and industrial water to Mombasa. The extension of Sabaki Pipeline is proposed as the alternative for the above dams.

(2) Kwale District

The District receives the heaviest annual rainfall of more than 1,200 mm in the Province. Small forests are scattered in the plateau along the coastline and form groundwater reservoirs. Several springs emerge at the fringe of those forests. However, the spring water quality is sometimes not suitable for drinking water. Although small perennial rivers supply the domestic water, their runoff is almost dried up in the drier months. Main water source for domestic and industrial uses depends on the development of boreholes.

(3) Taita Taveta District

Water source in the district depends on springs flow. Major springs are (i) Mzima Springs, (ii) Njoro Springs, and (iii) small springs around Wundanyi.

The discharge of Mzima Spring is estimated at 4.3 m^3/s without seasonal fluctuation. It supplies a stable discharge to Tsavo River and precious augmentation of river flow to the Athi River. At present, the Mzima Pipeline which is about 240 km long supplies 0.43 m^3/s domestic water from the Mzima Springs to Mombasa.

Njoro Springs which are organized into a major spring and a few small springs emerge in the vicinity of Taveta town. The discharge is estimated at 2.6 m^3/s in total. At present, the spring water is utilized for irrigation.

Small springs around Wundanyi emerge at the fringe of Taita Hills. Mean annual rainfall of more than 600 mm was recorded in the area. Relatively fertile land and forest extend in and around Taita Hills. The springs form the Voi River which is the only perennial water source for Voi town. The river flows to the east but eventually dries up in the semi-arid land between Voi and Mombasa. The river emerges again in the coastline as the Rare River.

(4) Kilifi District

The lowest reach of the Sabaki River lies in the center of the District. At present, Sabaki Pipeline is the only surface water source for the District. The pipeline extends to Malindi, Kilifi and Mombasa. Since the capacity of the existing pipeline does not meet the demand in 2010, the MOWD carries out survey of exploratory shallow well and boreholes along the Sabaki River for the extension of existing pipeline and the future development of irrigation schemes.

(5) Tana River District

Most of the urban areas in the District are located near the main stream of the Tana River. The river runoff is the main water source for the District. A few existing irrigation projects were started along the Tana River. At present, Tana Delta

Irrigation Project is at the construction stage. In the rural areas, there are no perennial surface water sources. Boreholes with a combination of water harvesting are required.

(6) Lamu District

In the District, the Lamu Island is the major demand center of the domestic and industrial water demand. At present, the development of boreholes is being carried out by MOWD. However, the development yield of boreholes is quite limited even adding the yield of water harvesting. The water transfer scheme from the lower reach of the Tana River is proposed meeting the domestic and industrial water demand in 2010.

Geology

The geology is diversified, consisting of rocks whose age range from Pre-cambrian to recent. Four divisions can be recognized: the Cenozoic, Mesozoic, and Paleozoic sedimentary rocks, and Pre-cambrian metamorphic basement rocks.

Physiography

The physiographic units are chiefly related to the main sedimentary rocks, the Coastal plains, Duruma-Wajir Lowlands, Coastal ranges, Low Foreland Plateau, lying to the West of the coast plain.

Groundwater

The Pleistocene reef complex sands having the highest potential contain an unconfined aquifer at shallow depth along most of the coast. High-yielding boreholes and wells tap Tiwi aquifer in the Mombasa-Ukunda area on the South Coast and at Kikambala and Vipingo between Mombasa and Kilifi. North of Kilifi the well fields are lower and the water quality deteriorates. Lamu Island extracts water from sand dunes along the southern shores of the island.

The hinterland lacks adequate surface and subsurface water resources. Shallow aquifers exist in weathered or fractured rocks and SIDA and KWAHO projects are undertaking the introduction of shallow wells with handpumps.

(1) Kilifi District

The average boreholes yield in the District is 6 m^3/hr, but the yields may actually vary from nil to over 38 m^3/hr. The average borehole depth is 71 meters. The average rest level of the water in boreholes is 28 meters.

The Cainozoic sediments of the coastal region have greater groundwater potential than the Kartro rocks further inland. The sediments having the highest

groundwater potential are the Pleitocene reef complex sands an unconfined aquifer at shallow depth along most of the coast. High-yielding boeholes and wells tap this aquifer at Kikambala and Vipingo between Mombasa and Kilifi. North of Kilifi the well yields are lower and the water quality deteriorates.

(2) Kwale District

Kwale District lacks adequate surface and underground water resources. There are only two reliable surface water sources both of which are to the north of the District. Several seasonal springs from the Shimba Hills catchment area and few seasonal rivers in the south are the other sources of water. These springs have varying degrees of reliability and salinity as they flow towards the Indian Ocean. Pumped water supply schemes in the Shimba Hills area based upon these springs and rivers, together with groundwater in the coastal sedimentary formation, serve as temporary solution to water problems.

In addition to springs and rivers, there are number of earth dams across the district especially in the hinterland area for ranching purposes. These dams are however unprotected and many are silted, seasonal and are used mostly for watering animals. Past experience has shown that, because of unreliable rainfall, most dams in the hinterland sometimes fail to fill up during the rains. Such dams should either have fairly large catchment areas above them or a large number of smaller dams should be constructed.

Water is therefore a priority problem for many communities and especially in the hinterland where women have to travel very long distances to fetch water from dams in the dry season. SIDA and KWAHO are currently undertaking the introduction of community owned handpumps along the coastal zone and rehabilitation of dams in the hinterland. The project has already had some impact.

(3) Lamu District

Much of the water for human and livestock consumption is obtained from sub-surface sources. Lamu Island, which has the most modern water supply system in the District, extracts its water from sand dunes which run for approximately 15 km. along the southern shores of the island. The source is recharge by rain water. Its reliability therefore depends on the reliability of rainfall.

Much of the water for household use is from shallow wells. Djabias (underground water tanks) are common all over the District. Most of the ground water sources are saline. Some parts of Lake Kenyatta area are supplied by water from Lake Kenyatta.

Supply of fresh drinking water for humans and livestock is a major constraint to economic development in the area. Major sources of drinking water supply are traditional water catchment (djabias) which are scattered all over the District; most

of these require renovations. There are also underground wells, mainly in the sand dunes in Lamu Island and Mkokoni, and Lake Kenyatta which is a fresh water lake.

The Lake Kenyatta water supply in Mpeketoni should be expanded to cater not only for Mpeketoni township but also neighboring sub-towns. The current expansion of Lamu Island Water Project is expected to solve water problems in Lamu Island and Mokowe Townships.

(4) Mombasa District

Water from these sources is drawn by gravity and piped to the four major water supplies in the District. Despite the four sources being fully operational,Mombasa District still experiences shortage of water due to high demand of the increasing population and industries. There is also a continuing problem of machine damage due to siltation. The water supply line from Marere Springs to the southern mainland is at its maximum extension and may not be expanded further for a while. There are also a few shallow wells used for irrigation and religious purposes in Likoni. The water is used for domestic industrial and livestock purposes. About 42,589 households are served by these water supplies.

Mombasa District receives its water supply from neighboring districts, that is, Mzima springs in Taita Tavita District, Marere River and Tiwi boreholes in Kwale District, and Sabaki River in Kilifi District. These are distributed through four major water supplies in the District, which are Mombasa, Changamwe, Kisauni and Likoni. Apart from these there are few wells mostly run by womens' groups scattered around the District. These so far have proved inadequate in serving the population and the existing hospitals, schools and industries. The worst hit areas are Island and Changamwe Divisions, where the largest number of infrastructures facilities are located because they have the largest share of population. With the steady increase in population a corresponding increase in water should be pursued.

(5) Taita Taveta District

Water is the most important development input in any given country. The use of water to sustain agricultural growth; to support domestic stock and game animals; for human consumption and industrial processing in the district should be planned in a comprehensive way as the same resources may be put to any or all of these uses at the same time.

Provision of water in the lowlands of the District has been constrained by the availability of permanent water sources such as rivers and lakes. The Taita Hills and the hillslopes have enough water sources which need to be tapped in order to extend water facilities to the nearby lowlands. Although there are many water projects in the District, the major ones are reflected in the infrastructure inventory.

(6) Tana River District

There are potential water resources although most of them have not been tapped. The River Tana is the greatest source of water for domestic use and irrigation. During the rainy seasons, seasonal rivers (Kokani, Galole, Hirimani, etc.) flood and can be tapped for use during the dry weather. There is also a potential for sub-surface water resources. Although sub-surface water is scarce and salty, efforts should be made in future to establish the actual potential. A few surface dams have been constructed to arrest some of the rain water. The River Tana has been a major threat in floods and terrain around it is susceptible to soil erosion. Efforts to control the river have been made and will be intensified in future.

Aquifer characteristics by district

District code	name	Elevation (m)	Total depth(m)	Water struck(m)	level rest(m)	Yield (m3/hr)	Draw down(m)
310	Kilifi	122.62	70.83	47.17	28.24	5.90	14.29
320	Kwale	217.2	62.75	38.39	19.97	5.17	11.55
330	Lamu	56.5	52.71	13.75	12.00	9.22	2.00
340	Mombasa	42.12	63.04	28.95	20.05	7.74	6.94
350	Taita Taveta	752.08	74.78	49.57	22.76	7.54	26.57
360	Tana River	177.11	123.73	95.00	87.83	2.33	24.25

Groundwater development plan and cost by district

District code	name	Proposed Drinking (B/H+D)	number (S/W+H)	Proposed Livestock (B/H+D)	number (S/W+W)	Proposed (million) US$	cost (million) K£
310	Kilifi	54	526	47	482	31.4	40
320	Kwale	69	498	68	504	41.1	52
330	Lamu	15	83	32	293	14.8	19
340	Mombasa	0	0	0	0	0.0	0
350	Taita Taveta	24	190	33	295	17.6	22
360	Tana River	22	179	56	649	27.3	34

Irrigation Development Possibility

Irrigation development possibility as of 1990 was roughly checked through comparing estimated irrigation potential area and present irrigation area (existing area + future development plan) as shown in following table.

Code	310	320	330	340	350	360
District	Kilifi	Kwale	Lamu	Mombasa	Taita Taveta	Tana River
Availability	❑	○	○	❑	○	×

note : × There is no area for irrigation development
❑ There is some area for irrigation development (less than 500 ha)
○ There is more area for irrigation development (less than 5000 ha)
● There is more than enough area for irrigation development (more than 5000 ha)

Kilifi

District

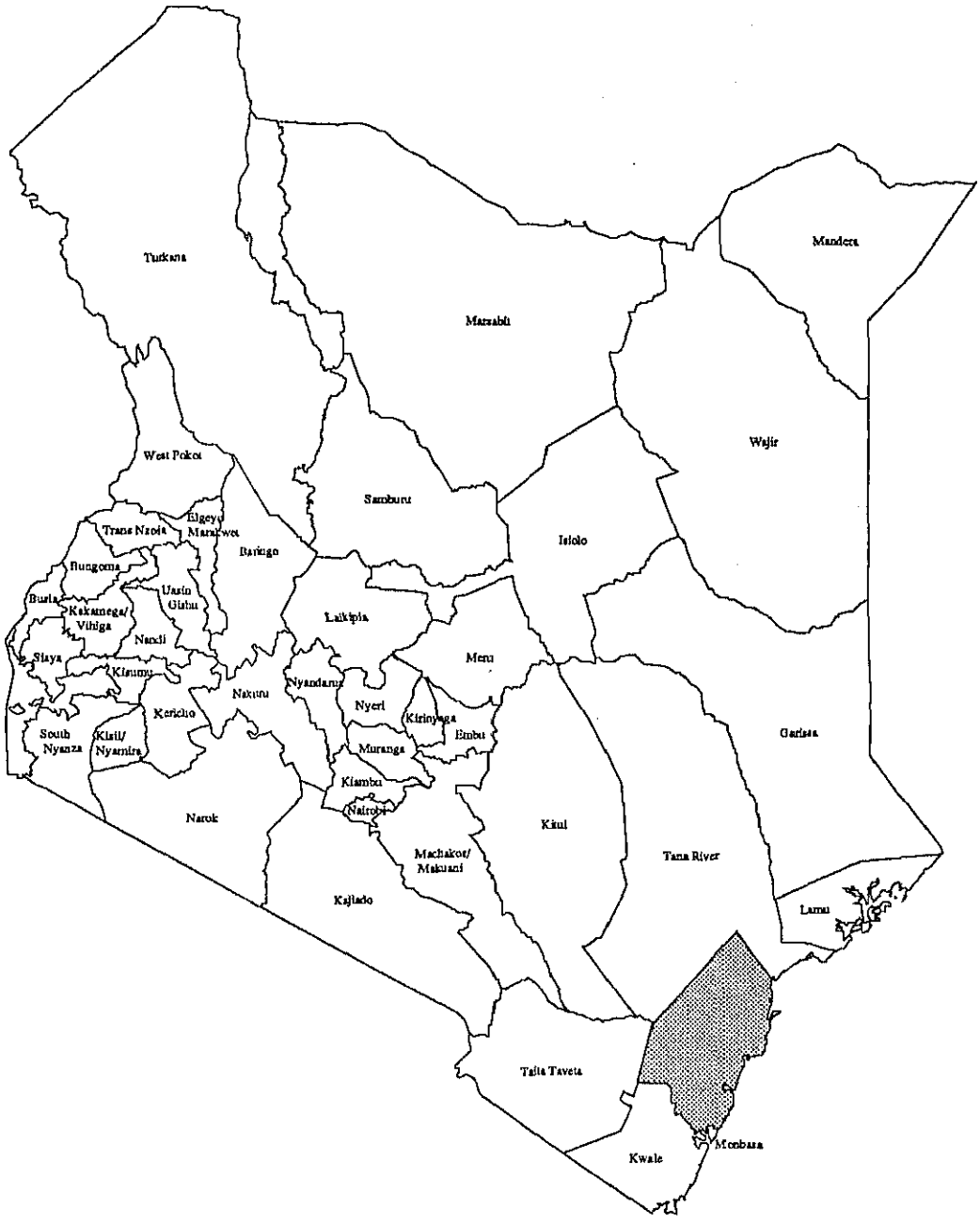
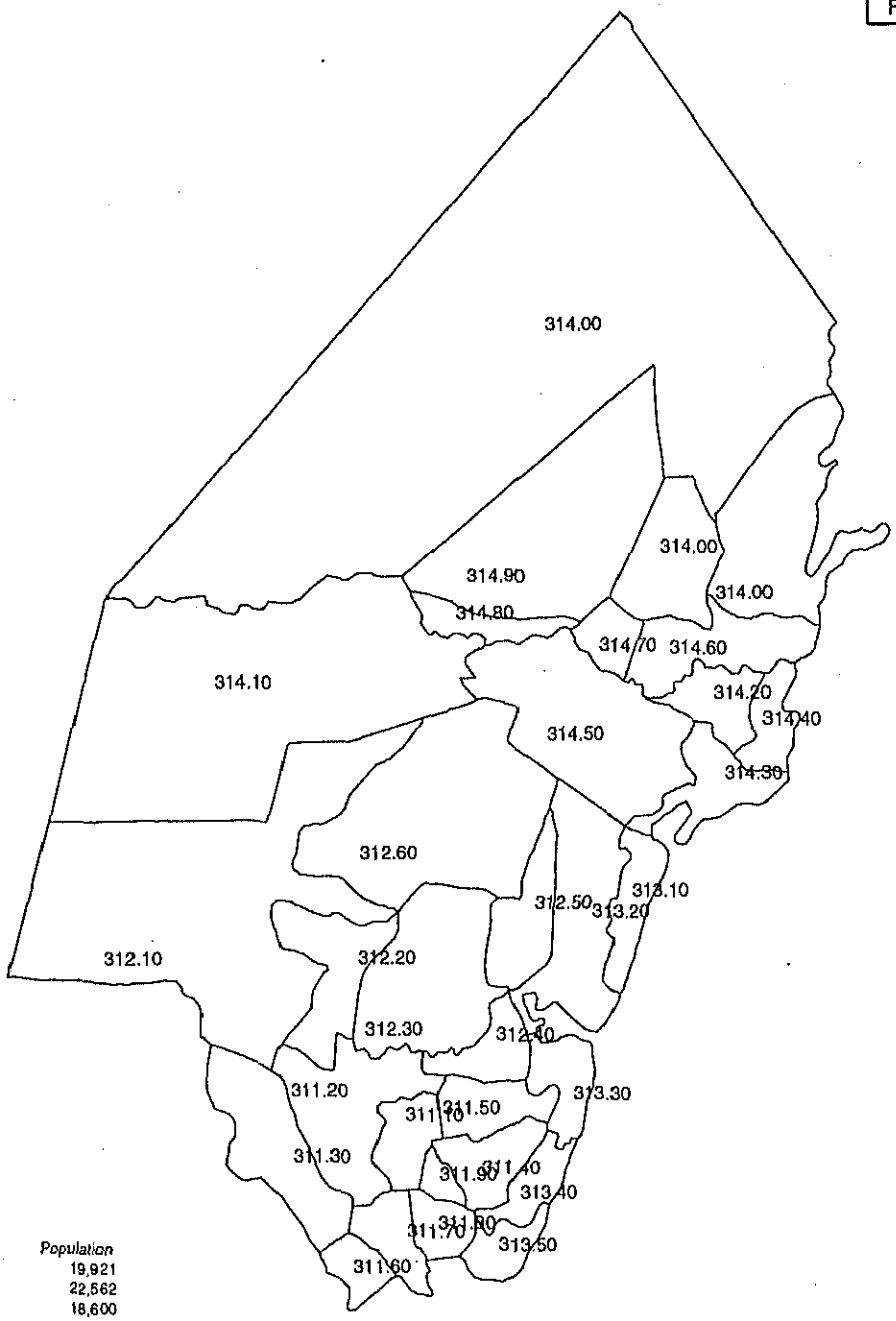
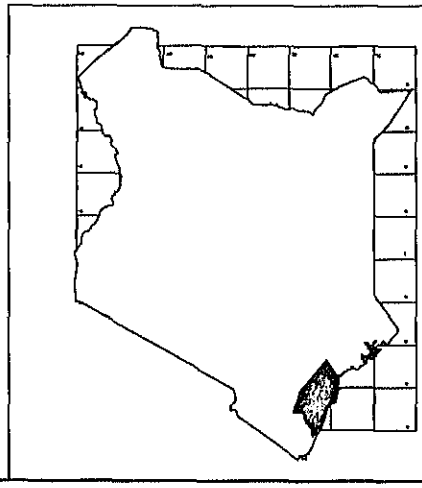


Fig.



Code	Location	Population
311.1	Kaloleni	19,921
311.2	Kayafungo	22,562
311.3	Mariakani	18,600
311.4	Mwarakaya	15,467
311.5	Chonyi	16,316
311.6	Rabai	20,987
311.7	Ruruma	19,084
311.8	Kambe Ribe	10,184
311.9	Jibana	9,423
312.1	Ndingiria	12,159
312.2	Bamba	13,948
312.3	Ganze	10,850
312.4	Kauma	9,569
312.5	Sokoke	6,563
312.6	Vitengeni	12,348
313.1	Roka	14,935
313.2	Tezo	26,892
313.3	Takaungu/Mavueni	13,805
313.4	Junju	12,753
313.5	Mtwara	16,539
314.1	Chakama	1,783
314.2	Jilore	6,178
314.3	Gede	17,137
314.4	Malindi Town	28,871
314.5	Ganda	19,791
314.6	Magarini	12,846
314.7	Dagamra	4,291
314.8	Garashi	3,437
314.9	Baricho	3,780
314.A	Marafa	4,871
314.B	Fundisha	20,308
314.C	Adu	5,788



310 Kilifi

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 310 Kilifi District

1-1 Population Projection (Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
310	Kilifi District	12,417		654.1	62.1	592.0	897.2	159.5	737.7	1,166	269.6	896.6
311.1	Kaloleni	98	Kalolemi	29.7	-	29.7	37.9	0.8	37.0	46.2	1.2	45.0
311.2	Kayafungo	296		33.7	-	33.7	41.9	-	41.9	51.0	-	51.0
311.3	Mariakani	268	Mariakani	31.2	7.6	23.6	48.9	19.4	29.4	68.9	33.1	35.8
311.4	Mwarakaya	117		23.1	-	23.1	28.7	-	28.7	34.9	-	34.9
311.5	Chonyi	114		22.8	-	22.8	28.5	-	28.5	34.6	-	34.6
311.6	Rabai	64	Mazeras	31.3	-	31.3	39.6	0.6	39.0	48.2	0.8	47.4
311.7	Ruruma	94		28.5	-	28.5	35.5	-	35.5	43.1	-	43.1
311.8	Kambe Ribe	70		15.2	-	15.2	18.9	-	18.9	23.0	-	23.0
311.9	Jibana	31		14.1	-	14.1	17.5	-	17.5	21.3	-	21.3
312.1	Ndingiria	1,269		18.1	-	18.1	22.6	-	22.6	27.5	-	27.5
312.2	Bamba	205	Bamba	20.8	-	20.8	26.3	0.4	25.9	32.0	0.5	31.5
312.3	Ganze	386		16.2	-	16.2	20.2	-	20.2	24.5	-	24.5
312.4	Kauma	99		14.3	-	14.3	17.8	-	17.8	21.6	-	21.6
312.5	Sokoke	150		9.8	-	9.8	12.2	-	12.2	14.8	-	14.8
312.6	Vitengeni	690		18.4	-	18.4	23.0	-	23.0	27.9	-	27.9
313.1	Roka	111		22.3	-	22.3	27.8	-	27.8	33.7	-	33.7
313.2	Tezo	317	Kilifi	43.9	12.5	31.4	71.1	32.0	39.1	101.9	54.4	47.5
313.3	Takaungu/Mavueni	105		20.6	-	20.6	25.7	-	25.7	31.2	-	31.2
313.4	Junju	83		19.0	-	19.0	23.7	-	23.7	28.8	-	28.8
313.5	Mtwara	73		24.7	-	24.7	30.7	-	30.7	37.4	-	37.4
314.1	Chakama	1,434		2.7	-	2.7	3.3	-	3.3	4.0	-	4.0
314.2	Jilore	109	Kakoneni	9.2	-	9.2	11.7	0.2	11.5	14.3	0.3	14.0
314.3	Gede	141	Watamu	24.4	2.1	22.3	33.2	5.4	27.8	42.9	9.1	33.8
314.4	Malindi Town	86	Malindi	45.0	36.7	8.3	104.3	93.9	10.4	172.4	159.8	12.6
314.5	Ganda	508		29.5	-	29.5	36.8	-	36.8	44.7	-	44.7
314.6	Magarini	209	Mambrui	22.4	3.2	19.2	30.7	6.8	23.9	39.5	10.5	29.0
314.7	Dagamra	70		6.4	-	6.4	8.0	-	8.0	9.7	-	9.7
314.8	Garashi	77		5.1	-	5.1	6.4	-	6.4	7.8	-	7.8
314.9	Baricho	688		5.6	-	5.6	7.0	-	7.0	8.5	-	8.5
314.A	Marafa	228		7.3	-	7.3	9.1	-	9.1	11.0	-	11.0
314.B	Fundisha	410		30.3	-	30.3	37.7	-	37.7	45.9	-	45.9
314.C	Adu	3,817		8.6	-	8.6	10.8	-	10.8	13.1	-	13.1

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	114.1	226.5	340.3
Percentage to GDP	1.5%	1.6%	1.7%
2) GRDP per Capita (K.Pound)	174.5	252.4	291.8
Ratio to GDP per capita	0.51	0.56	0.58
Urban (K.Pound)	620.6	457.0	413.9
Rural (K.Pound)	127.6	208.2	255.0

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	57,600	tons
Sorghum/Millet	7	tons
Potato	1,808	tons
Rice	4,672	tons
Wheat/Barley	-	tons
Coffee	-	tons
Tea	-	tons
Milk	13,713	tons
Meat	1,300	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	12.0
Textile	1.0
Wood	1.0
Paper	2.0
Chemical	0.0
Non-metal	1.0
Metal	1.0
Machinery	0.0
Others	0.0
Total	18.0

3) Water Supply Schemes in Service Centre

Piped system	41
Communal water points	0
Other sources	5

4) Educational Facilities

Primary school	-
Secondary school	42
Institute	13

5) Medical Facilities

Hospital	5
Health Centre	9
Dispensary	40
Others	1

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	54,883
Leprosy	44
Infectious Hepatitis	762
Bilharzia	14,767
Eye Infections	21,242

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
12,523	12,414	109	2,650	12	412	0	1,204	8,136

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
24	16	50	117	161	80	62	47	51	61	97	72	842

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
3LA05	496	2.3	0.5	0.3	0.2	0.1

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
122.62	70.83	47.17	28.24	5.9	14.29

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
5,353,076	11,788,286	17,141,362

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
1,931	0	304	3,442	0	0	0

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
4,168	3,522	0	1.2

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
102.55	128.45	-	0.05

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Kilifi District	12,399	8,981	2,821	3,705	16,784	23,497	3,443	6,206	23,681	40,472	4,275	7,762
Kaloleni	738	0	138	57	1,028	123	165	105	1,515	174	201	152
Kayafungo	675	0	156	0	907	0	186	0	1,263	0	226	0
Mariakani	468	1,099	119	2,846	627	2,864	152	4,624	869	4,967	195	5,497
Mwarakaya	517	0	107	0	710	0	127	0	1,020	0	155	0
Chonyi	513	0	106	0	701	0	126	0	1,008	0	153	0
Rabai	651	0	145	0	880	84	173	0	1,239	118	211	0
Ruruma	643	0	132	0	883	0	157	0	1,272	0	191	0
Kambe Ribe	308	0	71	0	415	0	84	0	580	0	102	0
Jibana	330	0	65	0	455	0	78	0	662	0	94	0
Ndingiria	360	0	84	0	482	0	100	0	667	0	122	0
Bamba	412	0	97	0	552	52	115	0	766	74	140	0
Ganze	323	0	75	0	432	0	89	0	602	0	109	0
Kauma	303	0	66	0	411	0	79	0	582	0	96	0
Sokoke	194	0	45	0	260	0	54	0	360	0	66	0
Vitengeni	371	0	86	0	498	0	102	0	695	0	124	0
Roka	441	0	103	0	591	0	123	0	820	0	150	0
Tezo	621	1,807	160	297	832	4,712	208	538	1,154	8,168	271	755
Takaungu/Mavueni	408	0	96	0	547	0	114	0	758	0	138	0
Junju	458	0	88	0	636	0	105	0	930	0	128	0
Mtwara	546	0	115	37	747	0	136	73	1,071	0	166	112
Chakama	53	0	12	0	70	0	15	0	97	0	18	0
Jilore	200	0	43	0	271	31	51	0	388	45	62	0
Gede	475	304	106	0	645	791	129	0	914	1,372	160	0
Malindi Town	165	5,307	81	468	221	13,831	150	866	307	23,982	233	1,246
Ganda	592	0	137	0	794	0	163	0	1,106	0	198	0
Magarini	379	462	93	0	508	1,007	113	0	705	1,572	140	0
Dagamra	127	0	30	0	170	0	35	0	235	0	43	0
Garashi	102	0	24	0	136	0	28	0	188	0	34	0
Baricho	112	0	26	0	149	0	31	0	208	0	38	0
Marafa	144	0	34	0	193	0	40	0	267	0	49	0
Fundisha	599	0	141	0	804	0	167	0	1,115	0	204	0
Adu	171	0	40	0	229	0	48	0	318	0	58	0

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Mariakani	33,100	Mzima pipeline	2nd Mzima P/L	g	2.4	0	4,621
Kilifi	54,500	Sabaki pipeline	Rare reservoir	p	13.9	70	9,645
Watamu	9,200		Sabaki pipeline	g	20.1	0	5,151
Malindi	159,800	Sabaki Pipeline	Sabaki Pipeline & Rare Dam	g	49	0	64,369
Mambrui	14,400	Borehole /small dam	Sabaki river	p	5.5	60	4,479

g: gravity p; pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No (Nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
Burangi	80	200	Malindi	Magarini	Irrigation	MOA	0.2	3HC
Dagamra	48	0	Malindi	Garashi	Irrigation	MOA	1.968	3HC
Chakama(Prop)	100	?	?	?	Irrigaiton	?	4.1	3HC
Sabaki	12	64	Malindi	Malindi	Irrigaiton	IDB	0.492	3HD1
Jilore(Mongotini)	60	120	Malindi	Jilore	Irrigation	MOA	2.46	3HD1
Nzofuni	0	?	?	?	Irrigaiton	?	?	3LA
Masheheni	30	?	Malindi	Magarini	Irrigation	MOA	1.23	?
Magombe(Rare)	0	0	Ganze	Kauma	Irrigation	MOA	?	?

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million) US$	Cost (million) K£	Major Crops
Sabaki Extension	3,000	Sabaki River	77.3	19.8	24.9	Rice

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million) US$	Cost(million) K£	Implementation Schedule 93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million) US$	Cost(million) K£	Implementation Schedule 93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million) US$	Cost (million) K£	Implementation Schedule 93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Kilifi	12,500	0.6	MOLG	4.9	6.2												☆	☆	☆	●	●	●	
Malindi	36,700	1.0	MOLG	7.6	9.6												☆	☆	☆	●	●	●	

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
Rare	6246	W	91	37.3	0.50	21	35,117

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers Drinking (B/H+D)	Proposed Numbers Drinking (S/W+H)	Proposed Numbers Livestock (B/H+D)	Proposed Numbers Livestock (S/W+H)	Executing Agency	Cost (million) US$	Cost (million) K£	Implementation Schedule 93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	Remarks
54	526	47	482	MOWD/	30.5	38.4	☆	●	●	●	●	●													Safe water supply

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4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan: Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline	Total	Implementation Program (%): Up to 2000	2001-2010
- Quantity (m3/d)	765	3,957	6,123	3,195	30	51	55	0	9,449	23,625	38.9	61.1
- No. of Facilities	0	104	1,219	83,244	6	11	11	0	0	84,595		
- Cost (mill.US$)	0	13.77	5.91	50.23	0.04	0.14	0.11	0	0	70.21		
(mill.K£)	0	17.37	7.46	63.34	0.05	0.18	0.14	0	0	88.53		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	237	1,255	2,371	8	8	7	39	3,925	42.8	57.2
- No. of Facilities	0	47	482	4	5	5	0	543		
- Cost (mill.US$)	0	4.39	2.26	0.01	0.02	0.01	0	6.7		
(mill.K£)	0	5.54	2.85	0.01	0.03	0.02	0	8.44		

4.11 Watering Points in Nomadic Pasturage Area

Asumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos)	Executing Agency	Cost (million)		Implementaion of Watering Points (No.)	
			US$	K£	up to 2000	2001-2010
7,562	12	MOWD	2.3	2.8	4	8

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
Baricho Dam	W+I	Malindi+Mombasa	Sabaki	-

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																	
		US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Athi River Basin Study (Update)	TARDA	4.0	5.0		☆	☆	☆	☆	☆												

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
	(WRAP underway for two divisions)	MOWD	2.5	3.2		☆	☆	☆														

☆ Study

o River Basin Study (proposed under separate programme)

Note : WRAP study is underway for partial areas (two divisions : Bahari and Ganza)

Kwale District

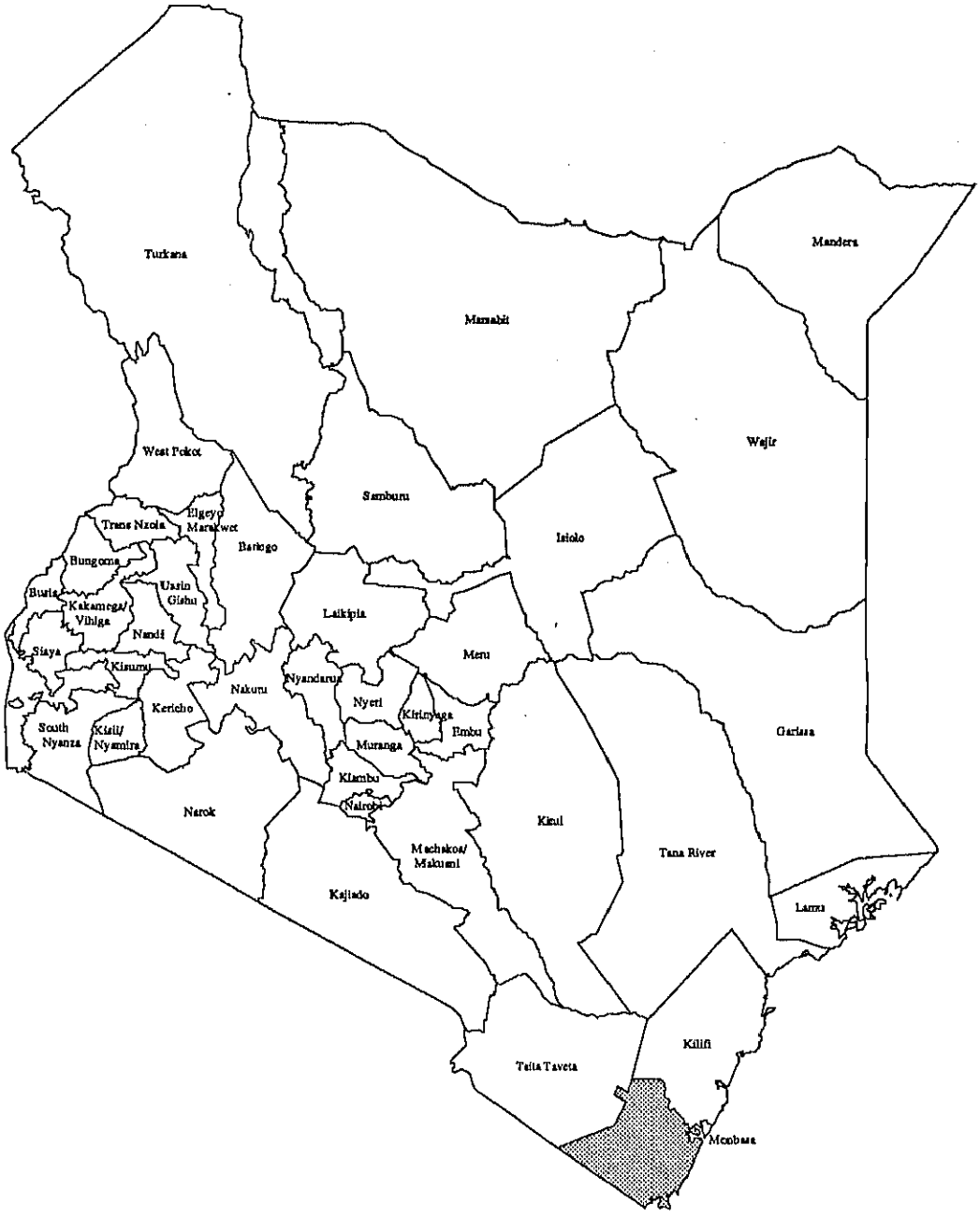
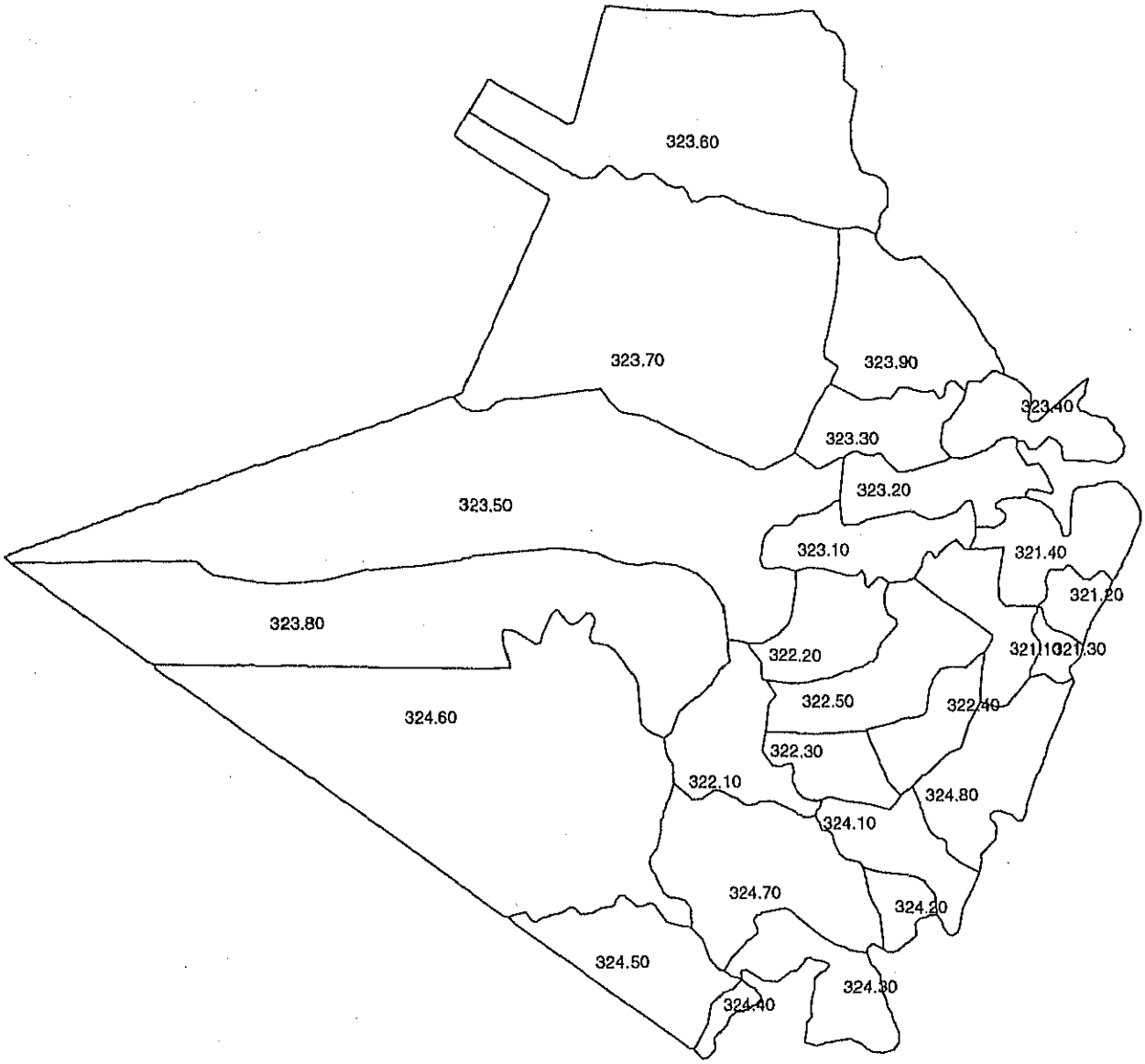
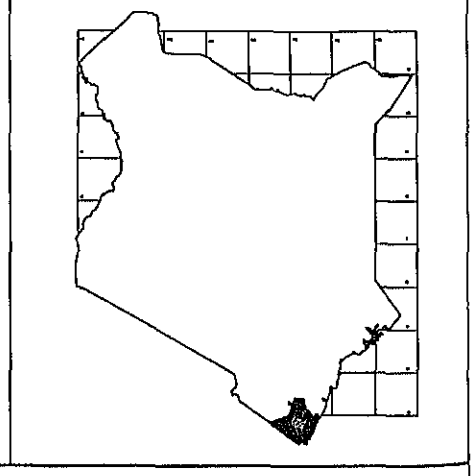


Fig.



Code	Location	Population
321.1	Shimba North	13,601
321.2	Waa	9,049
321.3	Tiwi	10,297
321.4	Ngombeni	13,380
322.1	Mkongani	11,246
322.2	Mwaluphamba	10,371
322.3	Lukore	4,734
322.4	Majimboni	2,899
322.5	Shimba Hills Nat. Reserve	0
323.1	Kinango South	6,254
323.2	Kinango North	8,878
323.3	Kilibole West	5,601
323.4	Kilibole East	11,148
323.5	Puma	11,867
323.6	North Samburu	14,802
323.7	South Samburu	14,795
323.8	Ndavaya	5,893
323.9	Mwavumbo	15,475
324.1	Msambweni	15,920
324.2	Shirazi/Funzi	7,963
324.3	Pongwe/Kidimu	8,876
324.4	Vanga	1,870
324.5	Lungalunga	14,022
324.6	Mwereni	15,904
324.7	Kikoneni	25,125
324.8	Diani	28,393



320 Kwale

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 320 Kwale District

1-1 Population Projection (Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990 Total	1990 Urban	1990 Rural	2000 Total	2000 Urban	2000 Rural	2010 Total	2010 Urban	2010 Rural
320	Kwale District	8,255		408.9	14.7	394.2	523.2	42.9	480.3	632.3	65.5	566.8
321.1	Shimba North	126	Kwale	19.7	3.7	16.0	29.2	9.6	19.6	38.3	15.2	23.1
321.2	Waa	47		12.7	-	12.7	15.5	-	15.5	18.3	-	18.3
321.3	Tiwi	30		14.5	-	14.5	17.7	-	17.7	20.8	-	20.8
321.4	Ngombeni	165		18.8	-	18.8	22.9	-	22.9	27.1	-	27.1
322.1	Mkongani	183		15.8	-	15.8	19.3	-	19.3	22.8	-	22.8
322.2	Mwaluphamba	148		14.6	-	14.6	17.8	-	17.8	21.0	-	21.0
322.3	Lukore	96		6.7	-	6.7	8.1	-	8.1	9.6	-	9.6
322.4	Majimboni	101		4.1	-	4.1	5.0	-	5.0	5.9	-	5.9
322.5	Shimba Hills Nat. Reser	214		0.0	-	0.0	0.0	-	0.0	0.0	-	0.0
323.1	Kinango South	148	Kinango	8.8	-	8.8	15.1	4.3	10.7	18.4	5.7	12.7
323.2	Kinango North	154		12.5	-	12.5	15.2	-	15.2	18.0	-	18.0
323.3	Kilibole West	137		7.9	-	7.9	9.6	-	9.6	11.3	-	11.3
323.4	Kilibole East	130		15.7	-	15.7	19.1	-	19.1	22.6	-	22.6
323.5	Puma	1,301		16.7	-	16.7	20.4	-	20.4	24.0	-	24.0
323.6	North Samburu	756		20.8	-	20.8	25.4	-	25.4	30.0	-	30.0
323.7	South Samburu	1,081		20.8	-	20.8	25.4	-	25.4	29.9	-	29.9
323.8	Ndavaya	875		8.3	-	8.3	10.1	-	10.1	11.9	-	11.9
323.9	Mwavumbo	268		21.8	-	21.8	26.5	-	26.5	31.3	-	31.3
324.1	Msambweni	132	Msambweni	22.2	8.4	13.8	38.6	21.8	16.8	54.3	34.5	19.8
324.2	Shirazi/Funzi	49		11.2	-	11.2	13.7	-	13.7	16.1	-	16.1
324.3	Pongwe/Kidimu	155		12.5	-	12.5	15.2	-	15.2	18.0	-	18.0
324.4	Vanga	25		2.6	-	2.6	3.2	-	3.2	3.8	-	3.8
324.5	Lungalunga	213	Lungalunga	22.3	2.6	19.7	29.7	5.6	24.0	36.5	8.1	28.4
324.6	Mwereni	1,165		22.4	-	22.4	27.3	-	27.3	32.2	-	32.2
324.7	Kikoneni	350		35.4	-	35.4	43.1	-	43.1	50.9	-	50.9
324.8	Diani	206	Ukanda	40.0	-	40.0	50.2	1.5	48.7	59.4	1.9	57.5

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	34.7	59.9	87.1
Percentage to GDP	0.4%	0.4%	0.4%
2) GRDP per Capita (K.Pound)	84.8	114.4	137.8
Ratio to GDP per capita	0.25	0.25	0.27
Urban (K.Pound)	882.9	572.6	574.0
Rural (K.Pound)	55.1	73.6	87.4

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	43,395	tons
Sorghum/Millet	140	tons
Potato	4,032	tons
Rice	1,053	tons
Wheat/Barley	-	tons
Coffee	-	tons
Tea	-	tons
Milk	1,155	tons
Meat	N.A	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	3.0
Textile	0.0
Wood	1.0
Paper	0.0
Chemical	0.0
Non-metal	0.0
Metal	0.0
Machinery	0.0
Others	0.0
Total	4.0

3) Water Supply Schemes in Service Centre

Piped system	12
Communal water points	6
Other sources	16

4) Educational Facilities

Primary school	228
Secondary school	20
Institute	9

5) Medical Facilities

Hospital	4
Health Centre	5
Dispensary	27
Others	0

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	19,365
Leprosy	48
Infectious Hepatitis	482
Bilharzia	12,238
Eye Infections	10,134

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
8,322	8,257	65	792	0	486	0	1,000	5,979

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
36	19	62	120	149	60	49	47	48	80	108	79	862

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
3KC04	145	1.2	0.2	0.1	0.0	0.0
3KG01	2,388	4.6	2.1	1.8	1.6	1.3
3MA03	8,619	6.5	1.6	0.8	0.7	0.4

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
217.2	62.75	38.39	19.97	5.17	11.55

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
5,363,595	7,478,533	12,842,128

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
1,366	0	937	2,471	0	0	0

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
1,969	1,969	52.4	49.2

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
239.67	222.43	-	-

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Kwale District	9,207	2,126	5,019	172	12,425	6,314	5,725	317	17,516	9,829	6,528	459
Shimba North	430	535	214	0	592	1,416	256	0	861	2,281	301	0
Waa	342	0	161	0	470	0	181	0	683	0	205	0
Tiwi	388	0	183	1	535	0	206	2	777	0	233	3
Ngombeni	457	0	238	0	620	0	268	0	884	0	303	0
Mkongani	352	0	200	0	471	0	225	0	656	0	255	0
Mwaluphamba	347	0	184	0	471	0	207	0	665	0	235	0
Lukore	178	0	84	0	246	0	95	0	358	0	107	0
Majimboni	109	0	51	0	150	0	58	0	219	0	66	0
Shimba Hills N. Reserve	0	0	0	0	0	0	0	0	0	0	0	0
Kinango South	192	0	111	0	255	641	138	0	354	861	158	0
Kinango North	255	0	158	0	336	0	178	0	456	0	201	0
Kilibole West	156	0	99	0	205	0	112	0	275	0	127	0
Kilibole East	310	0	198	0	408	0	223	0	548	0	253	0
Puma	331	0	211	0	434	0	237	0	583	0	269	0
North Samburu	413	0	263	0	541	0	296	0	728	0	335	0
South Samburu	412	0	263	0	541	0	296	0	728	0	335	0
Ndavaya	164	0	105	0	215	0	118	0	290	0	134	0
Mwavumbo	432	0	275	0	565	0	309	0	761	0	351	0
Msambweni	370	1,215	200	57	510	3,215	260	105	740	5,178	319	152
Shirazi/Funzi	300	0	141	57	413	0	159	105	601	0	180	152
Pongwe/Kidimu	335	0	158	0	461	0	177	0	670	0	201	0
Vanga	71	0	33	0	98	0	37	0	141	0	42	0
Lungalunga	440	376	257	57	588	828	297	105	820	1,219	340	152
Mwereni	444	0	282	0	581	0	318	0	783	0	360	0
Kikoneni	908	0	446	0	1,244	0	502	0	1,791	0	569	0
Diani	1,071	0	504	0	1,475	215	572	0	2,144	289	649	0

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Kwale	15,200	Marere spring	Marere pipeline	p	7.8	200	4,755
Kinango	5,800	Marere pipeline	Marere pipeline	p	18.7	130	4,773
Msambweni	34,500	Boreholes	Boreholes + Mkurumuji river	p	375	40	45,479
Lungalunga	8,200	Boreholes	Umba river	p	1.3	40	2,355

g: gravity p: pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No (Nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
Pongwe	15	40	Matuqa	Tiwi	Irrigation	M OF A	0.615	3K
Semkube	26	1	Matuga	Tiwi	Irrigation	M OF A	1.066	3K
Milalani	30	200	Msambweni	Msambweni	Drainage	M .OF A	1.23	3K
Majoreni	30	100	Msambweni	Pongwe	Drainage	M OF A	1.23	3K
Msambweni	32	120	Msambweni	Musambweni	Irrigation	MA	1.312	3K
Vanga(Ext.)	400	?	?	?	Irrigaiton	?	16.4	3K
Mhaka	25	30	Msambweni	Kinondo	Irrigation	M OF A	1.025	?
Msambeni	0	0	?	?	Irrigation	?	?	?

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million)		Major Crops
				US$	K£	
-	-	-	-	-	-	-

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million)		Implementation Schedule																
				US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Kwale	*3,700*	*0.9*	*MOLG*	*7.2*	*9.1*													☆	☆	☆	●	●	●

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
Mwachi	7497	W	86	113.0	2.75	77	97,013
Pemba	866	W	70	0.3	0.23	weir	1,100

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers				Executing Agency	Cost (million)		Implementation Schedule																Remarks
Drinking		Livestock																					
(B/H+D)	(S/W+H)	(B/H+D)	(S/W+H)		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	
69	498	68	504	MOWD/	40.0	50.4	☆	●	●	●	●														Safe water supply

★ Design ☆ Study ● Construction

4.9 Source Development Plan for Rural Water Supply

District	*Source Development Plan*									Total	*Implementation Program (%)*	
	Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	1,566	5,038	4,775	2,720	101	49	133	0	3,071	17,453	38.7	61.3
- No. of Facilities	0	119	944	59,067	10	13	21	0	0	60,174		
- Cost (mill.US$)	0	18.14	4.38	35.34	0.14	0.14	0.27	0	0	58.41		
(mill.K£)	0	22.88	5.52	44.57	0.17	0.17	0.35	0	0	73.65		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	921	2,639	2,529	65	17	49	75	6,295	46.8	53.2
- No. of Facilities	0	68	504	12	10	15	0	609		
- Cost (mill.US$)	0	9.57	2.29	0.08	0.04	0.1	0	12.07		
(mill.K£)	0	12.06	2.88	0.1	0.05	0.12	0	15.23		

4.11 Watering Points in Nomadic Pasturage Area

Asumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos)	Executing Agency	Cost (million)		Implementaion of Watering Points (No.)	
			US$	K£	up to 2000	2001-2010
5,503	9	MOWD	1.9	2.4	3	6

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
-	-	-	-	-

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																
		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-																		

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

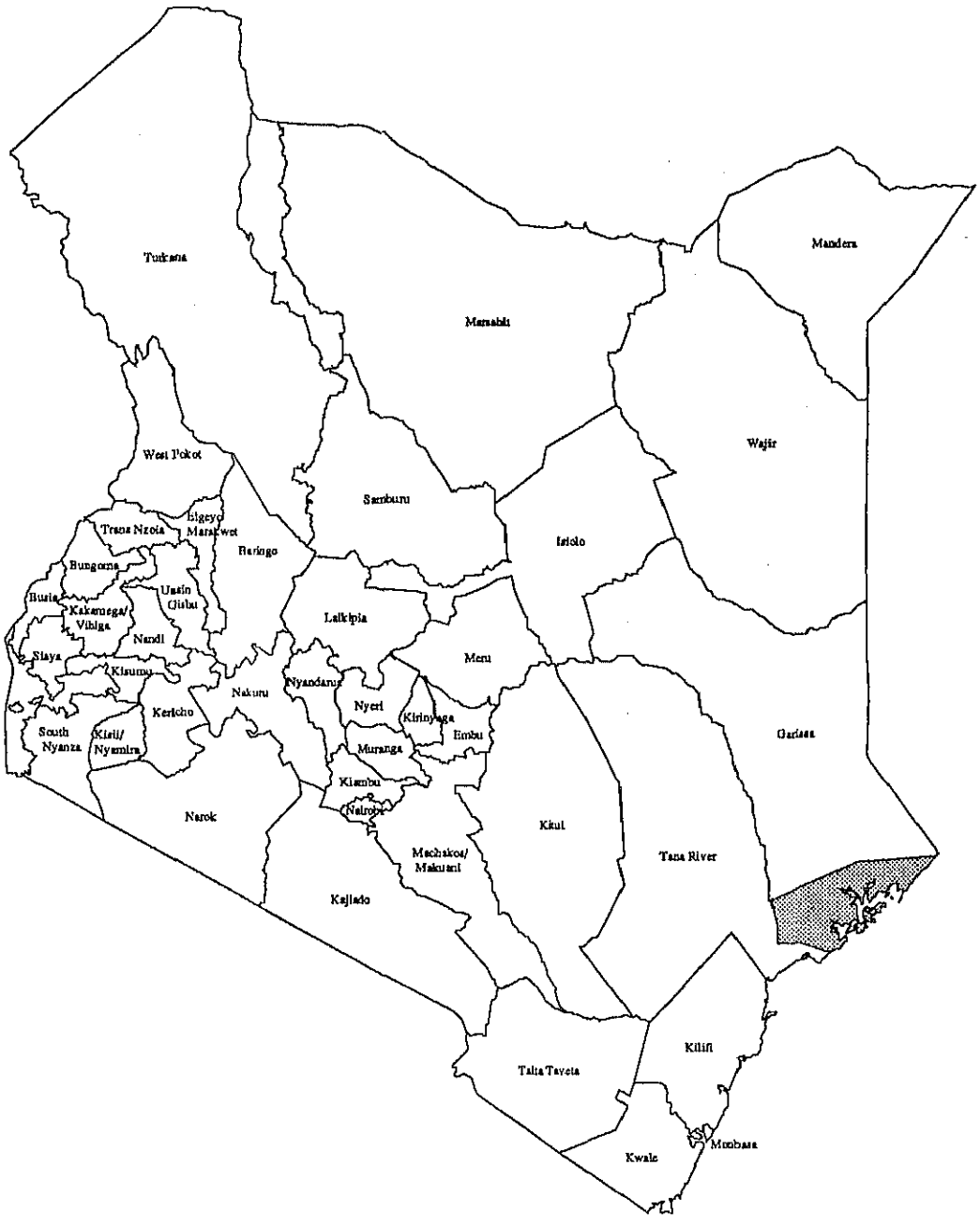
Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
		MOWD	3.0	3.8		☆	☆	☆														

☆ Study

○ River Basin Study (proposed under separate programme)

Lamu

District



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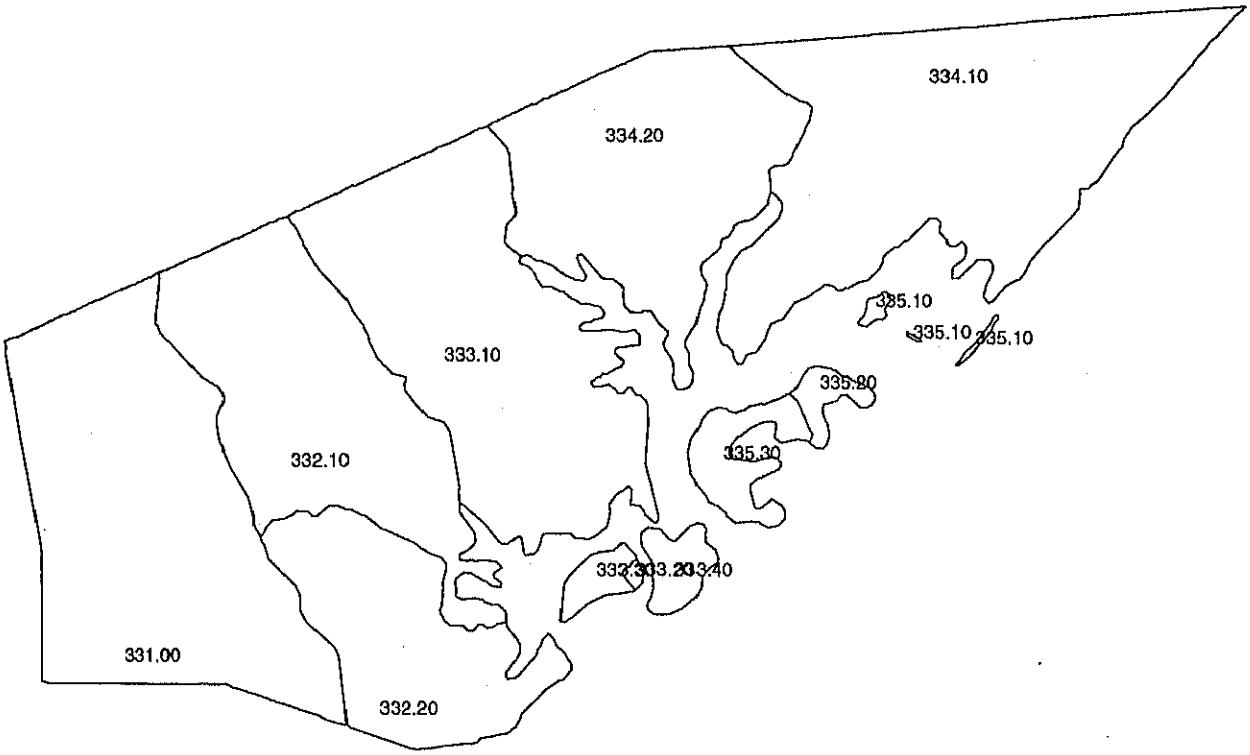
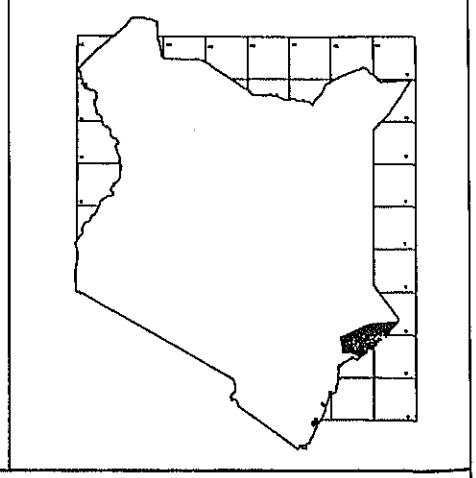


Code	Location	Population
331	Witu	3,349
332.1	Mkunumbi	922
332.2	Mpeketoni/Baharini	10,848
333.1	MkoweE	3,100
333.2	Lamu Town	8,394
333.3	Lamu Island	1,126
333.4	Manda/Sheta Island	1,230
334.1	Kiunga	1,359
334.2	Milimani	276
335.1	Ndau/Kuwauyu Island	1,375
335.2	Faza/Tchudwa/Kizingitini	7,334
335.3	Siu	2,987



330 Lamu

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 330 Lamu District

1-1 Population Projection

(Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
330	Lamu District			60.5	12.3	48.2	86.3	27.8	58.5	120.1	46.3	73.8
331.0	Witu	1,298	Witu	4.9	3.3	1.6	9.4	7.5	2.0	14.9	12.4	2.5
332.1	Mkunumbi	904		1.4	-	1.4	1.7	-	1.7	2.2	-	2.2
332.2	Mpeketoni/Baharini	581		16.6	-	16.6	20.1	-	20.1	25.3	-	25.3
333.1	Mokowe	1,179		4.7	-	4.7	5.7	-	5.7	7.2	-	7.2
333.2	Lamu Town	5	Lamu	9.0	9.0	0.0	20.3	20.3	0.0	33.9	33.9	0.0
333.3	Lamu Island	47		1.7	-	1.7	2.1	-	2.1	2.6	-	2.6
333.4	Manda/Shela Island	67		1.9	-	1.9	2.3	-	2.3	2.9	-	2.9
334.1	Kiunga	1,378		2.1	-	2.1	2.5	-	2.5	3.2	-	3.2
334.2	Milimani	863		0.4	-	0.4	0.5	-	0.5	0.6	-	0.6
335.1	Ndau/Kuwauyu Island	15		2.1	-	2.1	2.5	-	2.5	3.2	-	3.2
335.2	Faza/Tchudwa/Kizingiti	45		11.2	-	11.2	13.6	-	13.6	17.1	-	17.1
335.3	Siu	123		4.6	-	4.6	5.5	-	5.5	7.0	-	7.0

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	21.1	42.2	64.1
Percentage to GDP	0.3%	0.3%	0.3%
2) GRDP per Capita (K.Pound)	348.3	489.6	533.8
Ratio to GDP per capita	1.02	1.09	1.05
Urban (K.Pound)	859.1	719.4	660.4
Rural (K.Pound)	218.1	380.6	454.3

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	1,960	tons
Sorghum/Millet	63	tons
Potato	36	tons
Rice	16	tons
Wheat/Barley	-	tons
Coffee	-	tons
Tea	-	tons
Milk	-	tons
Meat	-	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	3
Textile	0
Wood	1
Paper	0
Chemical	0
Non-metal	0
Metal	0
Machinery	0
Others	0
Total	4

3) Water Supply Schemes in Service Centre

Piped system	3
Communal water points	1
Other sources	10

4) Educational Facilities

Primary school	46
Secondary school	6
Institute	4

5) Medical Facilities

Hospital	3
Health Centre	4
Dispensary	11
Others	1

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	10,735
Leprosy	11
Infectious Hepatitis	84
Bilharzia	2,727
Eye Infections	4,699

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
6,814	6,506	308	2,534	0	119	0	200	3,653

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
16	9	40	105	156	83	51	34	40	40	79	55	711

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
-	-	-	-	-	-	-

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
56.5	52.71	13.75	12	9.22	2

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
3,605,400	5,715,459	9,320,859

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
2,680	0	562	4,248	0	0	0

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
1,035	430	0	0.2

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
37.15	15.92	-	-

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Lamu District	1,028	1,779	1,088	341	1,365	4,092	1,478	632	2,007	6,955	3,069	910
Witu	33	477	52	0	44	1,097	86	0	66	1,866	201	0
Mkunumbi	28	0	30	0	37	0	39	0	53	0	77	0
Mpeketoni/Baharini	385	0	351	0	517	0	453	0	777	0	910	0
MkoweE	94	0	100	0	125	0	130	0	179	0	260	0
Lamu Town	0	1,302	48	341	0	2,995	115	632	0	5,089	305	910
Lamu Island	42	0	36	0	58	0	47	0	89	0	95	0
Manda/Shela Island	38	0	40	0	49	0	51	0	70	0	103	0
Kiunga	41	0	44	0	54	0	57	0	77	0	114	0
Milimani	8	0	9	0	11	0	12	0	15	0	23	0
Ndau/Kuwauyu Island	41	0	44	0	54	0	57	0	78	0	115	0
Faza/Tchudwa/Kizingitini	222	0	237	0	289	0	306	0	416	0	615	0
Siu	96	0	97	0	127	0	125	0	187	0	251	0

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Witu	12,500	1 no shallow well	Mkondo wa Cambi river	p	11.6	10	5,403
Lamu	34,000	20 shallow wells	P/L from Tana River + B/H	p	121	40	37,534

g: gravity p; pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No (Nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
Marembo-Lazi	0	0	?	?	Irrigaiton	?	?	?
Maziwa	0	0	?	?	Irrigaiton	?	?	?
Mwina	0	0	?	?	Irrigaiton	?	?	?
Tana Delta 2	0	0	?	?	Irrigaiton	?	?	?
Wenje-Bububu	0	0	?	?	Irrigaiton	?	?	?

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million)		Major Crops
				US$	K£	
-	-	-	-	-	-	-

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million)		Implementation Schedule																
				US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Lamu	9,000	0.9	MOLG	7.0	8.8											☆	☆	☆	●	●	●		

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
-	-	-	-	-	-	-	-

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers				Executing Agency	Cost (million)		Implementation Schedule																Remarks
Drinking		Livestock																					
(B/H+D)	(S/W+H)	(B/H+D)	(S/W+H)		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	
15	83	32	293	MOWD/	14.4	18.1	☆	●	●																Safe water supply

★ Design ☆ Study ● Construction

4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan									Total	Implementation Program (%)	
	Surface Water	*Borehole*	*Shallow Well*	*Roof Catch*	*Small Dam*	*Subsur-face Dam*	*Sand Dam*	*Rock Catch*	*Existing Pipeline*		*Up to 2000*	*2001-2010*
- Quantity (m3/d)	0	652	777	259	0	0	0	0	299	1,987	34.4	65.6
- No. of Facilities	0	22	160	8,053	0	0	0	0	0	8,235		
- Cost (mill.US$)	0	2.19	0.76	5.13	0	0	0	0	0	8.08		
(mill.K£)	0	2.76	0.96	6.47	0	0	0	0	0	10.19		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	0	1,203	1,442	0	0	0	0	2,645	19.7	80.3
- No. of Facilities	0	32	293	0	0	0	0	325		
- Cost (mill.US$)	0	4.04	1.41	0	0	0	0	5.44		
(mill.K£)	0	5.09	1.77	0	0	0	0	6.86		

4.11 Watering Points in Nomadic Pasturage Area

Asumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos)	Executing Agency	Cost (million)		Implementaion of Watering Points (No.)	
			US$	K£	up to 2000	2001-2010
3,481	6	MOWD	1.1	1.4	2	4

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
-	-	-	-	-

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																
		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-																		

★ Design ☆ Study ● Construction

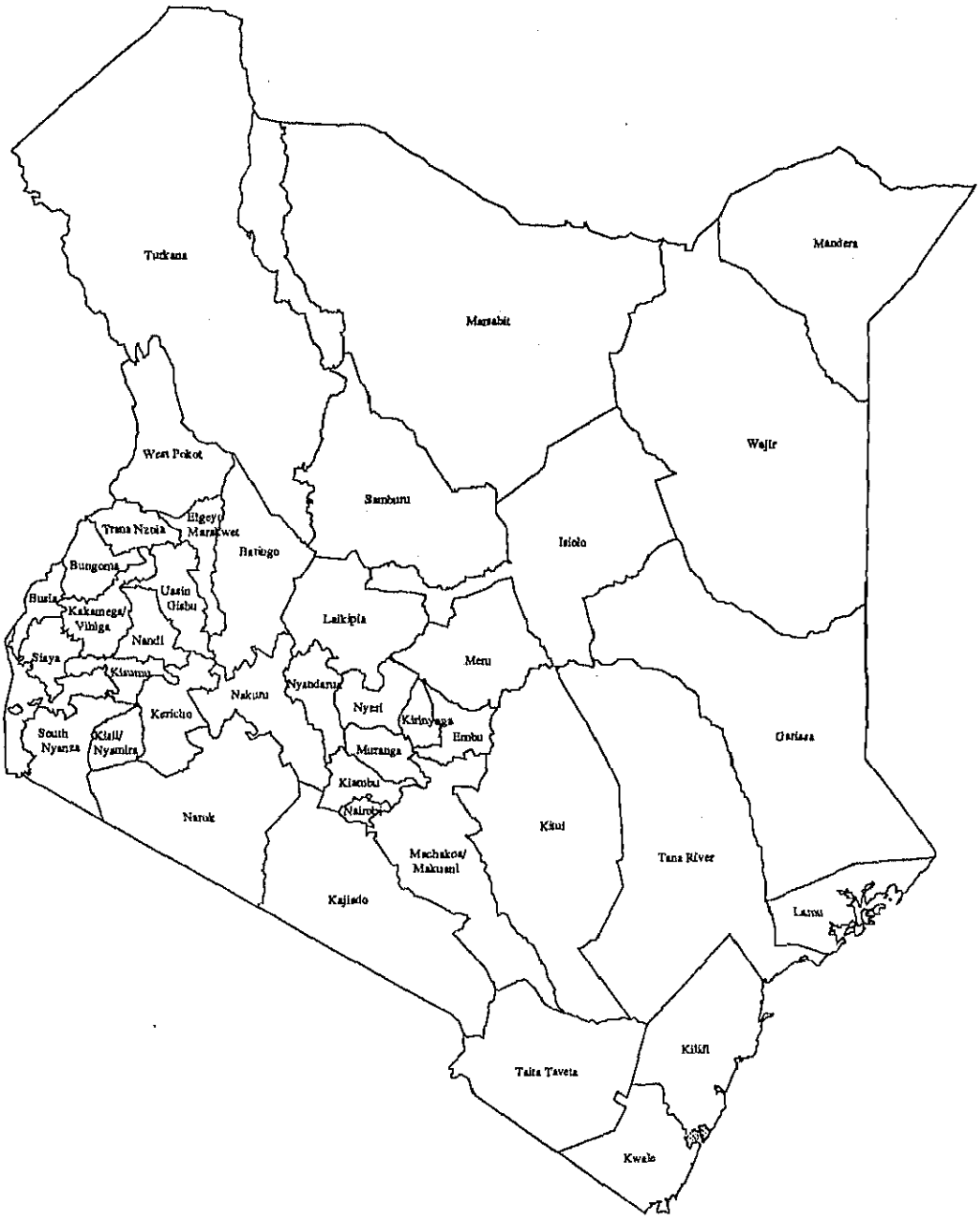
5.3 District Water Resource Study

Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
	(WRAP proposed)	MOWD	-	-		☆	☆	☆														

☆ Study

o River Basin Study (proposed under separate programme)

Mombasa District



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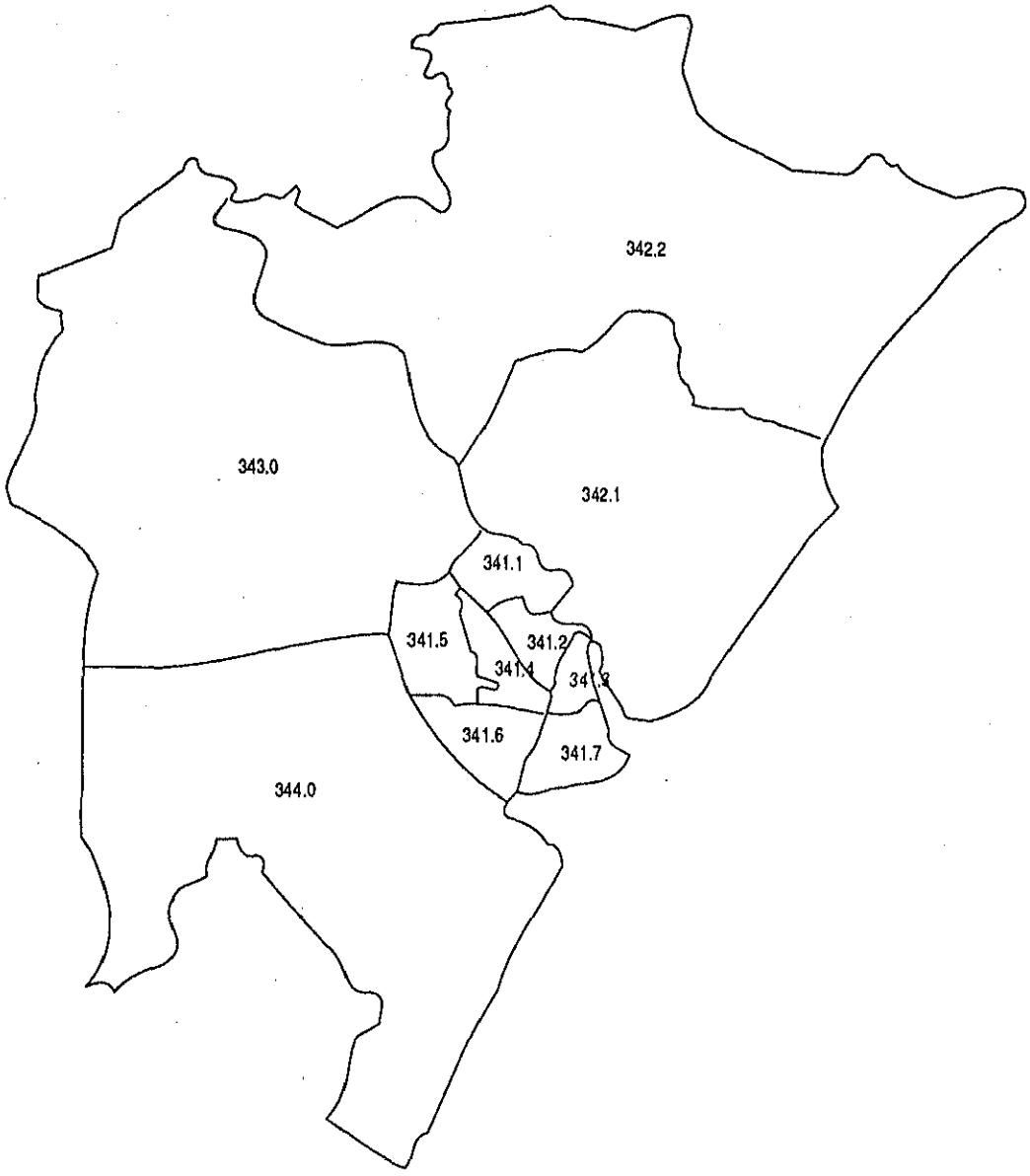
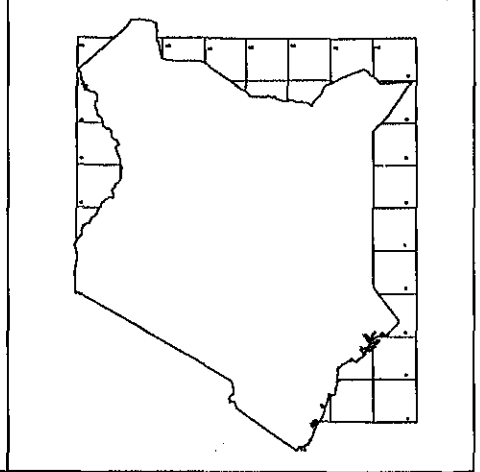


Code	Location	Population
341.1	Tudor	17,156
341.2	Tononoka	27,245
341.3	Old Town	19,959
341.4	Majengo	42,841
341.5	Shimanzi	8,061
341.6	Ganjoni	11,366
341.7	Kizingo	11,654
342.1	Kisauni	61,533
342.2	Mwakirunge	18,766
343	Changamwe	40,184
344	Likoni	82,353



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340 Monbasa

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 340 Mombasa District

1-1 Population Projection

(Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
340	Mombasa	210	Mombasa	479.6	479.6	0.0	672.9	672.9	0.0	904.4	904.4	0.0

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	691.3	1253.4	1884.5
Percentage to GDP	8.9%	9.1%	9.2%
2) GRDP per Capita (K.Pound)	1441.3	1862.6	2083.8
Ratio to GDP per capita	4.22	4.14	4.11
Urban (K.Pound)	1441.3	1862.6	2083.8
Rural (K.Pound)	-	-	-

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	808	tons
Sorghum/Millet	18,072	tons
Potato	144	tons
Rice	325	tons
Wheat/Barley	-	tons
Coffee	-	tons
Tea	-	tons
Milk	2,240	tons
Meat	8,421	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	45
Textile	68
Wood	23
Paper	32
Chemical	21
Non-metal	14
Metal	5
Machinery	33
Others	17
Total	258

3) Water Supply Schemes in Service Centre

Piped system	23
Communal water points	0
Other sources	0

4) Educational Facilities

Primary school	71
Secondary school	33
Institute	10

5) Medical Facilities

Hospital	6
Health Centre	16
Dispensary	10
Others	11

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	15,847
Leprosy	40
Infectious Hepatitis	152
Bilharzia	1,714
Eye Infections	12,797

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
275	210	65	8	0	143	0	59	0

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
24	17	40	163	267	117	91	72	72	101	103	66	1,138

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
-	-	-	-	-	-	-

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
42.12	63.04	28.95	20.05	7.74	6.94

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
140,913	64,505	205,418

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
120	0	31	120	0	0	0

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
3	3	0	0

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
4.00	9.54	-	-

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Mombasa District	0	69,350	138	30,768	0	99,157	182	52,286	0	135,745	239	66,834

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Mombasa	904,400	Mzima P/L /Sabaki P/L /Marere P/L	2nd Mzima/Mwachi Dam, Pemba Dam	g	261.9	0	441,575

g: gravity p: pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No (Nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
-	-	-	-	-	-	-	-	-

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million)		Major Crops
				US$	K£	
-	-	-	-	-	-	-

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million)		Implementation Schedule																
				US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Mombasa	479,600	11.6	MOLG	46.6	58.7		☆	☆	☆	●	●	●											

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
-	-	-	-	-	-	-	-

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers				Executing Agency	Cost (million)		Implementation Schedule																Remarks
Drinking		Livestock																					
(B/H+D)	(S/W+H)	(B/H+D)	(S/W+H)		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	
-	-	-	-	-																					-

★ Design ☆ Study ● Construction

4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan									Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	0	0	0	0	0	0	0	0	0	0		
- No. of Facilities	0	0	0	0	0	0	0	0	0	0		
- Cost (mill.US$)	0	0	0	0	0	0	0	0	0	0		
(mill.K£)	0	0	0	0	0	0	0	0	0	0		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	0	0	0	0	0	0	0	0		
- No. of Facilities	0	0	0	0	0	0	0	0		
- Cost (mill.US$)	0	0	0	0	0	0	0	0		
(mill.K£)	0	0	0	0	0	0	0	0		

4.11 Watering Points in Nomadic Pasturage Area

Assumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos.)	Executing Agency	Cost (million)		Implementation of Watering Points (No.)	
			US$	K£	Up to 2000	2000-2010
-	-	-			-	-

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
-	-	-	-	-

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																
		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-																		

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

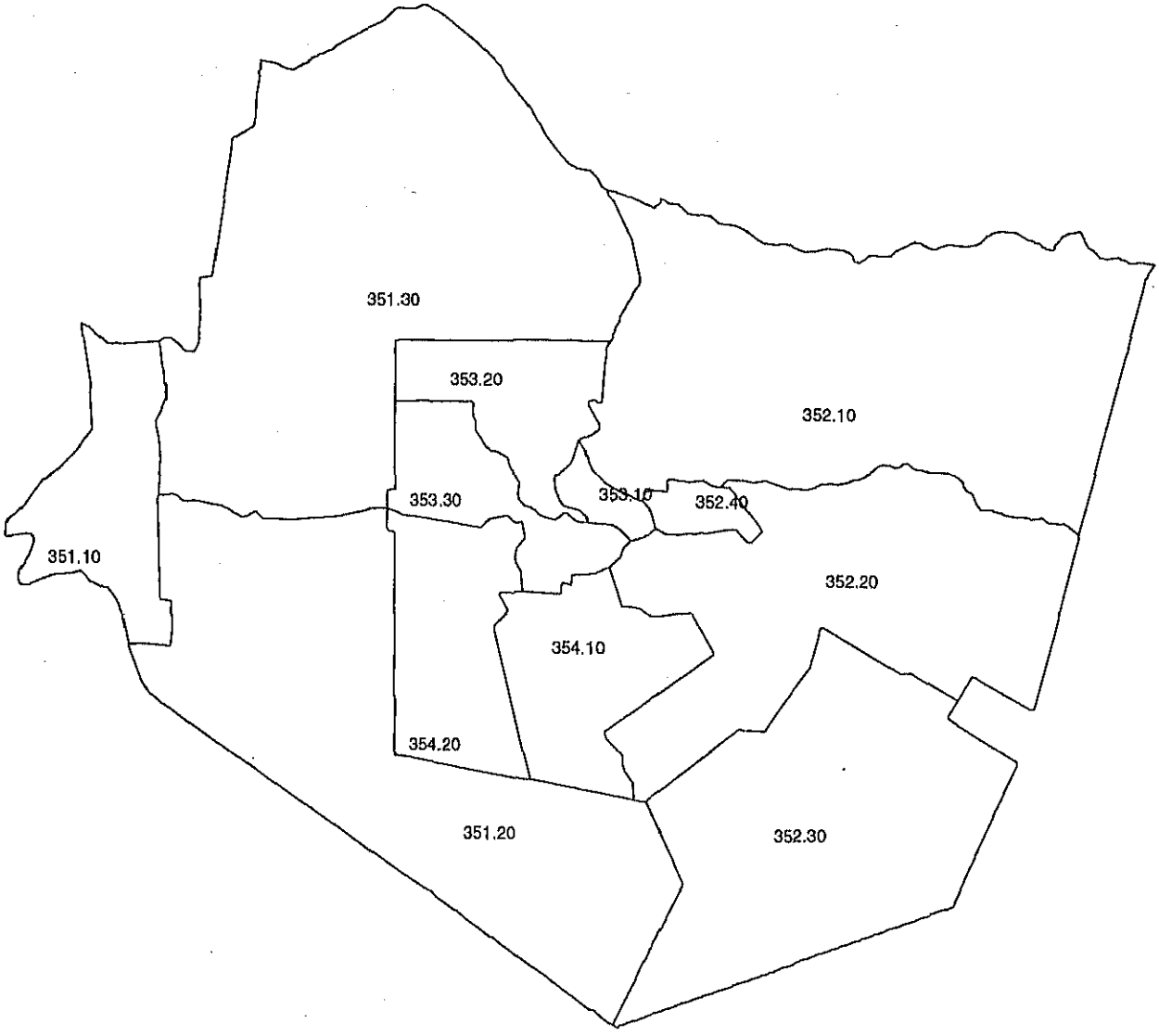
Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
		MOWD	2.5	3.2		☆	☆	☆														

☆ Study

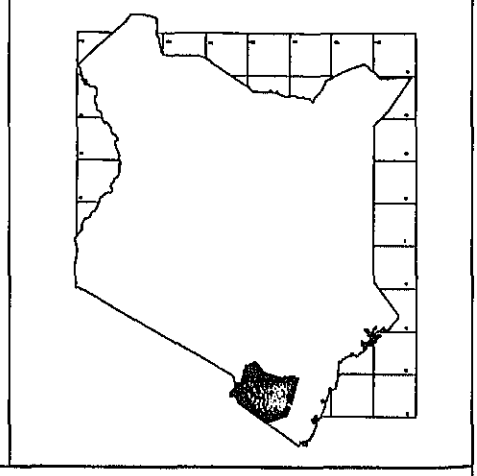
o River Basin Study (proposed under separate programme)

Taita Taveta District

Fig.



Code	Location	Population
351.1	Taveta	25,862
351.2	Kimorigho	292
351.3	Chala	437
352.1	Mbololo	13,883
352.2	Sagala	8,500
352.3	Kisigau	6,214
352.4	Voi	8,554
353.1	Mbale	11,498
353.2	Werugha	25,764
353.3	Mwanda	11,749
354.1	Chawia	25,654
354.2	Bura	9,190



350 Taita Taveta

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 350 Taita Taveta District

1-1 Population Projection

(Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
350	Taita Taveta	16,960		215.2	27.0	188.2	265.7	49.3	216.4	331.4	72.7	258.6
351.1	Taveta	677	Taveta	46.8	12.1	34.7	60.5	20.6	39.9	76.6	28.8	47.7
351.2	Kimorigho	2,737		0.4	-	0.4	0.5	-	0.5	0.5	-	0.5
351.3	Chala	3,597		0.6	-	0.6	0.7	-	0.7	0.8	-	0.8
352.1	Mbololo	3,188		18.6	-	18.6	21.4	-	21.4	25.6	-	25.6
352.2	Sagala	2,052		11.4	-	11.4	13.1	-	13.1	15.7	-	15.7
352.3	Kisigau	2,046		8.3	-	8.3	9.6	-	9.6	11.5	-	11.5
352.4	Voi	116	Voi	13.8	12.2	1.6	25.3	23.6	1.8	38.1	35.9	2.1
353.1	Mbale	102		15.4	-	15.4	17.7	-	17.7	21.2	-	21.2
353.2	Werugha	535	Wundanyi	37.3	2.7	34.6	45.0	5.2	39.8	55.5	8.0	47.5
353.3	Mwanda	471		15.8	-	15.8	18.1	-	18.1	21.7	-	21.7
354.1	Chawia	710		34.4	-	34.4	39.6	-	39.6	47.3	-	47.3
354.2	Bura	729		12.3	-	12.3	14.2	-	14.2	17.0	-	17.0

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	46.7	85.9	126.9
Percentage to GDP	0.6%	0.6%	0.6%
2) GRDP per Capita (K.Pound)	217.2	323.2	383.1
Ratio to GDP per capita	0.64	0.72	0.76
Urban (K.Pound)	724.3	749.9	778.7
Rural (K.Pound)	144.5	226.0	271.8

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	10,010	tons
Sorghum/Millet	45,017	tons
Potato	520	tons
Rice	4	tons
Wheat/Barley	-	tons
Coffee	299	tons
Tea	-	tons
Milk	7,000	tons
Meat	1,525	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	8
Textile	6
Wood	1
Paper	1
Chemical	1
Non-metal	0
Metal	0
Machinery	0
Others	0
Total	17

3) Water Supply Schemes in Service Centre

Piped system	30
Communal water points	0
Other sources	1

4) Educational Facilities

Primary school	165
Secondary school	33
Institute	1

5) Medical Facilities

Hospital	4
Health Centre	4
Dispensary	19
Others	0

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	15847
Leprosy	40
Infectious Hepatitis	152
Bilharzia	1714
Eye Infections	12797

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
16,975	16,959	16	10,604	131	179	0	800	5,245

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
34	23	75	98	66	21	17	17	24	37	111	87	614

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
3G 02	7252	6.4	0.6	0.4	0.4	0.1
3G 03	306	3.2	0.3	0.3	0.3	0.3
3HA08	25128	153.1	35.2	27.6	21.4	21.4

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
752.08	74.78	49.57	22.76	7.54	26.57

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
8,092,980	15,228,153	23,321,133

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
265	4	0	2,068	0	0	4

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
6,372	6,745	47.5	27.1

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
148.95	302.50	-	0.25

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Taita Taveta District	3,802	3,905	3,768	1,122	4,724	7,267	4,100	2,033	6,480	10,917	5,105	2,845
Taveta	687	1,750	729	446	850	3,028	835	761	1,159	4,330	1,013	979
Kimorigho	8	0	8	0	10	0	8	0	13	0	10	0
Chala	12	0	11	0	15	0	13	0	20	0	15	0
Mbololo	370	0	360	0	458	0	397	0	624	0	472	0
Sagala	226	0	221	0	281	0	243	0	382	0	289	0
Kisigau	165	0	161	0	205	0	178	0	278	0	211	0
Voi	31	1,764	89	354	38	3,471	142	672	52	5,393	205	996
Mbale	329	0	298	37	412	0	329	73	575	0	391	112
Werugha	727	390	682	0	911	768	761	0	1,266	1,194	913	0
Mwanda	321	0	305	114	398	0	336	211	549	0	400	303
Chawia	682	0	666	171	844	0	733	316	1,150	0	873	455
Bura	244	0	238	0	302	0	125	0	412	0	313	0

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Taveta	28,900	Njoro sprig	Njoro Spring	p	5	60	7,219
Voi	36,000	Mzima P/L	2nd Mzim pipeline	p	4.1	10	7,669
Wundanyi	8,000	Taita Hills streams	Sigaso/Manguri River	p	7.2	80	935

g: gravity p: pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No. (Nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
Madarasani	100	0	?	?	Drainage	?	4.1	3J
Ngutini	150	0	?	?	Irrigation	?	6.15	3J
Kimundia	150	?	?	?	Drainage	?	6.15	3J
Mwatate	0	?	?	?	Irrigaiton	?	?	3LA
Nyolo	200	?	?	?	Irrigaiton	?	8.2	3MA
Kimala Bl.C	10	0	?	?	Irrigation	?	0.41	?

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million)		Major Crops
				US$	K£	
Taita Taveta	3,780	Lumi River	37.6	11.9	15.0	Cotton, Maize

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million) US$	Cost(million) K£	Implementation Schedule 93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost (million) US$	Cost (million) K£	Implementation Schedule 93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Lumi Rivermouth (Lumi river)	- Construction of new dykes (11 km)	MOWD	8.3	10.5													☆	☆	☆	●	●	●

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million) US$	Cost (million) K£	Implementation Schedule 93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Voi	12,200	1.2	MOLG	9.2	11.6													☆	☆	☆	●	●	●
Wundanyi	2,700	0.3	MOLG	2.2	2.8													☆	☆	☆	●	●	●

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
-	-	-	-	-	-	-	-

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers Drinking (B/H+D)	Proposed Numbers Drinking (S/W+H)	Proposed Numbers Livestock (B/H+D)	Proposed Numbers Livestock (S/W+H)	Executing Agency	Cost (million) US$	Cost (million) K£	Implementation Schedule 93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	Remarks
24	190	33	295	MOWD/	17.1	21.5	☆	●	●																Safe water supply

★ Design ☆ Study ● Construction

4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan: Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline	Total	Implementation Program (%): Up to 2000	2001-2010
- Quantity (m3/d)	1,971	1,310	1,481	551	74	25	25	174	838	6,449	34.4	65.6
- No. of Facilities	0	35	296	17,923	5	5	5	24	0	18,293		
- Cost (mill.US$)	0	4.5	1.44	10.79	0.1	0.07	0.05	0.42	0	17.37		
(mill.K£)	0	5.67	1.81	13.61	0.13	0.09	0.06	0.53	0	21.91		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan: Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline	Total	Implementation Program (%): Up to 2000	2001-2010
- Quantity (m3/d)	1,876	1,167	1,468	96	22	22	87	4,738	35.2	64.8
- No. of Facilities	0	33	295	7	9	9	0	353		
- Cost (mill.US$)	0	4.06	1.43	0.13	0.06	0.04	0	5.72		
(mill.K£)	0	5.11	1.8	0.17	0.08	0.06	0	7.22		

4.11 Watering Points in Nomadic Pasturage Area

Asumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos)	Executing Agency	Cost (million)		Implementaion of Watering Points (No.)	
			US$	K£	up to 2000	2001-2010
4,889	8	MOWD	1.5	1.9	2	6

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
Tsavo Dam	W	Tsavo	-	-

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																
		US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Athi River Basin Study (Update)	TARDA	4.0	5.0		☆	☆	☆	☆	☆												

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

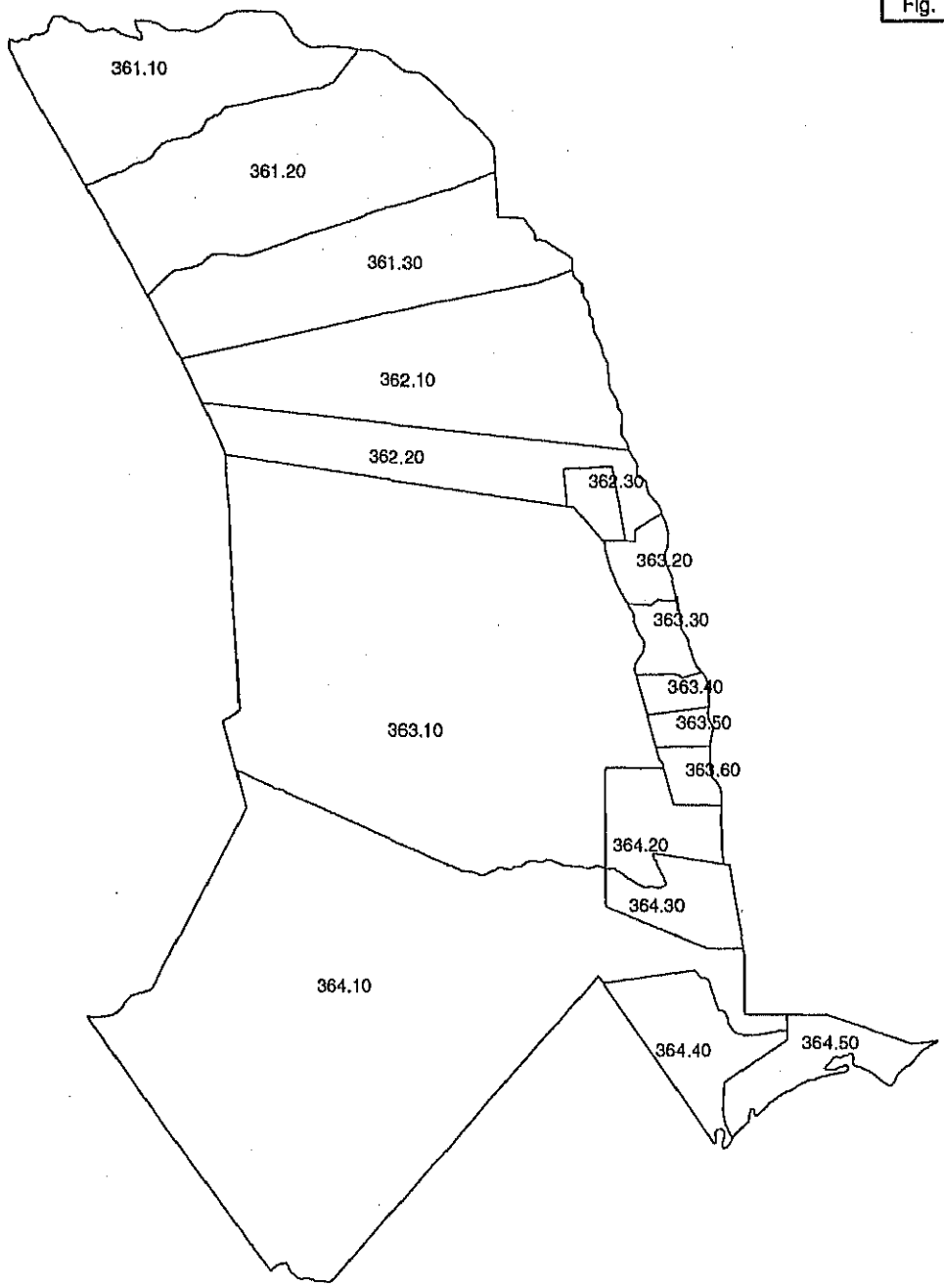
Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
		MOWD	2.5	3.2				☆	☆	☆												

☆ Study

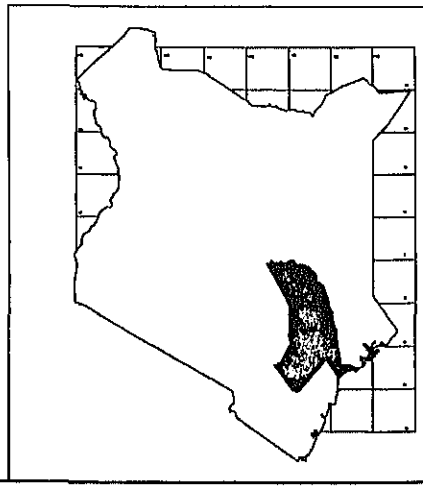
o River Basin Study (proposed under separate programme)

Tana River District

Fig.



Code	Location	Population
361.1	Mbalambala	3,781
361.2	Saka	3,887
361.3	Madogo	9,883
362.1	Nanighi	5,631
362.2	Chewele	2,679
362.3	Bura	1,786
363.1	Wayu	7,728
363.2	Milalulu	5,679
363.3	Zabaki	11,475
363.4	Ndura	3,751
363.5	Kinakomba	2,176
363.6	Gwano	2,054
364.1	Bilisa	8,148
364.2	Ndera	2,956
364.3	Salama	5,128
364.4	Mgao	7,951
364.5	Chara	7,708



360 Tana River

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 360 Tana River District

1-1 Population Projection

(Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
360	Tana River District	38,693		137.9	11.7	126.2	186.1	33.1	153.0	235.4	51.2	184.2
361.1	Mbalambala	2,275		5.5	-	5.5	6.6	-	6.6	8.0	-	8.0
361.2	Saka	3,532		5.6	-	5.6	6.8	-	6.8	8.2	-	8.2
361.3	Madogo	2,657		14.3	-	14.3	17.4	-	17.4	20.9	-	20.9
362.1	Nanighi	3,337		8.2	-	8.2	9.9	-	9.9	11.9	-	11.9
362.2	Chewele	1,667		3.9	-	3.9	4.7	-	4.7	5.7	-	5.7
362.3	Bura	225	Bura+Madogo	2.6	-	2.6	5.2	2.1	3.1	6.6	2.8	3.8
363.1	Wayu	9,970		11.2	-	11.2	13.6	-	13.6	16.4	-	16.4
363.2	Milalulu	304		8.2	-	8.2	10.0	-	10.0	12.0	-	12.0
363.3	Zabaki	257	Hola	17.0	8.1	8.9	32.3	21.6	10.8	47.7	34.8	13.0
363.4	Ndura	173		5.4	-	5.4	6.6	-	6.6	7.9	-	7.9
363.5	Kinakomba	153		3.2	-	3.2	3.8	-	3.8	4.6	-	4.6
363.6	Gwano	207	Wenje	3.0	-	3.0	3.9	0.3	3.6	4.7	0.4	4.3
364.1	Bilisa	10,999	Garsen	15.4	3.6	11.8	22.3	7.9	14.3	28.9	11.7	17.2
364.2	Ndera	708		4.3	-	4.3	5.2	-	5.2	6.3	-	6.3
364.3	Salama	609		7.4	-	7.4	9.0	-	9.0	10.9	-	10.9
364.4	Mgao	926	Tarassa	11.5	-	11.5	15.1	1.2	14.0	18.4	1.5	16.8
364.5	Chara	694		11.2	-	11.2	13.6	-	13.6	16.3	-	16.3

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	10.2	18.4	27.5
Percentage to GDP	0.1%	0.1%	0.1%
2) GRDP per Capita (K.Pound)	73.7	99.0	116.9
Ratio to GDP per capita	0.22	0.22	0.23
Urban (K.Pound)	498.4	333.5	330.0
Rural (K.Pound)	34.4	48.3	57.7

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	3,961	tons
Sorghum/Millet	3,268	tons
Potato	3	tons
Rice	3,117	tons
Wheat/Barley	-	tons
Coffee	6,500	tons
Tea	-	tons
Milk	33,100	tons
Meat	3,487	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	1
Textile	1
Wood	0
Paper	0
Chemical	0
Non-metal	0
Metal	0
Machinery	0
Others	0
Total	2

3) Water Supply Schemes in Service Centre

Piped system	8
Communal water points	0
Other sources	9

4) Educational Facilities

Primary school	107
Secondary school	8
Institute	5

5) Medical Facilities

Hospital	3
Health Centre	3
Dispensary	28
Others	2

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	13,861
Leprosy	7
Infectious Hepatitis	80
Bilharzia	7,923
Eye Infections	6,762

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
38,694	38,694	0	5,267	118	3	0	239	33,067

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
25	17	62	122	58	25	17	16	20	45	146	77	637

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
-	-	-	-	-	-	-

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
177.11	123.73	95	87.83	2.33	24.25

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
19,821,337	40,293,158	60,114,495

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
440	0	237	906	0	0	0

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
14,944	13,396	0	2.4

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
413.15	528.82	33.15	6.38

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Tana River District	2,529	1,692	6,966	94	3,303	4,873	7,632	178	4,551	7,681	8,506	264
Mbalambala	109	0	296	0	141	0	315	0	194	0	345	0
Saka	112	0	304	0	146	0	323	0	200	0	355	0
Madogo	284	0	773	0	370	0	822	0	509	0	903	0
Nanighi	162	0	440	0	211	0	468	0	290	0	515	0
Chewele	77	0	210	0	100	0	223	0	138	0	245	0
Bura	51	0	140	0	67	307	173	0	91	418	193	0
Wayu	222	0	604	0	290	0	643	0	398	0	706	0
Milalulu	163	0	444	0	213	0	472	0	292	0	519	0
Zabaki	176	1,171	588	94	229	3,180	765	178	315	5,222	935	264
Ndura	108	0	293	0	141	0	312	0	193	0	343	0
Kinakomba	62	0	170	0	82	0	181	0	112	0	199	0
Gwano	59	0	161	0	77	44	174	0	106	59	192	0
Bilisa	234	521	686	0	305	1,171	772	0	419	1,750	870	0
Ndera	85	0	231	0	111	0	246	0	152	0	270	0
Salama	148	0	401	0	192	0	427	0	264	0	469	0
Mgao	229	0	622	0	298	171	675	0	409	232	743	0
Chara	248	0	603	0	330	0	641	0	469	0	704	0

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Bura & Madogo	2,800	Tana River	Tana River	p	0.2	20	947
Hola	34,800	Tana River	Tana River	p	1.3	20	6,850
Garsen	11,700	Tana River	Tana River	p	0.6	20	2,989

g: gravity p: pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No (Nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
Laza	40	?	?	?	Irrigaiton	?	1.64	4GG
Caza	0	200	Galole	Zubuki	Irrigation	NOT	1.2	?
Chewele	100	100	Bura	Chewele	Irrigation	RDF/DDC	1.2	?
Semikaro	100	100	Garsen	Chara	Irrigation	RDF/DDC/	1.7	?
Nanighi	100	100	Bura	Nanighi	Irrigation	RDF	4.1	?
Makinduni	100	100	Galole	Zubuki	Irrigation	RDF/DDC	4.1	?
Mikomani	100	100	Bura	Chewele	Irrigation	RDF/DDC/	4.1	?
Kikesa	0	0	?	?	Irrigation	?	?	?
Kora	0	0	?	?	Irrigation	?	?	?
Milomani	0	?	?	?	Irrigaiton	?	?	?

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million)		Major Crops
				US$	K£	
Tana Delta	12,000	Tana River	515.6	141.4	178.2	Rice

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million)		Implementation Schedule																
				US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Hola	8,100	0.9	MOLG	7.4	9.3												☆	☆	☆	●	●	●	

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
-	-	-	-	-	-	-	-

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers				Executing Agency	Cost (million)		Implementation Schedule																Remarks
Drinking		Livestock																					
(B/H+D)	(S/W+H)	(B/H+D)	(S/W+H)		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	
22	179	56	649	MOWD/	26.5	33.4	☆	●	●	●	●														Safe water supply

★ Design ☆ Study ● Construction

4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan									Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	948	918	1,906	541	21	15	15	40	97	4,501	38.3	61.7
- No. of Facilities	0	32	328	18,534	9	4	4	8	0	18,919		
- Cost (mill.US$)	0	3.31	1.52	11.14	0.03	0.04	0.03	0.14	0	16.21		
(mill.K£)	0	4.18	1.92	14.05	0.03	0.05	0.04	0.18	0	20.44		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	2,100	1,852	3,779	65	47	47	30	7,920	43.2	56.8
- No. of Facilities	0	56	649	10	9	9	0	733		
- Cost (mill.US$)	0	6.64	3.02	0.09	0.13	0.1	0	9.98		
(mill.K£)	0	8.37	3.81	0.11	0.17	0.12	0	12.58		

4.11 Watering Points in Nomadic Pasturage Area

Asumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos)	Executing Agency	Cost (million)		Implementaion of Watering Points (No.)	
			US$	K£	up to 2000	2001-2010
32,277	52	MOWD	8.9	11.2	16	36

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
Mbalambala (Tana R.)	W	Ewaso Ngiro R.	Small	Adamson Falls
Adamson Falls Dam	P+W+I	Rural	Small	Kora
Kora Dam	P+W+I	Rural		

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																
		US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Tana River Basin Study (Update)	TARDA	4.0	5.0				☆	☆	☆	☆	☆										

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Tana	(WRAP proposed)	MOWD	-	-	☆	☆																

☆ Study

o River Basin Study (proposed under separate programme)

Eastern Province

Eastern Province

Socio-Economic Profiles

Eastern Province has an total area of 159.9 thousand km^2 or 27% of the national total. Most of the land is of medium and poor potential and mainly of range potential. Of the total provincial area, 4.1 thousand km^2 or 2.6% of the provincial area is occupied by water areas such as lakes and rivers. The rest of the land area of 155.8 thousand km^2, 31.7 thousand km^2 or 20% is reserved area for uses such as national parks and reserved areas. The rest, 124.0 thousand km^2 or 80%, is habitable areas where the people carry out their daily activities. The district population distribution was as follows:

Code	District	Area (km^2)	Population in 1990 (1000)	Density (persons/km^2)
410	Embu	2,714	382	141
420	Isiolo	25,605	75	3
430	Kitui	29,389	684	23
440	Machakos/Makueni	14,183	1,486	105
450	Marsabit	78,078	138	2
460	Meru	9,922	1,213	122

In 1990, 3,978,000 people or 17.5% of the national population were living in Eastern Province. Its district distribution is shown in the above table.

The urban population numbered 356 thousand or 8.9% of the total provincial population. It was distributed into 25 towns in six Districts as follows: two towns with 20 thousand of urban population in Embu District; four towns, 28 thousand, in Isiolo; two towns, 17 thousand, in Kitui; seven towns, 166 thousand, in Machakos/Makueni; six towns, 34 thousand, in Marsabit; and four towns, 92 thousand, in Meru. Among these towns, the top 10 towns in terms of urban population were Machakos, Meru, Athi River, Embu, Isiolo, Kangundo, Marsabit, Kitui, Mwingi and Mayole in that order.

Embu functions as the provincial capital as well as the district headquarters of Embu District, which is at present the fourth largest town in the province. Besides, district headquarters of the other Districts are Isiolo in Isiolo District; Kitui in Kitui; Machakos in Machakos; Marsabit in Marsabit; and Meru in Meru. In addition, Makueni town is functioning as the District headquarters of the new Makueni District at present.

Land of medium to low agricultural potential occupies a considerable part of Machakos District and slightly less in Embu, Meru and Kitui Districts. Maize dominates the crop acreage in six Districts in the province, despite the low potential of much of the area for maize. Sorghum, millet and beans are important in the province. Livestock is very important in the province supplying either subsistence requirements or cash obtained from sale of the livestock. The cash crop of importance is cotton, although some coffee and tea are cultivated in high land area of Meru District.

Meru ranks as the most industrialized town in the province. Machakos, Athi River and

Embu are important service town centres located in fertile regions with potential for small-scale industries based on agricultural products. Besides, Moyale, Marsabit, Kitui and Isiolo are also listed up as industrialized towns in the province, although there are few major manufacturing establishments in these towns.

Eastern Province recorded K£393 million at 1989 constant prices or 5% of GDP, according to the Study Team's estimation explained in Chapter 5 of Sectoral Report "A". Machakos/Makueni District recorded the largest GRDP in the province. It was estimated at K£180 million or 2.3% of GDP. On the other hand, Isiolo recorded the largest GRDP per capita in the province. It was estimated at K£318 in 1990, although even Isiolo accounted for only 93% of the national average. GRDP per capita of the other Districts recorded as follows: K£158 or 46% in Marsabit; K£130 or 38% in Embu; K£121 or 35% in Machakos/Makueni; K£73 or 21% in Meru; and K£41 or 12% in Kitui. Kitui had the smallest GRDP per capita in the country.

Surface Water

The Province is located astride the equator from Kitui District in the south to the Marsabit District to the north. Almost all of the land is classified into semi-arid and arid land. Although the large perennial rivers, the Tana and the Athi rivers, flow down across the Province, The Ewaso Ngiro River dries up in the Lorian Swamp and the other rivers are seasonal.

(1) Machakos District

The District receives a mean annual rainfall of 796 mm. Distinctive wetter months are April during the Long Rains and November during the Short Rains. For the driest months, from June to September, monthly rainfall is less than 10 mm on average. This rainfall distribution with a longer dry period make the construction of storage dams impossible.

At present, a part of domestic demand in Machakos town is catered for by the water supply of Nol-tresh pipeline from the foot of Mt.Kilimanjaro. The Athi River will be a major water source for the future urban water supply systems, though it will need pumping-up. To cope with the future water demand for rural water supply, the development of groundwater and small dams will be required as major water sources.

(2) Kitui District

The District receives an annual rainfall of 714 mm on average. Distinctive wetter months are April during Long Rains and and November during Short Rains. For the drier months, from June to September, monthly rainfall is less than 20 mm on average. The land is organized into semi-arid land in the north and arid land in the south.

Several methods of water harvesting have been carried out traditionally. At present, roof and rock catchments, small dams, and subsurface/sand dams are the major water source for rural water supply. As demand increases in the urban areas, Kitui and Mwingi suffer from a serious water shortage. The water transfer schemes over long distances will be required from Masinga Dam to Kitui and from Kiambere Dam to Mwingi.

(3) Embu and Meru Districts

The Districts are located on eastern foot of Mt.Kenya. Annual rainfall of more than 1,000 mm has been recorded in the western parts of the Districts where Embu and Meru towns are located. The eastern parts of the district where the Tana River flows down eastwards, however, receives an annual rainfall of about 600 mm on average.

Several perennial tributaries flowing down to the foot of Mt.Kenya will become the major water sources for urban water supply, while, the combination of boreholes and water harvesting, such as small dams and roof catchment will be required for rural water supply.

(4) Isiolo District

The District receives an annual rainfall of 432 mm on average. About 100 mm of monthly rainfall has been recorded in the wetter months in April and November, while in the drier months, from June through October, the monthly rainfall is less than 5 mm on average.

The District is located along the Ewaso Ngiro River which flows from west to east. Although the river has a perennial flow of about 22 m^3/s in the center of the District, the river dries up at the eastern boundary of the District.

At present, available surface water has already been utilised for the major demands. The remaining water sources depend on the development of groundwater and sub-surface/sand dam. However, Isiolo town which is the district center suffers from water shortage seriously. The water transfer scheme from Meru District may be required as an alternative water source.

The water of Ewaso Ngiro River is also an important water source for livestock and wildlife. The dam for flow augmentation may keep the present perennial reach of the river.

(5) Marsabit District

The District lies in the arid land, though Marsabit town which is located on the plateau with an altitude of 1,380 m asl and the towns around the international boundary between Kenya and Ethiopia receive an annual rainfall of 600 mm on

average. The remaining land receives an annual rainfall ranging from 180 mm to 300 mm.

No perennial river was identified in the District except a few small springs. The development of boreholes will be required as the major water source and water harvesting methods as a subordinate measure.

Geology

The geology is diversified, consisting of rocks whose age range from Pre-cambrian till recent. Four divisions can be recognized: the Quaternary sedimentary rocks in the eastern part, Tertiary and Quaternary volcanic rocks in the northern and central parts, and Pre-cambrian metamorphic basement rocks in the central and southern part.

Physiography

Northern Plainlands spread in the northern part, Duruma-Wajir Lowlands in the far east, Low Foreland Plateau in the central and southern parts, and Highlands in the south-western part.

Groundwater

The Pre-cambrian metamorphic basement rocks, even where weathered or fractured zones are encountered, yield very little water (1.5 to 6 m^3/hr). The Quaternary sedimentary rocks mainly in Isiolo District yield fair amount water. Tertiary and Quaternary volcanic rocks in the northern and central parts yield little amount of water.

(1) Embu District

Availability and utilization of surface and sub-surface water resources is a serious problem, especially in the lower parts of the District- the medium and marginal potential zones of Gachoka and Siakago Divisions. These lower zones not only lack of clean water in the form of springs or streams, but whatever water is available from stagnant rivers, ponds (at times dug from dry, sandy riverbeds), or wells. In addition, the local population has to share these water resources with other uses, such as watering livestock and irrigation.

A few areas are well served by the District's major rivers and streams. These are in northern-western and south-western parts of the District.

There are number of potential water resources within the District. The District's 6 major rivers, three - Rupingazi, Thuci and Tana - also form District boundaries. The north-western and south-western areas of the District are generally well served by the rivers and streams. Existing water projects have the potential to serve only about 30% of the District's population. Therefore, 70% of the population relies on other sources, such as rivers, streams, and dams for its water needs. The increased demand for water facilities has been caused by an ever-increasing population and by

the growth of market centres and institutions occasioned by the population demanding certain socio-economic services.

There will, therefore, be a need to conserve forest and soils in catchment areas to avoid scarcities of water in future.

(2) Isiolo District

Deep boreholes drilled in the Merti Beds should be confined to the fresh ground water zone, to a recommended minimum depth of 110 metres.

Fresh-water supplies could be developed along the Ewaso Ng'iro from shallow gravel-packed boreholes drilled within the immediate floodplain, to a recommended maximum depth of 50 metres. Judicious exploration would be necessary to reveal permeable beds that are hydraulically continuous with river channel deposits. Generally speaking, boreholes should be as close to the river as possible for maximum recharge potential, yet far enough away so as to avoid serious inundation.

Developing water supplies from such an unpredictable source, as the Ewaso Ng'iro, is a difficult and risky operation, as it is not possible to foretell future river floods and diversions. However, until the flood water can be controlled by dams, pipelines, irrigation schemes, gabbions etc., one must design, keeping the risk in mind.

No boreholes, either shallow or deep, should be drilled along the Galan Gof east of Benane. Fresh-water supplies can be developed from clay fill subsurface in the sandy river bed.

The District, being a semi-arid area, enjoys sunshine of about 9 hours a day. This solar energy could be used to provide lighting in schools, health centres, and even in marketing and rural centres.

Windmills turn could be used for piping water from the wells and boreholes for domestic use, watering animals, and irrigation.

Water is the major constraint in the District due to unreliable rainfall and the seasonal nature of the rivers. Without water, there is little prospect of increasing crop or livestock production or afforestation programmes. Water is needed to improve the existing settlements as well as to set up new ones for small-scale irrigation schemes. Due to lack of permanent rivers, major water development programmes have to maximize surface water springs, seasonal water courses, dams and ground water as well as underground water utilization in the form of wells and boreholes.

In 1978, the District has 3 small water supplies and 4 boreholes. In 1983 there was

1 major urban water supply, 6 small water supplies, 9 boreholes, 9 large pans and 3 small pans. All the pans and 5 of the boreholes are well planned and are, in fact, part of the Grazing Block Development Programme which is being implemented both in Garbatulla and Merti Divisions. The 6 small water supplies are well distributed, serving 2 divisional headquarters and other areas of major population concentration.

The major water supply is intended to serve Isiolo Town which has about one-quarter of the District population. Due to lack of maintenance, silting has greatly reduced the holding capacity of most of the pans. Water sources still remain the least-developed infrastructure in the District. Hence the water facilities available are not adequate for domestic use, livestock rearing, urban development, settlement, and irrigation.

(3) Kitui District

Water remains the most essential commodity in the entire District. Its development occupies the number one position in priority ranking of projects. Water is crucial input to all other development activities. The cost of fetching water (by mothers) is very high. It is cited as one of the bottlenecks hampering faster development in the District.

The inevitable search for water causes seasonal population mobility in the District. Sources of water are nearer during wet season and far away during the dry season when water is only available in a few river valleys. In places like Voo, Tharaka, Endau and Mutomo, women walk as much as 25 km. to get water in the dry season. Of the many water schemes started in the District, only three have water throughout the year. The majority have faulty machinery, were wrongly sited or poorly designed hence, are not operational. The majority institutions in the Districts lack potable water and temporary measures have to be made almost daily tp bring water to them.

(4) Machakos District

The groundwater occurrence is controlled by available recharge and geological conditions of the area.

The district is composed mainly of metamorphic Basement rocks. The volcanic rocks occur in the northwest and southwest of the District and on the Yatta Plateau.

Except for the thin lake beds north of Machakos town, the sediments in the District are restricted to the narrow alluvial belts along the rivers. Piedmont deposits have developed locally on the hill slopes.

Fresh metamorphic and volcanic rocks can be considered impermeable and without storage capacity. In these rocks, ground water in exploitable quantities is only

found in weathered and fractured zones.

In Machakos District the only non-indurated sediments that store and transmit water are the quaternary alluvial deposits. The amount of ground water stored depends on the size and sorting of the grains. The Tertiary lake bed deposits are too thin to form aquifers.

(4) Marsabit District

Marsabit District is probably the driest district in the country. It has an average of less than 500mm of rainfall per annum, except for high altitude areas like Mt. Marsabit, Kulal and Moyale. Although the reliability of rainfall in these areas is high, during severe droughts they are affected like any other part of the District. An example is the 1984/85 drought when water shortage was experienced all over the District. Hence the people and livestock in Marsabit District rely on surface or ground water. There are three principal water horizons in the District:

- The upper horizon of mountains and hills, over 1500m to the summits of Mts. Marsabit and Kulal where there are number of springs.
- The second horizon 1,200m to 1,500m still on the mountains, on Mt. Marsabit springs like Badasa, Songa, and Balesa Bongole are at these levels.
- The rest of the district which generally lies between 400m-460m depend mostly on underground water. In these areas the ground water table varies greatly.

(5) Meru District

The geology of Meru District consists of the basement rocks and Tertiary volcanics. The basement rocks are characterized by the presence of isolated water-bearing aquifers. In contrary, the Tertiary volcanics form predominantly regional aquifer. A major part of the water discharged by the springs near the Ewaso Ngiro comes from the higher parts of Mt. Kenya or the Nyambenis. Boreholes are much more critical in the basement rocks than in the volcanics.

Underground Water: The average bore hole depth in the District is 108 m. though this varies from as low as 21 m. in Nkabune to 213 m. in Meru Town. Nearly half of the boreholes are in Timau Division.

Aquifer characteristics by district

District code	name	Elevation (m)	Total depth(m)	Water struck(m)	level rest(m)	Yield (m3/hr)	Draw down(m)
410	Embu	1217.75	59.43	44.20	17.16	4.23	31.86
420	Isiolo	835	98.37	66.59	43.12	7.16	24.11
430	Kitui	1022.67	91.07	45.12	25.79	4.28	44.88
440	Machakos	1442.08	99.64	70.18	33.45	5.29	40.39
450	Marsabit	737.56	102.38	72.4	54.88	5.08	22.95
460	Meru	1179.00	87.46	66.10	40.93	7.20	26.76

Groundwater development plan and cost by district

District code	name	Proposed Drinking (B/H+D)	number (S/W+H)	Proposed Livestock (B/H+D)	number (S/W+W)	Proposed (million) US$	cost (million) K£
410	Embu	68	402	20	146	21.4	27
420	Isiolo	13	49	182	1241	52.8	67
430	Kitui	82	881	103	1251	58.8	74
440	Machakos /Makueni	184	2277	96	994	78.9	99
450	Marsabit	23	77	471	2128	116.3	147
460	Meru	315	637	171	331	88.7	112

Irrigation Development Possibility

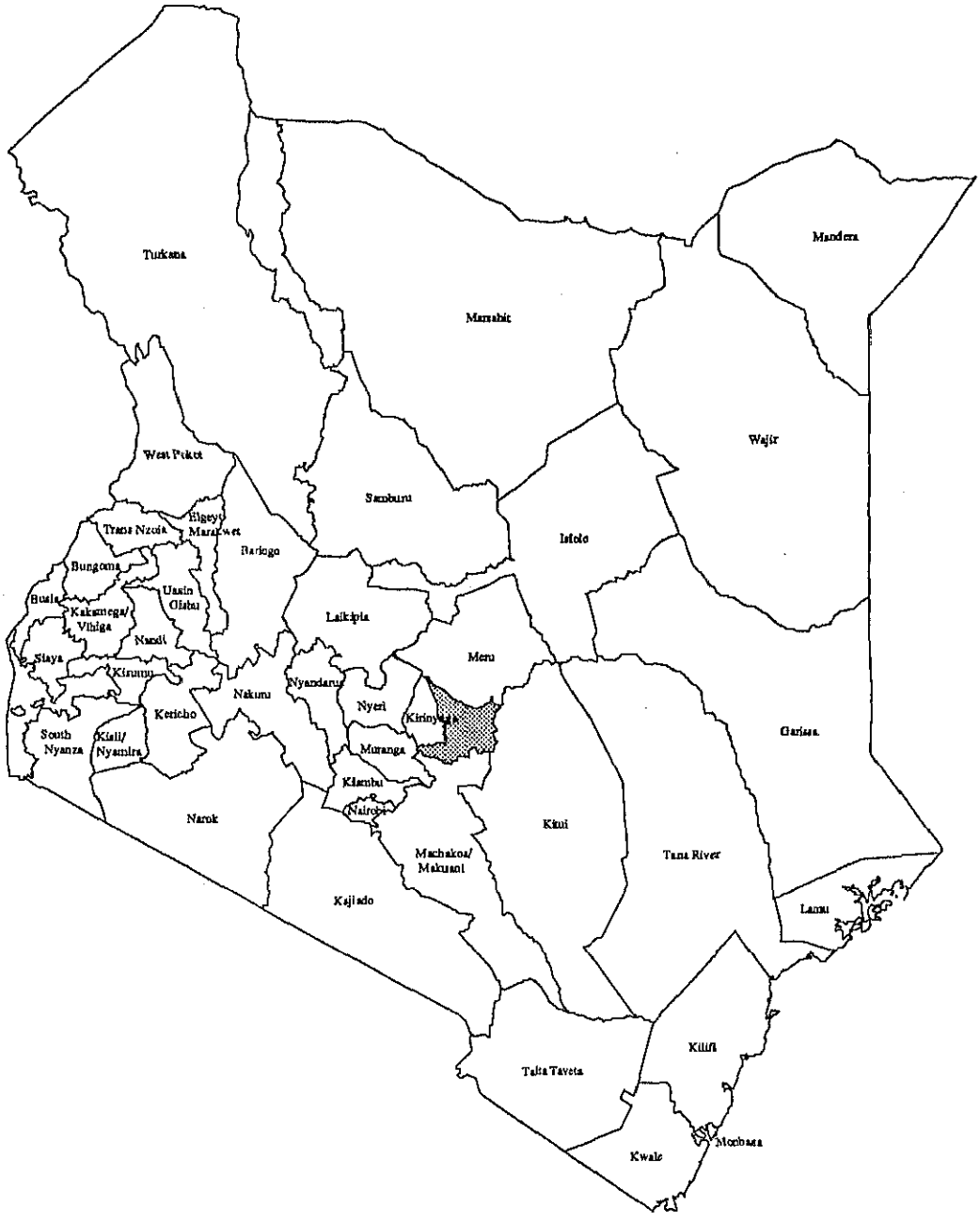
Irrigation development possibility as of 1990 was roughly checked through comparing estimated irrigation potential area and present irrigation area (existing area + future development plan) as shown in following table.

Code	410	420	430	440	450	460
District	Embu	Isiolo	Kitui	Machakos	Marsabit	Meru
Availability	●	●	●	❑	❑	●

note : × There is no area for irrigation development
❑ There is some area for irrigation development (less than 500 ha)
○ There is more area for irrigation development (less than 5000 ha)
● There is more than enough area for irrigation development (more than 5000 ha)

Embu

District



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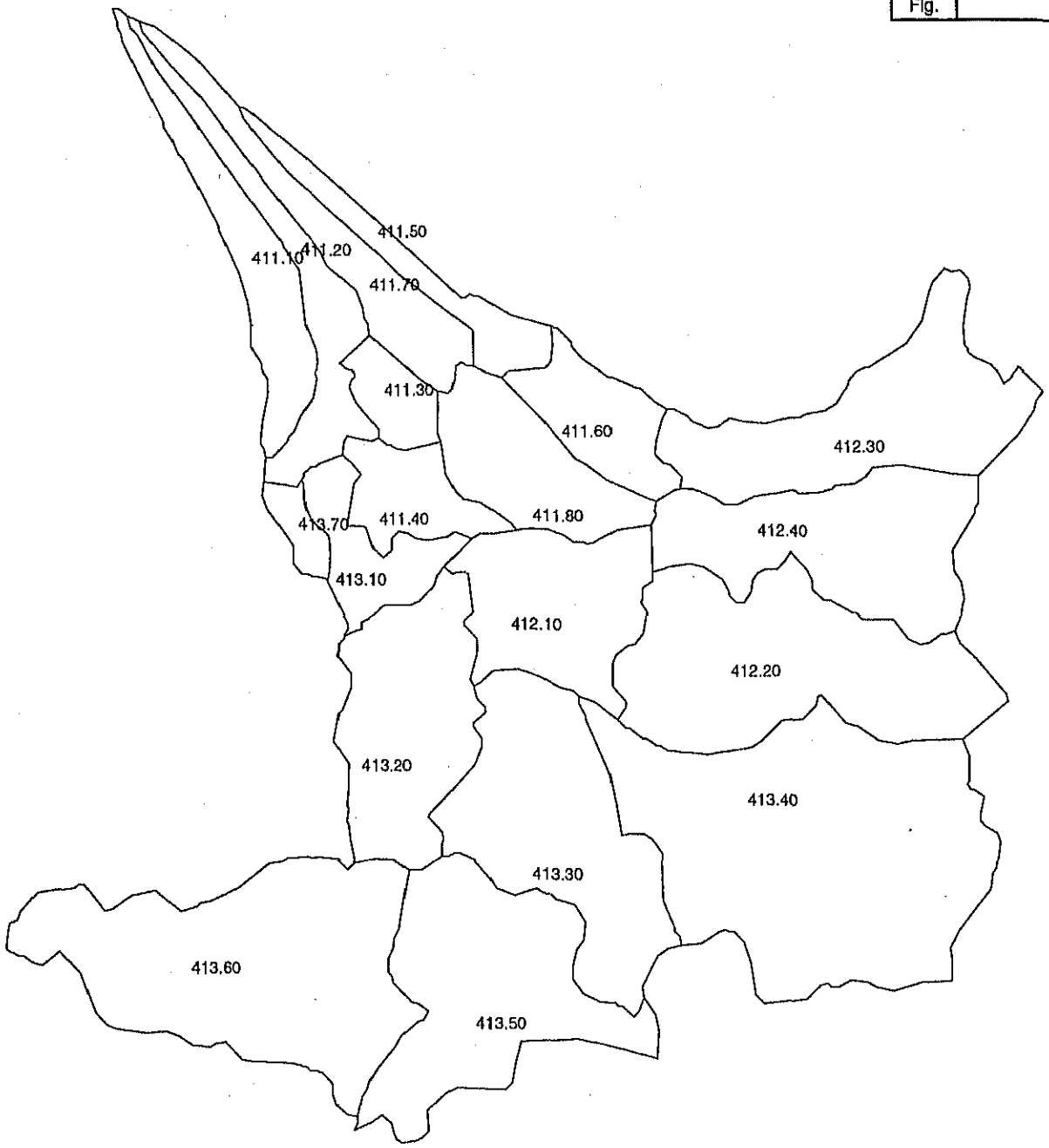
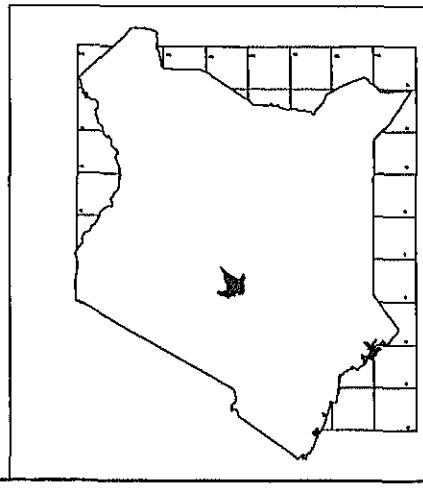


Code	Location	Population
411.1	Nginda	17,239
411.2	Ngandori	21,383
411.3	Gaturi North	16,897
411.4	Gaturi South	20,088
411.5	Kyeni North	15,549
411.6	Kyeni South	15,396
411.7	Kacaari North	16,832
411.8	Kacaari South	24,747
412.1	Nthawa	10,263
412.2	Muminji	6,259
412.3	Kiangombe	8,852
412.4	Evurore	12,856
413.1	Mbeti North	7,019
413.2	Mbeti South	6,724
413.3	Mavuria	13,648
413.4	Kiambere	10,793
413.5	Makima	6,630
413.6	Karaba	16,012
413.7	Embu Municipality	15,986



410 Embu

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. *Socio-Economic Profile : 410 Embu District*

1-1 Population Projection (Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
410	Embu District	2,715		381.9	20.4	361.5	500.8	50.5	450.2	619.2	81.8	537.4
411.1	Nginda	91		25.2	-	25.2	31.4	-	31.4	37.5	-	37.5
411.2	Ngandori	87	Manyatta	31.3	-	31.3	39.4	0.5	38.9	47.1	0.6	46.5
411.3	Gaturi North	34		24.7	-	24.7	30.8	-	30.8	36.7	-	36.7
411.4	Gaturi South	57		29.4	-	29.4	36.6	-	36.6	43.7	-	43.7
411.5	Kyeni North	57		22.7	-	22.7	28.3	-	28.3	33.8	-	33.8
411.6	Kyeni South	69		22.5	-	22.5	28.0	-	28.0	33.5	-	33.5
411.7	Kigaari North	89		24.6	-	24.6	30.7	-	30.7	36.6	-	36.6
411.8	Kigaari South	102	Runyenjes	38.2	2.0	36.2	49.1	4.1	45.1	59.9	6.1	53.8
412.1	Nthawa	131	Siakago	15.0	-	15.0	19.2	0.5	18.7	23.0	0.7	22.3
412.2	Muminji	251		9.2	-	9.2	11.4	-	11.4	13.6	-	13.6
412.3	Kiangombe	190		12.9	-	12.9	16.1	-	16.1	19.2	-	19.2
412.4	Evurore	178	Ishiara	18.8	-	18.8	23.9	0.5	23.4	28.6	0.7	27.9
413.1	Mbeti North	59		10.3	-	10.3	12.8	-	12.8	15.3	-	15.3
413.2	Mbeti South	160		9.8	-	9.8	12.2	-	12.2	14.6	-	14.6
413.3	Mavuria	211	Kiritiri	20.0	-	20.0	25.5	0.6	24.9	30.5	0.8	29.7
413.4	Kiambere	412		15.8	-	15.8	19.7	-	19.7	23.5	-	23.5
413.5	Makima	213		9.7	-	9.7	12.1	-	12.1	14.4	-	14.4
413.6	Karaba	306		23.4	-	23.4	29.2	-	29.2	34.8	-	34.8
413.7	Embu Municipality	18	Embu	18.4	18.4	0.0	44.4	44.4	0.0	72.9	72.9	0.0

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	49.6	90.6	136.0
Percentage to GDP	0.6%	0.7%	0.7%
2) GRDP per Capita (K.Pound)	129.8	180.8	219.7
Ratio to GDP per capita	0.38	0.40	0.43
Urban (K.Pound)	1649.5	1259.1	1191.6
Rural (K.Pound)	44.1	59.8	71.8

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	75,400	tons
Sorghum/Millet	1,798	tons
Potato	21,400	tons
Rice	-	tons
Wheat/Barley	-	tons
Coffee	-	tons
Tea	13,716	tons
Milk	-	tons
Meat	-	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	6
Textile	2
Wood	3
Paper	0
Chemical	0
Non-metal	1
Metal	0
Machinery	0
Others	0
Total	12

3) Water Supply Schemes in Service Centre

Piped system	24
Communal water points	6
Other sources	92

4) Educational Facilities

Primary school	258
Secondary school	52
Institute	14

5) Medical Facilities

Hospital	4
Health Centre	24
Dispensary	13
Others	0

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	16,856
Leprosy	11
Infectious Hepatitis	88
Bilharzia	173
Eye Infections	15,090

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
2,714	2,714	0	289	0	8	8	2,398	11

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
33	28	98	249	125	23	19	23	20	127	226	70	1,046

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
4DC02	404	10.3	3.8	3.0	2.8	2.2
4DC03	197	2.3	0.3	0.2	0.2	0.2
4DD01	2,616	25.3	7.8	6.8	5.8	4.8
4DD02	1,500	54.5	9.3	4.9	3.8	2.2

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
1217.75	59.43	44.2	17.16	4.23	31.86

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
824,889	1,736,190	2,561,079

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
782	0	187	1,201	44	278	142

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
10,431	15,889	0	0.4

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
99.66	133.56	0.20	

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Embu District	10,020	2,949	2,655	488	14,491	7,446	3,159	900	22,094	12,275	3,779	1,290
Nginda	899	0	183	0	1,362	0	214	0	2,203	0	254	0
Ngandori	1,130	0	226	0	1,716	67	267	0	2,785	93	316	0
Gaturi North	897	0	179	0	1,363	0	210	0	2,215	0	249	0
Gaturi South	778	0	213	0	1,107	0	250	0	1,646	0	296	0
Kyeni North	826	0	165	0	1,255	0	193	0	2,039	0	229	0
Kyeni South	607	0	163	0	862	0	191	0	1,281	0	227	0
Kacaari North	891	0	178	0	1,353	0	209	0	2,198	0	248	0
Kacaari South	995	289	266	114	1,423	599	315	211	2,133	910	375	303
Nthawa	362	0	109	0	501	77	128	0	719	106	152	0
Mumbinji	186	0	66	0	250	0	78	0	342	0	92	0
Kiangombe	258	0	94	0	347	0	110	0	473	0	130	0
Evurore	373	0	136	0	499	75	161	0	679	103	191	0
Mbeti North	239	0	74	0	331	0	87	0	479	0	103	0
Mbeti South	216	0	71	0	295	0	84	0	413	0	99	0
Mavuria	396	0	145	0	530	91	171	0	722	125	202	0
Kiambere	313	0	114	57	419	0	134	105	570	0	159	152
Makima	191	0	70	0	257	0	82	0	351	0	98	0
Karaba	463	0	170	0	621	0	199	0	846	0	236	0
Embu Municipality	0	2,660	33	317	0	6,537	76	584	0	10,938	123	835

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Runyenjes	6,100	Ena River	Ena river	g	2.1	0	2,337
Siakago	800	Ena River	Ena River	p	7	70	0
Embu	72,900	Kapingazi River + Rupingazi River	Lower Kapingazi River	p	1.5	130	8,849
			+Upper Rupingazi River				

g: gravity p; pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No. (nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
Gachuriri	70	7	Gachoka	Mbeti South	Irrigation	Individuals	Not known	4DC
Mwiria	30	60	Manyatta	Nginda	"	Not known	"	4DC
Rupingazi	*80*	*200*	*Manyatta*	*Nginda*	"	*M. O. A.*	*0.8*	*4DC*
Makima	100	0	Gachoka	Makima	"	Not known	8.2	4DD
Mashamba	200	0	Gachoka	Makima	"	"	Not known	4DD
Meka	0	0	Gachoka	Mavuria	"	"	"	4DD
Thiba	0	0	Gachoka	Karaba	"	"	"	4DD
Catholic Diocese	800	1	Gachoka	Makima	"	Individuals	"	4DE
Tarda Schemes	0	0	Gachoka	Makima	"	Not known	"	4DE
Geokou	100	0	Siakago	Evurori	"	"	4.1	4EB
Kasafari	400	0	Runyenjes	Kyeni S.	"	"	16.4	4EB
Kererema	*0*	*0*	*Siakago*	*Kiangombe*	"	"	Not known	4EC
Kathinji	30	0	Siakago	Evurore	"	M. O. A.	0.4	4EC
Kanurumwe	0	0	Manyatta	Gaturi S.	"	Not known	Not known	4EC
Riachina	0	0	Gachoka	Kiambere	"	"	"	4ED
F. T. C.	1.94	1	Gachoka	Municipality	"	M. O. A.	0.07954	4DC
Thambana Canal	7	0	Manyatta	Ngandori	"	Not known	0.287	4DC
Njeruri Canal	200	0	Runyenjes	Kyeni North	"	"	8.2	4EC
Kamega	0	0			"	"	Not known	
Ramega	0				"	"	Not known	

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million) US$	Cost (million) K£	Major Crops
Lower Rupingazi	1,800	Rupingazi River	24.1	6.0	7.6	Cotton, Maize, Vegetables, Tobacco

4.4 Hydropower Development

Project	Description	Executing Agency	Cost (million) US$	Cost (million) K£	Implementation Schedule 93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Gitaru #3 Extension	Hydropower 72.5MW (Tana river) –Extension of existing Gitaru P/S	KPC/ TRDC	25	32				☆		★	★		●	●	●	●						

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million) US$	Cost(million) K£	Implementation Schedule 93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million) US$	Cost (million) K£	Implementation Schedule 93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Embu	18,400	1.0	MOLG	7.6	9.6								☆	☆	☆	●	●	●					

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
Mutonga	15329	P	550	356.1	195.50	42	117,944

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers Drinking (B/H+D)	Proposed Numbers Drinking (S/W+H)	Proposed Numbers Livestock (B/H+D)	Proposed Numbers Livestock (S/W+H)	Executing Agency	Cost (million) US$	Cost (million) K£	Implementation Schedule 93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	Remarks
68	402	20	146	MOCSS	20.9	26.3	☆	●	●	●															Small communication supply

★ Design ☆ Study ● Construction

4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan: Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline	Total	Implementation Program (%): Up to 2000	2001-2010
- Quantity (m3/d)	14,378	3,120	2,668	638	646	23	23	0	555	22,051	37.0	63.0
- No. of Facilities	0	83	537	18,126	18	6	6	0	0	18,776		
- Cost (mill.US$)	0	11.19	2.64	10.96	0.51	0.06	0.05	0	0	25.41		
(mill.K£)	0	14.11	3.33	13.82	0.64	0.08	0.06	0	0	32.04		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	2,176	596	710	102	3	3	12	3,602	44.8	55.2
- No. of Facilities	0	20	146	17	3	3	0	189		
- Cost (mill.US$)	0	2.13	0.7	0.08	0.01	0.01	0	2.92		
(mill.K£)	0	2.68	0.88	0.1	0.01	0.01	0	3.68		

4.11 Watering Points in Nomadic Pasturage Area

Assumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos.)	Executing Agency	Cost (million)		Implementation of Watering Points (No.)	
			US$	K£	Up to 2000	2000-2010
-	-	-			-	-

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
-	-	-	-	-

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																
		US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Tana River Basin Study (Update)	TARDA	4.0	5.0				☆	☆	☆	☆	☆										

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Tana		MOWD	2.5	3.2				o	o	o	o	o	☆									

☆ Study

o River Basin Study (proposed under separate programme)

Isiolo

District

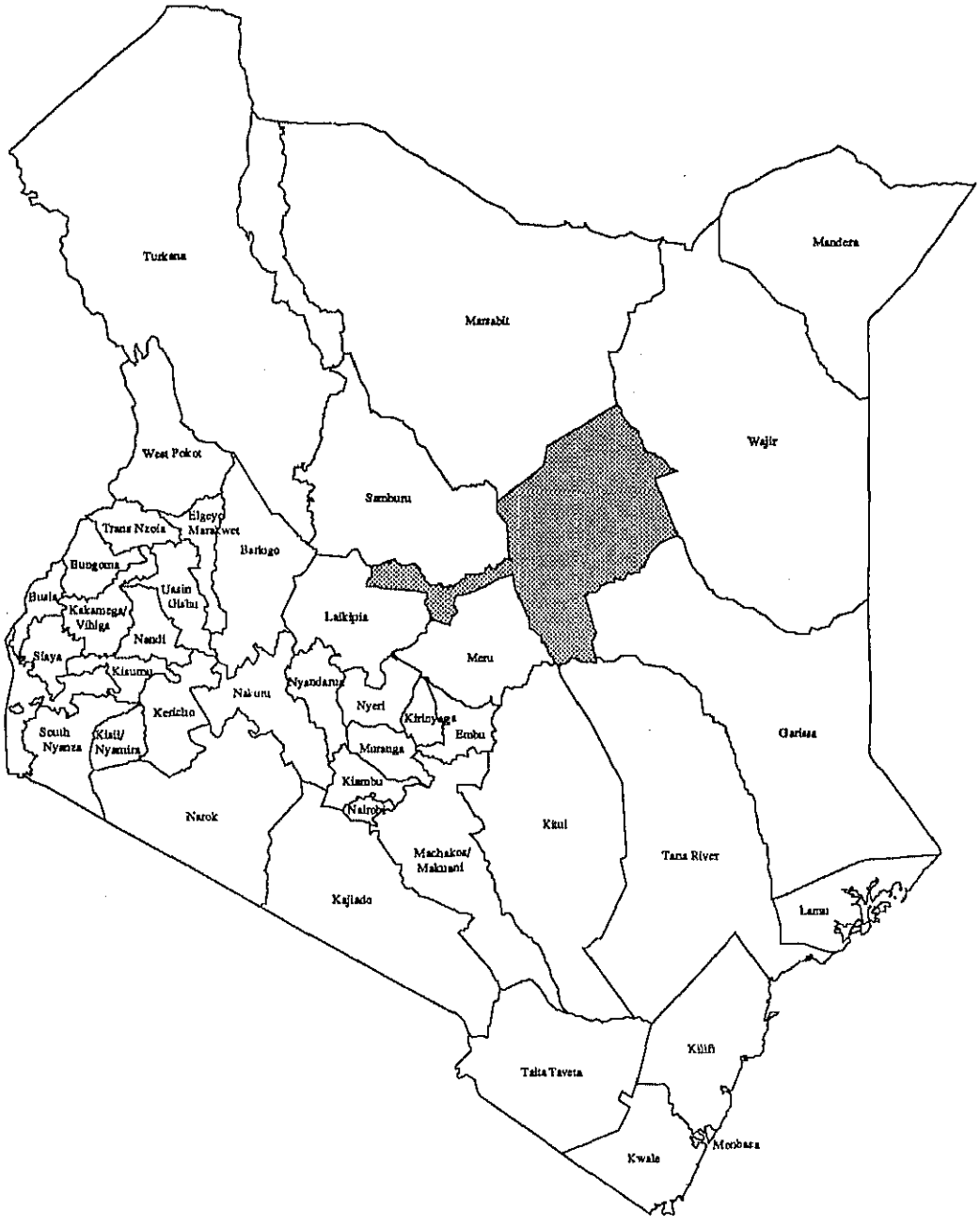
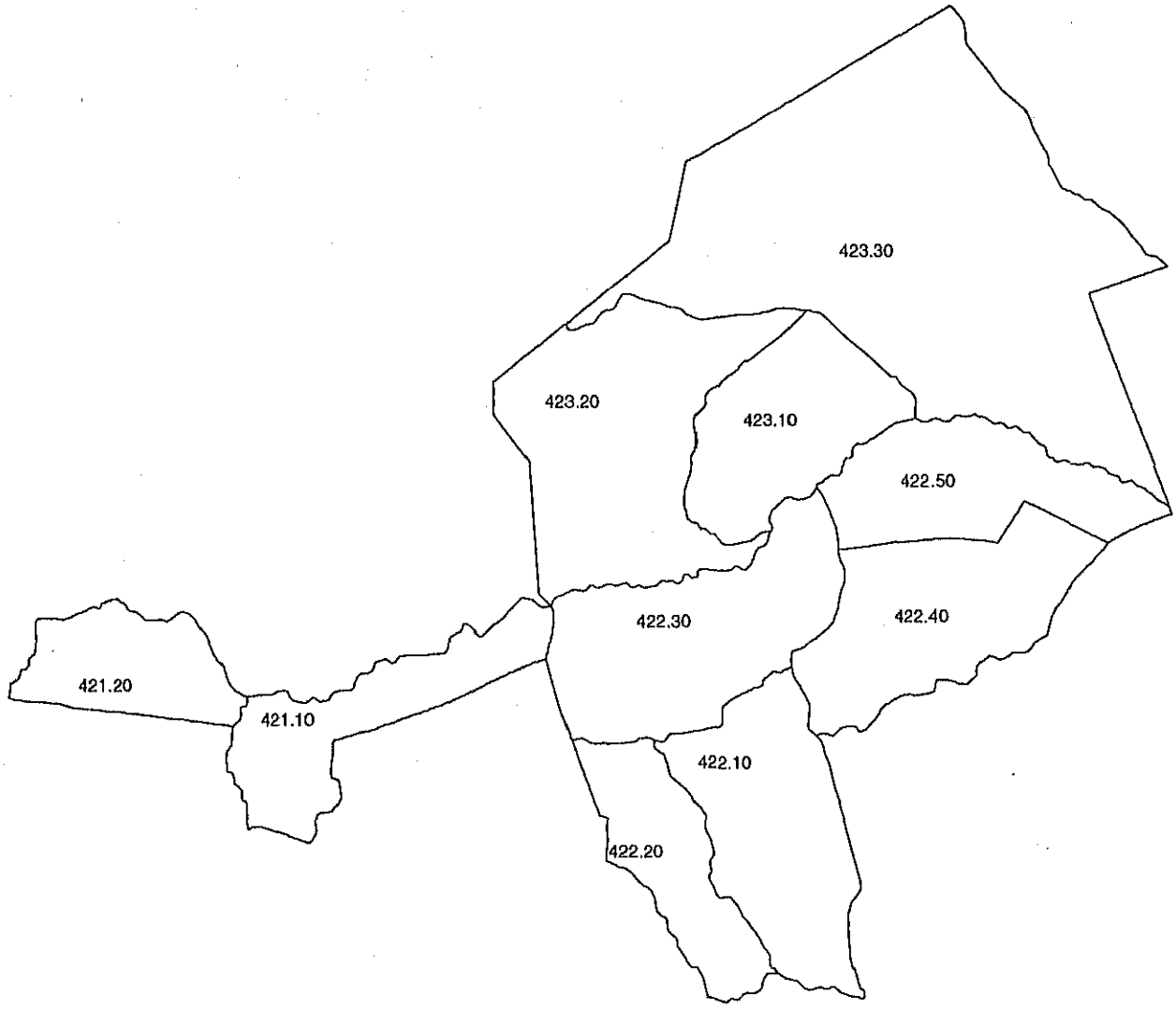
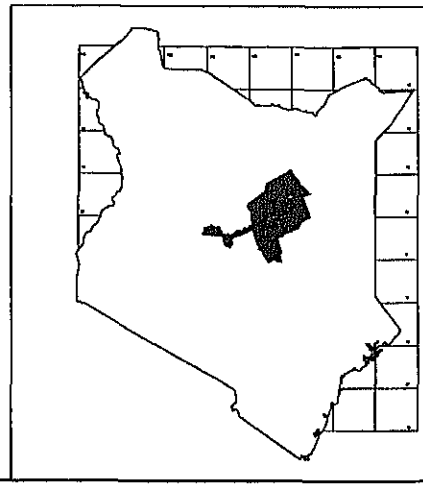


Fig.



Code	Location	Population
421.1	Central	14,702
421.2	Oldonyonyiro	2,701
422.1	Garbatula	4,820
422.2	Kinna	2,665
422.3	Kulamawe	5,037
422.4	Madogashe/Eldera	2,577
422.5	Serichо	3,589
423.1	Merti	3,726
423.2	Bisani Kiliku	1,748
423.3	Malragalla	1,914



420 Isiolo

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 420 Isiolo District

1-1 Population Projection (Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
420	Isioli District	25,605		74.8	27.9	46.9	129.5	79.2	50.3	210.5	136.1	74.5
421.1	Central	1,546	Isiolo	21.3	15.9	5.4	54.9	49.1	5.8	96.6	88.0	8.5
421.2	Oldonyonyiro	1,177	Oldonyonyiro	4.4	4.4	0.0	10.9	10.9	0.0	17.5	17.5	0.0
422.1	Garbatula	2,247	Gargatula	9.6	1.9	7.7	13.0	4.7	8.2	19.8	7.6	12.2
422.2	Kinna	1,308		4.2	-	4.2	4.6	-	4.6	6.7	-	6.7
422.3	Kulamawe	2,532		8.0	-	8.0	8.6	-	8.6	12.7	-	12.7
422.4	Madogashe/Eldera	2,270	Madogashe	4.1	-	4.1	4.6	0.2	4.4	6.8	0.3	6.5
422.5	Sericho	1,758		5.7	-	5.7	6.1	-	6.1	9.1	-	9.1
423.1	Merti	1,827	Merti	11.6	5.7	5.9	20.6	14.2	6.4	32.1	22.7	9.4
423.2	Bisani Kiliku	3,208		2.8	-	2.8	3.0	-	3.0	4.4	-	4.4
423.3	Malragalla	7,732		3.0	-	3.0	3.3	-	3.3	4.8	-	4.8

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	23.8	46.8	70.9
Percentage to GDP	0.3%	0.3%	0.3%
2) GRDP per Capita (K.Pound)	317.9	361.4	336.8
Ratio to GDP per capita	0.93	0.80	0.66
Urban (K.Pound)	463.9	374.8	349.3
Rural (K.Pound)	231.0	347.9	324.2

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	780	tons
Sorghum/Millet	28,479	tons
Potato	28	tons
Rice	-	tons
Wheat/Barley	-	tons
Coffee	8	tons
Tea	-	tons
Milk	25	tons
Meat	N.A	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	3
Textile	0
Wood	1
Paper	0
Chemical	0
Non-metal	0
Metal	0
Machinery	0
Others	0
Total	4

3) Water Supply Schemes in Service Centre

Piped system	4
Communal water points	2
Other sources	2

4) Educational Facilities

Primary school	43
Secondary school	5
Institute	3

5) Medical Facilities

Hospital	1
Health Centre	2
Dispensary	17
Others	6

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	4,145
Leprosy	0
Infectious Hepatitis	14
Bilharzia	43
Eye Infections	6,195

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
25,605	25,605	0	726	705	43	1,935	220	21,976

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
17	15	45	106	28	5	4	5	5	46	104	46	432

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
5E 03	15,300	21.3	5.7	5.7	5.7	5.7

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
835	98.37	66.59	43.12	7.16	24.11

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
11,495,339	23,594,196	35,089,535

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
0	0	0	0	0	0	0

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
3,079	6,880	0	0.7

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
172.64	360.53	27.06	59.62

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Isiolo District	928	4,034	7,465	172	1,073	11,664	11,386	318	1,809	20,423	25,802	458
Central	107	2,300	1,295	172	123	7,236	2,929	318	207	13,213	7,261	458
Oldonyonyiro	0	636	152	0	0	1,613	444	0	0	2,628	1,041	0
Garbatula	152	274	1,130	0	175	697	1,530	0	296	1,136	3,349	0
Kinna	84	0	588	0	97	0	740	0	164	0	1,603	0
Kulamawe	159	0	1,111	0	183	0	1,398	0	310	0	3,030	0
Eldera	81	0	569	0	94	27	723	0	158	39	1,566	0
Sericho	113	0	792	0	131	0	996	0	220	0	2,159	0
Merti	117	824	1,020	0	136	2,091	1,610	0	229	3,407	3,591	0
Bisani Kiliku	55	0	386	0	64	0	485	0	108	0	1,051	0
Malragalla	60	0	422	0	70	0	531	0	117	0	1,151	0

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Isiolo	88,100	Isiolo River	Boreholes + Spring	g	1245	0	152,573
Ol Doinyo Ng'iro	17,600	Sub-surface dam	Ewaso Ngiro River	p	17	100	8,323
Garbatula	7,600	Boreholes	Boreholes	g	161	0	40,389
Merti	22,700	Boreholes C3853	Ewaso Ngiro	p	1	10	5,460

g: gravity p; pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No. (nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
Kanbi Sheikh	50	-	Central	Isiolo West	Irrigation	M. O. A.	2.05	Isiolo River

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million)		Major Crops
				US$	K£	
-	-	-	-	-	-	-

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million)		Implementation Schedule															
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million)		Implementation Schedule															
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million)		Implementation Schedule															
				US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Isiolo	15,900	0.5	MOLG	3.6	4.5											☆	☆	☆	●	●	●		

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
-	-	-	-	-	-	-	-

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers				Executing Agency	Cost (million)		Implementation Schedule																Remarks
Drinking		Livestock																					
(B/H+D)	(S/W+H)	(B/H+D)	(S/W+H)		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	
13	49	182	1241	MORDASA	51.4	64.8	☆	●	●	●	●	●	●												Rural water supply

★ Design ☆ Study ● Construction

4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan									Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	301	545	673	155	2	8	25	61	12	1,782	16.5	83.5
- No. of Facilities	0	20	115	7,776	1	6	8	14	0	7,940		
- Cost (mill.US$)	0	1.91	0.58	4.71	0	0.02	0.05	0.24	0	7.52		
(mill.K£)	0	2.41	0.73	5.94	0	0.03	0.06	0.31	0	9.48		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	3,736	5,949	7,507	46	113	332	10	17,693	21.4	78.6
- No. of Facilities	0	182	1,241	2	14	37	0	1,476		
- Cost (mill.US$)	0	21.01	6.47	0.07	0.33	0.7	0	28.57		
(mill.K£)	0	26.49	8.15	0.08	0.41	0.89	0	36.03		

4.11 Watering Points in Nomadic Pasturage Area

Asumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos)	Executing Agency	Cost (million)		Implementaion of Watering Points (No.)	
			US$	K£	up to 2000	2001-2010
21,423	34	MOWD	4.9	6.2	10	24

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
Ewaso Ngiro River	W	Wajir		

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																
		US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Tana River Basin Study (Update)	TARDA	4.0	5.0				☆	☆	☆	☆	☆										
Ewaso Ngiro North River Basin Study	ENNRDA	2.5	3.2		☆	☆	☆														

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Ewaso Ngiro N.	(WRAP proposed)	MOWD	–	–																		

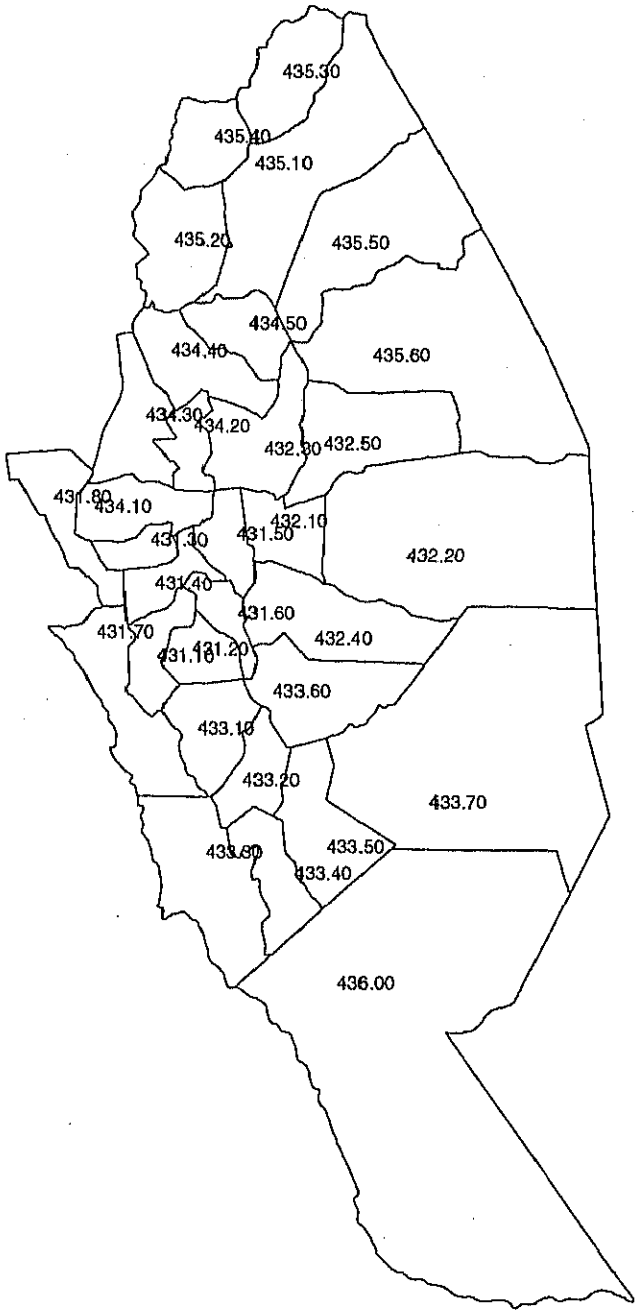
☆ Study

○ River Basin Study (proposed under separate programme)

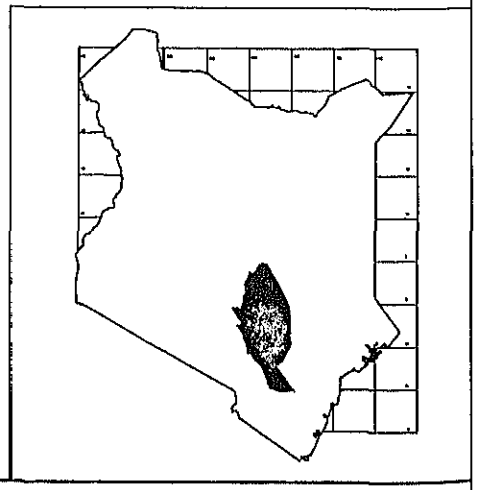
Kitui

District

Fig.



Code	Location	Population
431.1	Mulango	26,998
431.2	Kisasi	22,203
431.3	Matiyani	23,370
431.4	Changwithya	28,502
431.5	Miambani	16,807
431.6	Nzambani	16,878
431.7	Yatta	19,522
431.8	Tatta B2	4,387
432.1	Mutito	9,572
432.2	Endau	7,985
432.3	Mui	9,796
432.4	Zombe	10,976
432.5	Nuu	11,336
433.1	Ikanga	15,830
433.2	Mutomo	8,077
433.3	Athi	8,930
433.4	Ikutha	11,719
433.5	Kanziku	11,497
433.6	Voo	10,593
433.7	Mutha	7,211
434.1	Mutonguni	35,305
434.2	Migwani	17,840
434.3	Migwani West	16,911
434.4	Mwingi	29,609
434.5	Endui	10,215
435.1	Mivukoni	22,342
435.2	Katse	16,917
435.3	Tseikuru	10,628
435.4	Tharaka	6,049
435.5	Ngomeni	8,511
435.6	Ukasi	7,767
436	Tsavo National Park	0



430 Kitui

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 430 Kitui District

1-1 Population Projection

(Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
430	Kitui District	29,394		683.9	16.6	667.3	884.7	46.3	838.4	1069.4	76.6	992.9
431.1	Mulango	294		39.4	-	39.4	49.5	-	49.5	58.6	-	58.6
431.2	Kisasi	257		32.4	-	32.4	40.7	-	40.7	48.2	-	48.2
431.3	Matinyani	170		34.1	-	34.1	42.8	-	42.8	50.7	-	50.7
431.4	Changwithya	251	Kitui	44.4	9.3	35.1	68.5	24.3	44.2	93.0	40.7	52.3
431.5	Miambani	270	Miambani	24.5	-	24.5	31.0	0.2	30.8	36.8	0.3	36.5
431.6	Nzambani	199		24.6	-	24.6	30.9	-	30.9	36.6	-	36.6
431.7	Yatta	667		28.5	-	28.5	35.8	-	35.8	42.4	-	42.4
431.8	Yatta B2	430		6.4	-	6.4	8.0	-	8.0	9.5	-	9.5
432.1	Mutito	355	Ndooa(Muti)	14.0	-	14.0	17.7	0.2	17.5	21.0	0.2	20.8
432.2	Endau	2,555		11.6	-	11.6	14.6	-	14.6	17.3	-	17.3
432.3	Mui	604		14.3	-	14.3	18.0	-	18.0	21.3	-	21.3
432.4	Zombe	823		16.0	-	16.0	20.1	-	20.1	23.8	-	23.8
432.5	Nuu	829		16.5	-	16.5	20.8	-	20.8	24.6	-	24.6
433.1	Ikanga	464		23.1	-	23.1	29.0	-	29.0	34.4	-	34.4
433.2	Mutomo	323	Mutomo	11.8	-	11.8	15.9	1.1	14.8	19.0	1.5	17.5
433.3	Athi	930		13.0	-	13.0	16.4	-	16.4	19.4	-	19.4
433.4	Ikutha	394	Ikutha	17.1	-	17.1	21.9	0.4	21.5	26.0	0.6	25.4
433.5	Kanziku	633		16.8	-	16.8	21.1	-	21.1	24.9	-	24.9
433.6	Voo	700	Kisasi	15.4	-	15.4	19.7	0.2	19.4	23.3	0.3	23.0
433.7	Mutha	3,443		10.5	-	10.5	13.2	-	13.2	15.6	-	15.6
434.1	Mutonguni	427		51.5	-	51.5	64.7	-	64.7	76.6	-	76.6
434.2	Migwani	229	Migwani	26.0	-	26.0	32.7	0.1	32.7	38.8	0.1	38.7
434.3	Migwani West	472		24.7	-	24.7	31.0	-	31.0	36.7	-	36.7
434.4	Mwingi	533	Mwingi	47.1	7.3	39.8	69.1	19.1	50.0	91.2	32.0	59.2
434.5	Endui	370		14.9	-	14.9	18.7	-	18.7	22.2	-	22.2
435.1	Mivukoni	1,550	Kyuso	32.6	-	32.6	41.6	0.6	40.9	49.3	0.8	48.5
435.2	Katse	655		24.7	-	24.7	31.0	-	31.0	36.7	-	36.7
435.3	Tseikuru	548		15.5	-	15.5	19.5	-	19.5	23.1	-	23.1
435.4	Tharaka	393		8.8	-	8.8	11.1	-	11.1	13.1	-	13.1
435.5	Ngomeni	1,275		12.4	-	12.4	15.6	-	15.6	18.5	-	18.5
435.6	Ukasi	2,290		11.3	-	11.3	14.2	-	14.2	16.9	-	16.9
436.0	Tsave National Park	6,061		0.0	-	0.0	0.0	-	0.0	0.0	-	0.0

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	28.2	51.8	77.5
Percentage to GDP	0.4%	0.4%	0.4%
2) GRDP per Capita (K.Pound)	41.2	58.6	72.5
Ratio to GDP per capita	0.12	0.13	0.14
Urban (K.Pound)	766.4	519.9	481.0
Rural (K.Pound)	23.1	33.1	40.9

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	70,507	tons
Sorghum/Millet	27	tons
Potato	792	tons
Rice	-	tons
Wheat/Barley	-	tons
Coffee	16,299	tons
Tea	-	tons
Milk	661	tons
Meat	5,414	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	2
Textile	2
Wood	0
Paper	0
Chemical	0
Non-metal	0
Metal	0
Machinery	0
Others	0
Total	4

3) Water Supply Schemes in Service Centre

Piped system	27
Communal water points	0
Other sources	29

4) Educational Facilities

Primary school	622
Secondary school	85
Institute	26

5) Medical Facilities

Hospital	5
Health Centre	9
Dispensary	49
Others	25

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	38,850
Leprosy	22
Infectious Hepatitis	557
Bilharzia	3,383
Eye Infections	16,229

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
29,389	29,389	0	6,572	0	161	51	968	21,637

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
32	23	75	146	49	17	10	12	16	52	186	92	714

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
-	-	-	-	-	-	-

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
1022.67	91.07	45.12	25.79	4.28	44.88

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
9,658,200	27,888,304	37,546,504

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
0	0	0	11,558	0	0	0

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
16,134	16,020	7.8	7.3

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
303.04	600.69	-	28.04

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Kitui District	13,214	2,400	7,895	188	17,859	6,817	9,301	356	24,129	11,497	10,738	527
Mulango	780	0	463	0	1,054	0	541	0	1,423	0	621	0
Kisasi	641	0	381	0	867	0	445	0	1,171	0	511	0
Matiyani	675	0	401	0	912	0	469	0	1,232	0	538	0
Changwithya	696	1,345	441	188	941	3,586	550	356	1,271	6,117	663	527
Miambani	485	0	288	0	656	31	338	0	886	44	388	0
Nzambani	487	0	289	0	659	0	338	0	890	0	389	0
Yatta	563	0	335	0	762	0	391	0	1,030	0	449	0
Tatta B2	127	0	75	0	171	0	88	0	231	0	101	0
Mutito	277	0	164	0	374	23	192	0	504	33	221	0
Endau	232	0	137	0	313	0	160	0	424	0	184	0
Mui	283	0	168	0	382	0	196	0	516	0	226	0
Zombe	317	0	188	0	428	0	220	0	579	0	253	0
Nuu	327	0	194	0	442	0	227	0	598	0	261	0
Ikanga	457	0	271	0	618	0	317	0	835	0	364	0
Mutomo	233	0	139	0	315	163	165	0	425	227	190	0
Athi	258	0	153	0	349	0	179	0	471	0	206	0
Ikutha	339	0	201	0	457	62	236	0	618	85	271	0
Kanziku	332	0	197	0	449	0	231	0	606	0	265	0
Voo	306	0	182	0	413	36	213	0	559	51	245	0
Mutha	208	0	124	0	282	0	145	0	380	0	166	0
Mutonguni	1,019	0	605	0	1,378	0	708	0	1,862	0	813	0
Migwani	515	0	306	0	696	8	358	0	940	12	411	0
Migwani West	489	0	290	0	660	0	339	0	892	0	389	0
Mwingi	788	1,055	490	0	1,065	2,815	600	0	1,440	4,801	713	0
Endui	295	0	175	0	398	0	205	0	539	0	235	0
Mivukoni	645	0	383	0	872	91	450	0	1,178	126	517	0
Katse	489	0	290	0	660	0	339	0	892	0	389	0
Tseikuru	307	0	182	0	415	0	213	0	560	0	245	0
Tharaka	174	0	104	0	236	0	121	0	319	0	139	0
Ngomeni	246	0	146	0	332	0	171	0	448	0	196	0
Ukasi	224	0	133	0	303	0	156	0	410	0	179	0
Tsave National Park	0	0	0	0	0	0	0	0	0	0	0	0

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Kitui	40,800	Boreholes	Masinga Dam	g	9.8	0	9,415
Mutomo	1,600	Boreholes	Sub-Surface dam on Tiva river	p	16	110	0
Mwingi	32,000	Shallow wells	Kiambere Dam	p	40.5	290	16,141

g: gravity p; pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No (Nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
Katse	0	0	?	?	Irrigation	?	?	3DB
Bll Farm	5	?	Central	Changwithia	Irrigation	NONE	0.205	?
Ratulani	20	?	Mwingi	Katulani	Irrigation	NONE	0.82	?
Thunguthu	30	?	?	?	Irrigation	?	1.23	?
Ndooa	100	300	Estern	Mutitu	Irrigation	NONE	4.1	?
Kyuso	0	0	?	?	Irrigation	?	?	?
Tseikuru	0	0	?	?	Irrigation	?	?	?

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million)		Major Crops
				US$	K£	
-	-	-	-	-	-	-

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million)		Implementation Schedule																
				US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Kitui	9,300	0.5	MOLG	3.6	4.6													☆	☆	☆	●	●	●

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
-	-	-	-	-	-	-	-

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers				Executing Agency	Cost (million)		Implementation Schedule																Remarks
Drinking		Livestock																					
(B/H+D)	(S/W+H)	(B/H+D)	(S/W+H)		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	
82	881	103	1251	MOCSS	57.2	72.1	☆	●	●	●	●	●	●												Small communication supply

★ Design ☆ Study ● Construction

4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan									Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	846	5,506	10,782	3,029	104	325	292	539	2,622	24,045	42.6	57.4
- No. of Facilities	0	177	2,149	114,343	3	44	40	96	0	116,852		
- Cost (mill.US$)	0	20.46	10.17	68.71	0.14	0.93	0.62	1.65	0	102.68		
(mill.K£)	0	25.79	12.83	86.64	0.18	1.18	0.78	2.08	0	129.48		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	542	3,111	6,236	74	224	197	84	10,468	49.5	50.5
- No. of Facilities	0	103	1,251	6	36	34	0	1,430		
- Cost (mill.US$)	0	11.46	5.91	0.1	0.64	0.4	0	18.5		
(mill.K£)	0	14.44	7.45	0.12	0.8	0.51	0	23.33		

4.11 Watering Points in Nomadic Pasturage Area

Asumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos)	Executing Agency	Cost (million)		Implementaion of Watering Points (No.)	
			US$	K£	up to 2000	2001-2010
20,889	33	MOWD	5.3	6.7	10	23

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
Umaa Dam	W	Kitui	-	-
Mutuni Dam	W	Kitui	-	-
Kitimui Dam	W	Kitui	-	-

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																
		US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Tana River Basin Study (Update)	TARDA	4.0	5.0				☆	☆	☆	☆	☆										

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Tana		MOWD	2.5	3.2				o	o	o	o	o	☆								

☆ Study

o River Basin Study (proposed under separate programme)

Machakos/Makueni District

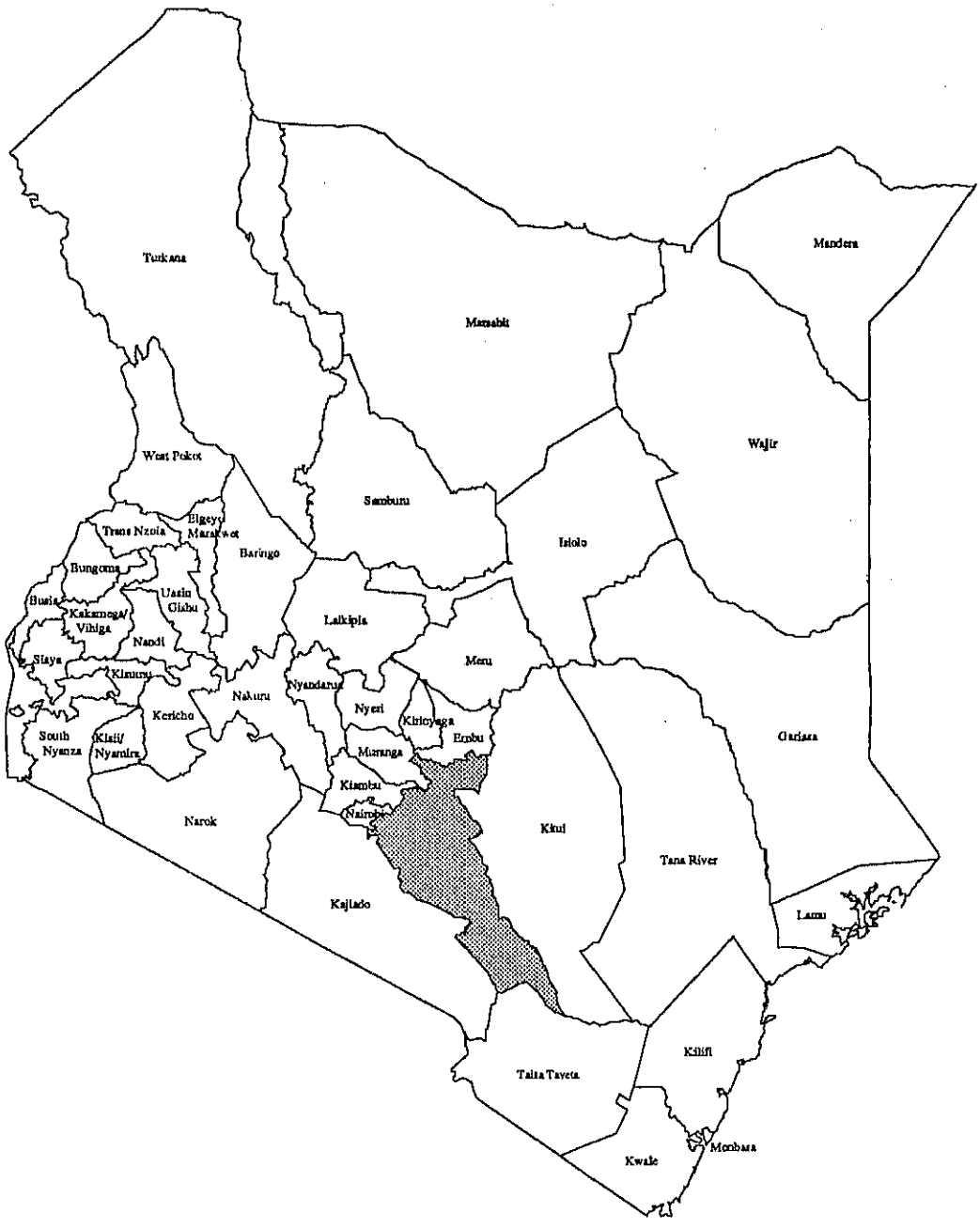
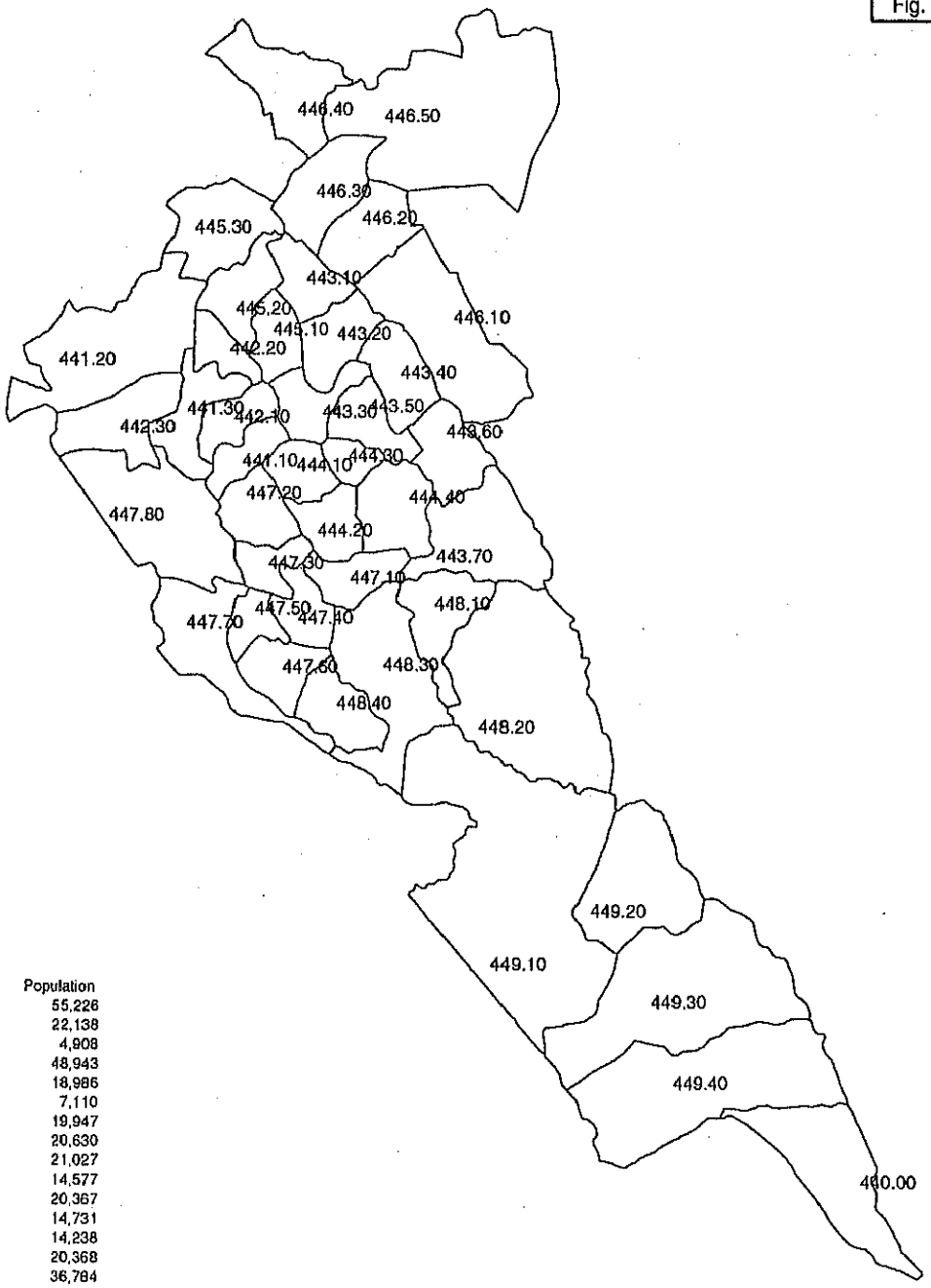
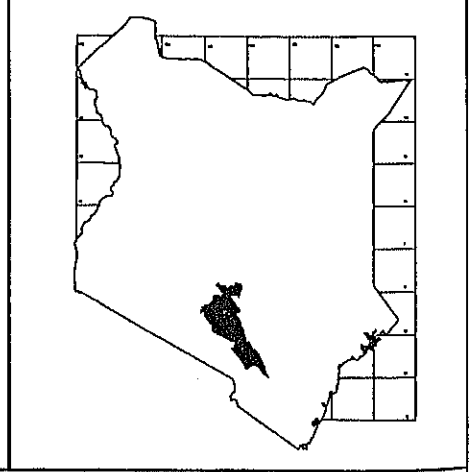


Fig.



Code	Location	Population
441.1	Muvuti	55,226
441.2	Mutituni	22,138
441.3	Mumbuni	4,908
442.1	Iveti	48,943
442.2	Mitaboni	18,986
442.3	Settlement Area	7,110
443.1	Mbiuni	19,947
443.2	Mwala	20,630
443.3	Masii	21,027
443.4	Wamunyu	14,577
443.5	Muthetheni	20,367
443.6	Kibauni	14,731
443.7	Kalawa	14,238
444.1	tulimani	20,368
444.2	Mbooni	36,784
444.3	Kiteta	13,907
444.4	Kisau	20,698
445.1	Kangundo	56,772
445.2	Matungulu	55,615
445.3	Donyo Sabuk	19,346
446.1	Kinyaata	29,839
446.2	Matuu	21,511
446.3	Ndalani	20,847
446.4	Ndithini	20,264
446.5	North Yatta	44,797
447.1	Okia	20,807
447.2	Kalama	27,175
447.3	Kithembe	26,115
447.4	Kilungu	27,491
447.5	Mukaa	18,230
447.6	Kasikeu	18,603
447.7	Konza South	14,007
447.8	Konza North	1,563
448.1	Makueni	15,580
448.2	Kathonzweni	46,682
448.3	Nzaui	35,847
448.4	Mbitini	27,865
449.1	Makindu	20,353
449.2	Kikumbulyu	18,260
449.3	Ngwata	27,707
449.4	Mtito Andei	32,661
44A.0	Tsavo National Park	0



440 Machakos/Makueni

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 440 Machakos/Makueni District

1-1 Population Projection

(Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
440	Machakos/Makueni	14,177		1486.2	165.9	1320.3	1985.2	394.6	1590.6	2577.2	652.5	1924.7
441.1	Muvuti	117	Machakos	78.7	55.8	22.9	158.9	131.3	27.6	251.7	218.3	33.4
441.2	Mutituni	618	Mitaboni+Machakos	31.5	28.8	2.7	72.0	68.7	3.3	117.9	113.9	4.0
441.3	Mumbuni	195	*<--Athi River	11.6	10.3	1.3	25.8	24.2	1.6	42.2	40.3	1.9
442.1	Iveti	127	*<--Machakos	69.9	35.3	34.6	124.7	83.1	41.6	188.5	138.1	50.4
442.2	Mitaboni	101		27.2	-	27.2	32.8	-	32.8	39.7	-	39.7
442.3	Settlement Area	264	Athi River	16.7	14.8	1.9	37.2	34.8	2.3	60.7	57.9	2.8
443.1	Mbiuni	156		28.6	-	28.6	34.5	-	34.5	41.7	-	41.7
443.2	Mwala	185	Syathani	29.6	-	29.6	36.0	0.4	35.6	43.6	0.5	43.1
443.3	*Masii*	154		30.2	-	30.2	36.3	-	36.3	44.0	-	44.0
443.4	Wamunyu	199	Kikima	20.9	-	20.9	25.5	0.3	25.2	30.9	0.4	30.5
443.5	Muthetheni	159		29.2	-	29.2	35.2	-	35.2	42.6	-	42.6
443.6	Kibauni	199		21.1	-	21.1	25.5	-	25.5	30.8	-	30.8
443.7	Kalawa	393		20.4	-	20.4	24.6	-	24.6	29.8	-	29.8
444.1	tulimani	128		29.2	-	29.2	35.2	-	35.2	42.6	-	42.6
444.2	Mbooni	152		52.8	-	52.8	63.5	-	63.5	76.9	-	76.9
444.3	Kiteta	77	Uaani/Tawa	19.9	-	19.9	24.5	0.5	24.0	29.7	0.6	29.1
444.4	Kisau	235		29.7	-	29.7	35.8	-	35.8	43.3	-	43.3
445.1	Kangundo	133	Kangundo	84.4	11.2	73.2	114.6	26.4	88.2	150.6	43.8	106.8
445.2	Matungulu	179	Tala	81.9	2.1	79.8	100.3	4.2	96.1	122.6	6.3	116.3
445.3	Donyo Sabuk	280		27.7	-	27.7	33.4	-	33.4	40.4	-	40.4
446.1	Kinyaata	565		42.8	-	42.8	51.6	-	51.6	62.4	-	62.4
446.2	Matuu	230	Matuu	30.8	-	30.8	39.8	2.6	37.2	48.6	3.6	45.0
446.3	Ndalani	262		29.9	-	29.9	36.0	-	36.0	43.6	-	43.6
446.4	Ndithini	311		29.1	-	29.1	35.0	-	35.0	42.4	-	42.4
446.5	North Yatta	1,067		64.2	-	64.2	77.4	-	77.4	93.7	-	93.7
447.1	Okia	153		29.8	-	29.8	35.9	-	35.9	43.5	-	43.5
447.2	Kalama	170		39.0	-	39.0	47.0	-	47.0	56.8	-	56.8
447.3	Kithembe	112		37.5	-	37.5	45.1	-	45.1	54.6	-	54.6
447.4	Kilungu	133	Nunguni	39.4	-	39.4	48.2	0.7	47.5	58.4	1.0	57.5
447.5	Mukaa	94		26.1	-	26.1	31.5	-	31.5	38.1	-	38.1
447.6	Kasikeu	159		26.7	-	26.7	32.1	-	32.1	38.9	-	38.9
447.7	Konza South	348	Sultan Hamud	21.6	1.5	20.1	27.2	3.0	24.2	33.8	4.5	29.3
447.8	Konza North	541		2.2	-	2.2	2.7	-	2.7	3.3	-	3.3
448.1	Makueni	230	Makueni	24.6	2.3	22.3	32.3	5.4	26.9	41.6	9.0	32.6
448.2	Kathonzweni	887		66.9	-	66.9	80.7	-	80.7	97.6	-	97.6
448.3	Nzaui	493	Emali	51.4	-	51.4	62.5	0.6	61.9	75.7	0.8	74.9
448.4	Mbitini	190		40.0	-	40.0	48.1	-	48.1	58.3	-	58.3
449.1	*Makindu*	1,508		29.2	-	29.2	35.2	-	35.2	42.6	-	42.6
449.2	Kikumbulyu	457		26.2	-	26.2	31.5	-	31.5	38.2	-	38.2
449.3	Ngwata	912		39.7	-	39.7	47.9	-	47.9	57.9	-	57.9
449.4	Mtito Andei	850	Mtito Andei+Kibwezi	47.7	3.8	43.9	61.3	8.4	52.9	77.5	13.5	64.0
44A.0	Tsavo National Park	454		0.0	-	0.0	0.0	-	0.0	0.0	-	0.0

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	180.4	365.8	555.7
Percentage to GDP	2.3%	2.6%	2.7%
2) GRDP per Capita (K.Pound)	121.4	184.2	215.6
Ratio to GDP per capita	0.36	0.41	0.43
Urban (K.Pound)	519.1	412.7	382.2
Rural (K.Pound)	71.4	127.6	159.2

1-3 *Present District Profile (1990)*

1) Agricultural Production (1989)

Product	Production	Unit
Maize	219,000	tons
Sorghum/Millet	9,455	tons
Potato	22,700	tons
Rice	-	tons
Wheat/Barley	-	tons
Coffee	56	tons
Tea	-	tons
Milk	5,707	tons
Meat	N.A	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	25
Textile	10
Wood	12
Paper	2
Chemical	2
Non-metal	3
Metal	0
Machinery	9
Others	0
Total	63

3) Water Supply Schemes in Service Centre

Piped system	121
Communal water points	0
Other sources	0

4) Educational Facilities

Primary school	1507
Secondary school	219
Institute	20

5) Medical Facilities

Hospital	6
Health Centre	35
Dispensary	46
Others	2

6) *Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)*

Diarrhoeal Diseases	58,185
Leprosy	30
Infectious Hepatitis	528
Bilharzia	5,303
Eye Infections	25,490

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
14,183	14,178	5	1,666	2	337	88	4,465	7,620

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
49	38	90	176	61	10	4	6	9	51	187	110	796

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
3DA02	5,724	18.7	5.2	3.4	2.6	1.3

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
1442.08	99.64	70.18	33.45	5.29	40.39

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
5,512,349	10,778,282	16,290,631

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
2,930	52	428	7,475	31	208	52

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
11,340	22,227	131.9	60.1

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
408.19	433.74	-	-

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Machakos/Makueni District	28,730	23,990	9,330	3,072	38,000	58,144	10,981	5,525	54,205	97,936	13,632	7,659
Muvuti	480	8,068	253	980	630	19,352	393	1,797	886	32,765	574	2,555
Mutituni	54	4,165	68	0	70	10,125	133	0	97	17,101	212	0
Mumbuni	32	1,489	27	0	44	3,572	50	0	64	6,048	78	0
Iveti	915	5,105	297	0	1,266	12,242	406	0	1,929	20,728	554	0
Mitaboni	544	0	187	0	706	0	213	0	979	0	259	0
Settlement Area	39	2,140	39	1,219	50	5,133	72	2,103	70	8,691	113	2,748
Mbiuni	586	0	196	0	764	0	224	0	1,066	0	272	0
Mwala	623	0	203	57	815	52	232	105	1,146	73	282	152
Masii	677	0	207	0	899	0	236	0	1,289	0	287	0
Wamunyu	414	0	143	0	536	42	164	0	741	58	200	0
Muthetheni	578	0	200	0	749	0	229	0	1,034	0	278	0
Kibauni	418	0	145	0	542	0	165	0	749	0	201	0
Kalawa	407	0	140	0	529	0	160	0	733	0	194	0
tulimani	716	0	200	0	968	0	229	0	1,426	0	278	0
Mbooni	1,371	0	361	0	1,884	0	413	0	2,845	0	502	0
Kiteta	462	0	137	0	615	69	157	0	887	95	191	0
Kisau	668	0	203	0	888	0	232	0	1,270	0	283	0
Kangundo	2,068	1,619	521	57	2,870	3,884	616	105	4,390	6,577	769	152
Matungulu	1,704	304	550	359	2,241	617	631	673	3,167	946	769	982
Donyo Sabuk	600	0	190	0	793	0	217	0	1,130	0	264	0
Kinyaata	847	0	293	0	1,098	0	335	0	1,516	0	407	0
Matuu	611	0	211	57	791	390	246	105	1,093	540	300	152
Ndalani	592	0	205	0	767	0	234	0	1,059	0	285	0
Ndithini	576	0	199	0	746	0	228	0	1,031	0	277	0
North Yatta	1,272	0	440	0	1,648	0	503	0	2,275	0	612	0
Okia	685	0	204	0	911	0	234	0	1,313	0	284	0
Kalama	771	0	267	0	1,000	0	305	0	1,381	0	371	0
Kithembe	812	0	257	0	1,079	0	293	0	1,551	0	356	0
Kilungu	925	0	270	0	1,240	106	310	0	1,805	146	377	0
Mukaa	620	0	179	0	838	0	205	0	1,235	0	249	0
Kasikeu	552	0	183	0	722	0	209	0	1,010	0	254	0
Konza South	400	217	140	133	519	441	162	243	717	675	199	343
Konza North	45	0	15	0	57	0	18	0	79	0	21	0
Makueni	442	333	157	94	573	797	184	178	792	1,350	227	264
Kathonzweni	1,326	0	459	116	1,717	0	524	216	2,371	0	637	311
Nzaui	1,146	0	352	0	1,517	84	404	0	2,167	117	491	0
Mbitini	976	0	274	0	1,312	0	313	0	1,917	0	380	0
Makindu	578	0	200	0	749	0	229	0	1,034	0	278	0
Kikumbulyu	518	0	179	0	672	0	205	0	928	0	249	0
Ngwata	789	0	272	0	1,023	0	311	0	1,415	0	378	0
Mtito Andei	891	550	307	0	1,162	1,238	357	0	1,618	2,026	440	0
Tsavo National Park	0	0	0	0	0	0	0	0	0	0	0	0

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
Machakos	356,400	Mamba Dam	Athi River P/L	p	56.7	600	78,112
Mitaboni	114,000	*Spring, Self-help*	*Kaathana River*	p	9.9	130	20,293
Athi River	98,200	Nol-Turesh P/L	Upper Athi Dam	g	9.9	0	19,658
Uaani/Tawa	700	Boreholes and Dam	Tawa river	g	4.1	0	1,113
Kangundo	43,900	Boreholes	Pipeline from Athi River	p	44	170	19,537
Tala	6,400	Boreholes	Pipeline from Athi river	p	28.3	160	8,437
Nunguni	1,000	Spring	Kyangonyo river	p	6.2	440	1,498
Wote	9,000	Boreholes	Kaiti river + Nzuuni river	p	3.9	180	3,263
Emali	800	Nol Tresh P/L	Nol Tresh P/L	p	7	150	1,691
Mtito Andei&Kibwezi	13,500	*Nol-Turesh P/L + Umani springs*	*Pipeline from Athi river*	p	77	70	19,537

g: gravity p: pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No (Nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
Kilome	0	?	?	?	Irrigaiton	?	?	3FA
Kwa-Chai Ext.	50	?	?	?	Irrigaiton	?	2.05	3FB
Mitito Andei	200	0	?	?	Irrigation	?	8.2	3FB
Kibwezi Pex	0	0	Kibwezi	Kikumbulyu	Irrigation	?	?	?

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million)		Major Crops
				US$	K£	
Kanzalu	4,055	Athi River	97.2	37.9	47.8	Rice
Kibwezi extension	13,200	Athi River	378.8	227.1	286.1	Rice

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million)		Implementation Schedule																
				US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Machakos	91,100	2.8	MOLG	22.1	27.8			☆	☆	☆	●	●	●										
Mitaboni	29,400	0.2	MOLG	1.6	2.0			☆	☆	☆	●	●	●										

★ Design ☆ Study ● Construction

4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
Yatta	20000	W	782	380.2	13.50	52	145,235

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers				Executing Agency	Cost (million)		Implementation Schedule																Remarks
Drinking		Livestock																					
(B/H+D)	(S/W+H)	(B/H+D)	(S/W+H)		US$	K£	93	94	95	96	97	98	99	20	01	02	03	04	05	06	07	08	09	10	
184	2277	96	994	MOCSS	76.8	96.8	☆	●	●	●	●	●	●	●	●	●										Small communication supply

★ Design ☆ Study ● Construction

4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan									Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	12,589	10,501	19,777	3,746	1,234	496	332	50	5,344	54,069	36.4	63.6
- No. of Facilities	0	312	3,860	157,275	34	63	47	13	0	161,604		
- Cost (mill.US$)	0	38.62	18.6	94.38	1.69	1.42	0.69	0.2	0	155.59		
(mill.K£)	0	48.7	23.45	119.01	2.13	1.79	0.87	0.25	0	196.2		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	3,927	2,726	5,032	444	95	65	154	12,443	38.4	61.6
- No. of Facilities	0	96	994	34	33	28	0	1,185		
- Cost (mill.US$)	0	9.93	4.69	0.6	0.26	0.13	0	15.61		
(mill.K£)	0	12.52	5.91	0.75	0.33	0.17	0	19.69		

4.11 Watering Points in Nomadic Pasturage Area

Asumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos)	Executing Agency	Cost (million)		Implementaion of Watering Points (No.)	
			US$	K£	up to 2000	2001-2010
6,424	10	MOWD	1.7	2.1	3	7

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
Thwake Dam	I+W	Rural	Kibwezi	-
Kiteta Dam	W	Rural	-	-
Mbuuni Dam	W	Machakos	-	-

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																	
		US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Athi River Basin Study (Update)	TARDA	4.0	5.0		☆	☆	☆	☆	☆												

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Athi	(WRAP proposed)	MOWD	-	-		☆	☆	☆														

☆ Study

o River Basin Study (proposed under separate programme)

Marsabit

District

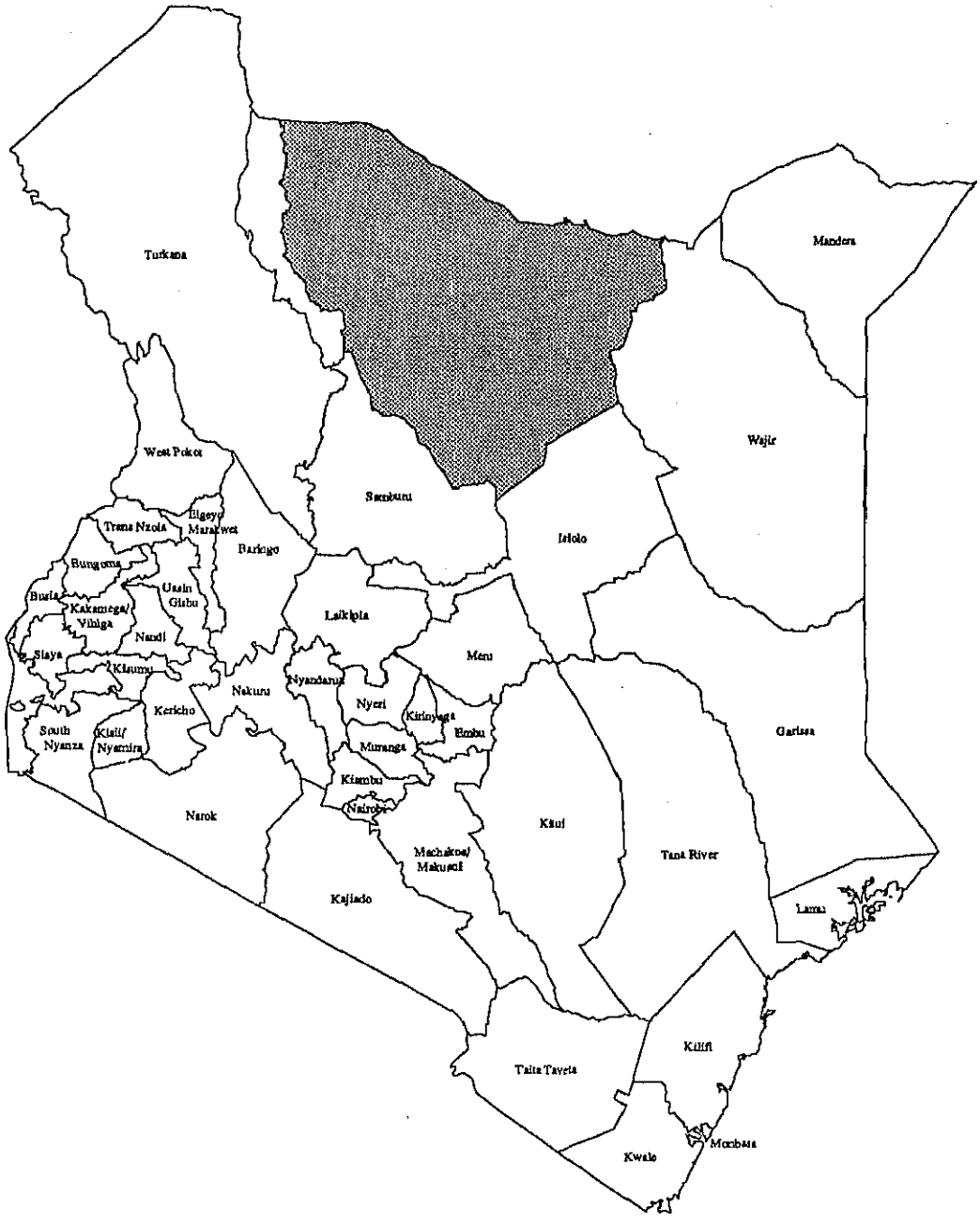
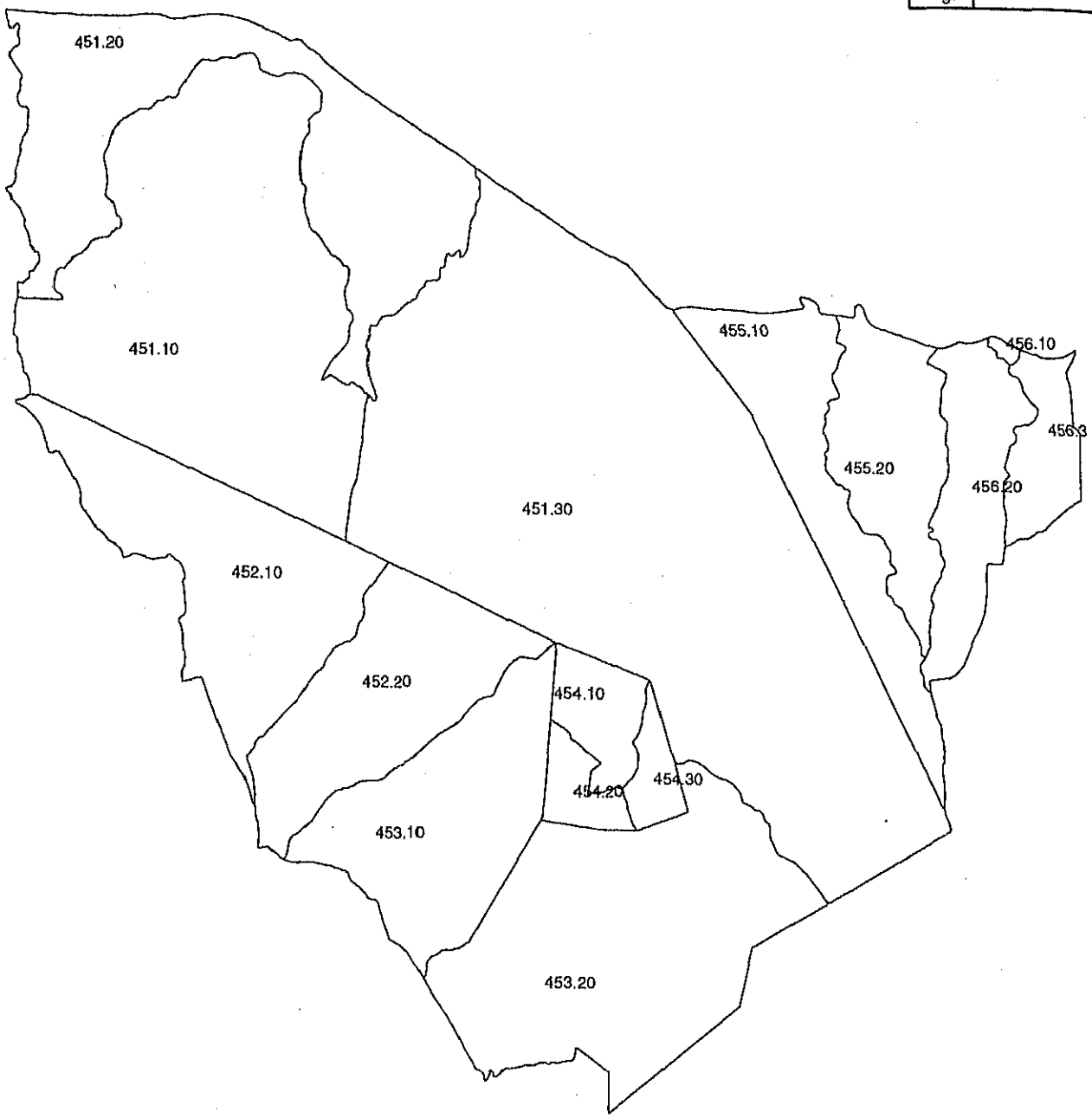
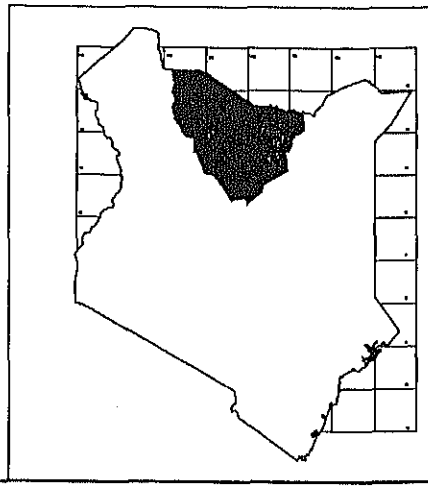


Fig.



Code	Location	Population
451.1	North Horr	5,075
451.2	Dukana	6,021
451.3	Maikona	13,088
452.1	Loiyangalani	5,731
452.2	Kargi	3,765
453.1	Korr	8,142
453.2	Logologo	6,505
454.1	Mountain	12,364
454.2	Karare	2,487
454.3	Sagante	2,417
455.1	Uran	5,476
455.2	Sololo	6,303
456.1	Moyale	7,478
456.2	Butiye	4,338
456.3	Godoma	7,026



450 Marsabit

THE STUDY
ON
THE NATIONAL WATER MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Socio-Economic Profile : 450 Marsabit District

1-1 Population Projection

(Unit:1000)

Code	Location	Land Area (sq.km)	Town Name	1990			2000			2010		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
450	Marsabit District	73,953		138.1	33.8	104.3	196.4	79.2	117.2	270.3	123.0	147.2
451.1	North Horr	11,287	North Horr	9.2	2.1	7.1	12.3	4.3	8.0	16.3	6.2	10.0
451.2	Dukana	7,107		8.4	-	8.4	9.5	-	9.5	11.9	-	11.9
451.3	Maikona	21,561		18.3	-	18.3	20.6	-	20.6	25.9	-	25.9
452.1	Loiyangalani	5,193		8.0	-	8.0	9.0	-	9.0	11.3	-	11.3
452.2	Kargi	4,129	Kargi	6.7	4.3	2.4	13.1	10.5	2.7	19.9	16.5	3.4
453.1	Korr	4,518	Korr	17.2	5.8	11.4	24.7	11.9	12.8	33.3	17.2	16.1
453.2	Logologo	8,124		9.1	-	9.1	10.2	-	10.2	12.9	-	12.9
454.1	Mountain	1,018	Marsabit	16.2	11.1	5.1	32.7	27.0	5.7	49.9	42.7	7.2
454.2	Karare	605		3.5	-	3.5	3.9	-	3.9	4.9	-	4.9
454.3	Sagante	539		3.4	-	3.4	3.8	-	3.8	4.8	-	4.8
455.1	Uran	3,455		7.7	-	7.7	8.6	-	8.6	10.8	-	10.8
455.2	Sololo	2,835	Sololo	7.6	3.7	3.9	13.4	9.0	4.4	19.8	14.2	5.5
456.1	Moyale	55	Moyale	6.8	6.8	0.0	16.5	16.5	0.0	26.2	26.2	0.0
456.2	Butiye	2,325		6.1	-	6.1	6.8	-	6.8	8.6	-	8.6
456.3	Godoma	1,202		9.8	-	9.8	11.1	-	11.1	13.9	-	13.9

1-2 GRDP Projection

Item	1990	2000	2010
1) GRDP (K.Pound million)	21.8	38.8	57.9
Percentage to GDP	0.3%	0.3%	0.3%
2) GRDP per Capita (K.Pound)	158.1	197.6	214.3
Ratio to GDP per capita	0.46	0.44	0.42
Urban (K.Pound)	446.6	360.4	355.3
Rural (K.Pound)	64.6	87.6	96.5

1-3 Present District Profile (1990)

1) Agricultural Production (1989)

Product	Production	Unit
Maize	7,236	tons
Sorghum/Millet	2,910	tons
Potato	60	tons
Rice	-	tons
Wheat/Barley	43	tons
Coffee	17,434	tons
Tea	-	tons
Milk	31,964	tons
Meat	5,428	tons

2) Number of Manufacturing Establishments (1986)

Type of Industry	Number
Food	9
Textile	0
Wood	1
Paper	0
Chemical	0
Non-metal	0
Metal	0
Machinery	0
Others	0
Total	10

3) Water Supply Schemes in Service Centre

Piped system	5
Communal water points	2
Other sources	5

4) Educational Facilities

Primary school	48
Secondary school	3
Institute	3

5) Medical Facilities

Hospital	2
Health Centre	4
Dispensary	11
Others	0

6) Out-patient of Infective Diseases in Relation to Water Supplies (1985-89 Average)

Diarrhoeal Diseases	5459
Leprosy	4
Infectious Hepatitis	88
Bilharzia	183
Eye Infections	2721

2. Land and resources

2.1 Present Land Use

Unit : km2

Total Area	Land Area	Water Area	Forest & Park	Swamp	Town	Barrenland	Agriculture Land	Other Land
78,078	73,952	4,126	5,661	403	390.39	46,488	85	20,924.61

2.2 Rain fall

Unit : mm

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
17	14	42	109	41	5	8	6	5	45	70	26	394

2.3 River Flow

Unit : m3/sec

Gauge Code	Catchment Area (km2)	Mean Flow	Low Flow Frequency			
			80%	90%	95%	Min.
-	-	-	-	-	-	-

2.4 Groundwater

Aquifer Characteristics

Elevation (m)	Total Depth (m)	Water Struck (m)	Level Rest (m)	Yield (m3/hr)	Draw Down (m)
737.56	102.38	72.4	54.88	5.08	22.95

Safe Abstruction Yield

Unit : m3/year

Borehole	Shallow	Total
20,221,098	27,050,316	47,271,414

2.5 Agriculture

Suitable Area for Major Crops

Unit: km2

Maize	Wheat	Rice	Sorghum	Potato	Coffee	Tea
61	0	21	1,538	0	0	0

Area of Irrigation Potential

Unit : ha

Surfce Water		Groundwater	
Upland	Lowland	Upland	Lowland
0	0	14	49.8

Livestock Population

Unit: 1,000

Cattle	Sheep/Goats	Camels	Donkeys
261.94	906.96	186.07	18.28

3 Water Demand Projection

Unit: cu.m/day

Location	1990				2000				2010			
	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry	Rural	Urban	Livestock	Industry
Marsabit District	2,069	4,888	14,932	513	2,504	11,672	19,020	950	3,587	18,468	34,373	1,368
North Horr	141	304	1,011	0	170	634	1,259	0	244	934	2,239	0
Dukana	167	0	1,117	0	202	0	1,316	0	290	0	2,300	0
Maikona	363	0	2,429	0	439	0	2,861	0	629	0	5,000	0
Loiyangalani	159	0	1,064	0	192	0	1,253	0	275	0	2,189	0
Kargi	47	622	459	0	57	1,542	736	0	82	2,483	1,450	0
Korr	226	838	1,703	0	273	1,752	2,192	0	392	2,579	3,940	0
Logologo	181	0	1,207	0	218	0	1,422	0	313	0	2,485	0
Mountain	104	1,605	1,040	228	127	3,980	1,730	421	184	6,409	3,446	607
Karare	69	0	462	0	85	0	544	0	120	0	950	0
Sagante	67	0	449	0	81	0	528	0	116	0	923	0
Uran	152	0	1,016	0	184	0	1,197	0	263	0	2,092	0
Sololo	78	535	641	0	94	1,327	924	0	134	2,137	1,755	0
Moyale	0	983	225	285	0	2,438	574	529	0	3,926	1,263	761
Butiye	120	0	805	0	146	0	948	0	208	0	1,657	0
Godoma	195	0	1,304	0	236	0	1,536	0	337	0	2,684	0

4 Action Plan

4.1 Urban Water Supply

Urban Name	Population	Present Raw Water Source	Future Raw Water Source	G/P	Pipe line (km)	Pump lift (m)	Cost 1000 US$
North Horr	6,300	Boreholes	Boreholes	g	232	0	22,017
Kargi	16,600	Boreholes	Boreholes + Subsurface Dam	g	756	0	66,779
Korr	17,200	Boreholes	Boreholes	g	593	0	56,810
Marsabit	42,700	Small river(Bakuli spring)	Boreholes +Small dams /Sub-surface dam/Spring	g	1739	0	177,736
Sololo	14,300	Boreholes	Boreholes	g	726	0	63,277
Moyale	26,200	Moyale Dam	Boreholes + Small Dam	g	608	0	68,275

g: gravity p: pump

4.2 Small Scale Irrigation Scheme

Scheme Name	Area (ha)	Farmers No. (Nos)	Division	Location	Type of Project	Imp. Agency	Cost million Kshs	Basin
-	-	-	-	-	-	-	-	-

4.3 Large Scale Irrigation Project

Project	Area (ha)	Water Source	Water Demand (MCM)	Cost (million)		Major Crops
				US$	K£	
-	-	-	-	-	-	-

4.4 Hydropower Development

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

★ Design ☆ Study ● Construction

4.5 Flood Mitigation Project

Project	Description	Executing Agency	Cost(million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
-	-	-	-	-																		

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4.6 Urban Drainage and Ad-hoc River Improvement Projects

Project	Population	Area (Km2)	Executing Agency	Cost (million)		Implementation Schedule																
				US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Mansabit	11,100	0.1	MOLG	0.8	1.1											☆	☆	☆	●	●	●		

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4.7 Dam Development Plan

Damsites	C.A. (km2)	Purpose	FSL (El. m)	Storage (MCM)	Yield (m3/s)	Height (m)	Cost (1,000US$)
-	-	-	-	-	-	-	-

W:Water Supply I:Irrigation P: Power

4.8 Groundwater Development Projects

Proposed Numbers				Executing Agency	Cost (million)		Implementation Schedule																	Remarks
Drinking		Livestock					93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	
(B/H+D)	(S/W+H)	(B/H+D)	(S/W+H)		US$	K£																			
23	77	471	2128	MORDASA	113.1	142.5	☆	●	●	●	●	●	●	●	●	●	●	●	●						Rural water supply

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4.9 Source Development Plan for Rural Water Supply

District	Source Development Plan									Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Roof Catch	Small Dam	Subsur-face Dam	Sand Dam	Rock Catch	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	54	1,502	1,270	365	9	64	70	13	206	3,553	28.7	71.3
- No. of Facilities	0	55	238	18,436	3	11	11	3	0	18,757		
- Cost (mill.US$)	0	6	1.14	11.05	0.01	0.18	0.14	0.05	0	18.58		
(mill.K£)	0	7.56	1.44	13.94	0.02	0.23	0.18	0.06	0	23.43		

4.10 Source Development Plan for Livestock Water Supply

District	Source Development Plan							Total	Implementation Program (%)	
	Surface Water	Borehole	Shallow Well	Small Dam	Subsur-face Dam	Sand Dam	Existing Pipeline		Up to 2000	2001-2010
- Quantity (m3/d)	753	14,425	11,587	132	539	711	262	28,409	21.0	79.0
- No. of Facilities	0	471	2,128	3	59	77	0	2,738		
- Cost (mill.US$)	0	57.43	10.48	0.19	1.56	1.51	0	71.17		
(mill.K£)	0	72.42	13.21	0.24	1.97	1.91	0	89.75		

4.11 Watering Points in Nomadic Pasturage Area

Asumed Nomadic Pasturage Area (km2)	No. of Watering Points (Nos)	Executing Agency	Cost (million)		Implementaion of Watering Points (No.)	
			US$	K£	up to 2000	2001-2010
20,305	32	MOWD	4.9	6.2	10	22

5 Future Water Resources Developmet Potential and Study Proposal

5.1 Potential Water Source for Future Development

Potential Water Source for Future Development	Purpose	Schemes		
		Water Supply	Irrigation	Hydropower
Habaswein Dam	W	Habaswein	-	-
Meri Dam	W	Meri	-	-
Malgis Dam	W	Marsabit		
Boreholes at Laisamis	W	Marsabit		

W:Water Supply I:Irrigation P: Power

5.2 River Basin Developmetn Study

Description	Executing Agency	Cost (million)		Implementation Schedule																
		US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Ewaso Ngiro North River Basin Study	ENNRDA	2.5	3.2		☆	☆	☆														

★ Design ☆ Study ● Construction

5.3 District Water Resource Study

Related Basin Study Proposed	Remarks	Executing Agency	Cost (million)		Implementation Schedule																
			US$	K£	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Ewaso Ngiro N.	(WRAP proposed)	MOWD	-	-	☆	☆																

☆ Study

o River Basin Study (proposed under separate programme)