CHAPTER 2 PRESENT CONDITION OF THE SA

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2.1 Overall SA

There are 339 villages located in the SA with more than 46.6 thousand households with a population of around 196,000 according to the result of 1998 census. Population growth in the SA is estimated at 2%, and population density therein is given as 293 people per square kilometer, while average number of households in a village is at 138. Majority (around 85% of the total) of the households are engaged in maize and other crop cultivation covering about 33 thousand hectare of arable area, or around 0.85 ha per household. Here, annual cropping is practiced on about two thirds or more of arable holding and the rest is kept fallow. Besides, an average household has 0.48 ha of land area used as homestead / individual woodlots. Therefore, average cropping acreage falls nearly 0.6 ha, from which only 0.7~0.8 ton of grain maize can be harvested, feeding only 3 ~ 4 adults per year. It follows that chronic food shortage prevails over the SA if off-farm income is not available to farm households.

Table 2.1 Summary of TA in the SA

District	Name of TA	Area (km^2)	Population *	household*	density *	No. of villages
Blantyre	Chigaru	90.10	14,044	3,393	156	22
	Kuntaja	149.70	24,378	6,065	163	66
	Kunthembwe	9.00	2,892	749	321	8
	Kapeni	186.60	72,365	16,055	388	100
	Lundu	8.95	3,774	991	422	8
	Makata	55.75	12,902	3,222	231	28
	Machinjiri	91.50	45,104	10,863	493	47
Chiradzulu	Chitera	54.45	12.965	3,279	238	36
	Mpama	23.70	7,925	2,014	334	24
2 districts	9 TAs	669.75 km^2	196,349	46,631 hh	293	339

Note: The data gives the population, households and surface area inside the study area only.

Except for urban area located in Blantyre-Limbe periurban quarters and Lunzu, Lirangwe townships, the population density tends to be higher in the southeast, and lower in the northwest. On the contrary, arable land area per household and fuelwood availability tends to be larger in the northwest / northeast, but smaller in the southeast. The percentage of the area covered by canopy (estimated from photo-interpretation) shows a higher percentage in the east because of higher rainfall and owing to larger estate occupation, but barren over the central and western parts of the SA. Due to unavoidable population pressure, villagers are obliged to reclaim even steep slope and rocky patches, sacrificing wood land, brushes and even homestead shading stands. Forest reserves and afforested areas including those included in BCFP are mostly distributed out of the SA, or surrounding the SA. The SA appears as a bare landscape where almost all wood resources available had been exploited for charcoal and have been depleted now.

A few decades ago there were abundant forests for villagers but they had been felled and the cleared land plots were allotted to new households. As a result, very few village forests still remain that can provide villagers with fuelwood, while majority depends on individual woodlots or stands of Eucalyptus around their homestead. Such deterioration in the natural vegetation has been wide-spread over the SA, but the extent of barreness is more outstanding in the southern and peri-urban part of the SA where many farm households have to buy daily fuelwood supplied from Mwanza, Chikwawa or Thyolo. In the SA, few woodlands remain where tree felling is banned and also in private estates where natural vegetation has been conserved as wind

breakers, shading trees for plantation / livestock and tobacco curing materials.

Demand for fuelwood has been ever increasing whereas supply has been dwindling year after year and the gap between these is met by purchase, and use of crop residue (mapesi) . Measures so far taken by the villagers in the SA to cope with fuelwood shortage are planting Eucalyptus around their homestead, along water drains and rocky hillsides or in-between rock outcrop where crop can hardly be sown. Device for saving fuelwood is not yet practiced as countermeasures, nor any type of energy substitutes been tried by villagers so far. Agroforestry seems to serve as powerful measures to mitigate wood shortage, however, villagers at large do not know how to practice it, though they already have basic knowledge on it.

Shortage problems are not confined only to fuelwood, but also water supply situation has become more serious as population grows. Many households in the SA depend their daily water fetching on rivers or springs. However, they also suffer from pollution especially in Lunzu river, the source of which stems from periurban area of TA Machinjiri that discharges sewage into the river, where medical wastes from hospitals are also spilled. Water conservation forests have been eventually extinct through fuelwood exploitation and urbanization, which formerly served as watershed buffer to maintain river-flow. The mean amount of annual precipitation has a tendency of decreasing from the southeastern to northwestern parts of the SA, implying that the importance of water conservation by planting trees are higher in this semi-arid zone where water in boreholes tends to deplete through accelerated deforestation taking place recently.

Topography of the SA is inclined towards north-west, the highest part of which lies in Machinjiri (Mt. Ndirande and Mt. Lunzu) while Shire river flows in the lowest part, with the altitude ranging from 1,610 m to 380 m or the mean gradient of river bed equivalent to around 1 %. Severe soil erosion readily takes place over steep hill-sides, developing into deep gullies and on undulated plateaus where shallow top-soils are soon saturated causing sheet erosion and river bank scouring. Increased surface of bare land through deforestation process has fostered soil erosion, by which precious top-soil has been washed away from arable land at the rate of 0.5 ~ 1.8 mm / year, at the same time adsorbed crop nutrients are also lost with run-off of clay minerals.

The erosion process only leaves behind gravel and pebbles with poorer capacity in absorbing or holding nutrients. Traditional high-ridging of crop fields is not effective enough to minimize the rate of soil loss, because water runs off through intra-ridge space or frequently torrential runoff water breaks weaker part of ridges where turbid runoff is spilled away downstream. Thus, both water and nutrients are lost with soil from the surface of farm plots where annual loss of nitrogen comes to about 1,300 bags of CAN equivalent from the entire SA.

Various NGOs, including World Vision, FINCA and CURE have been extending their support activities such as micro-credits, income generating schemes and other poverty eradicating measures and some of them have been proved to be successful. However, no panacea that is effectively applied for solving radical problems has so far been found because causes of problems differ from place to place and countermeasures to be properly taken therefor take much time or at prohibitive expense. The salient features of the SA by TA are summarized in table 2.1 and Annex H-1.

Currently available major infrastructure in the SA comprises of the following: two metal roads running across and along the boundary of the SA, electricity available only along these metalroads though none of the TA chiefs houses receive it, concrete bridges for metalroads but very few permanent ones connecting earth roads (most of wooden bridges are broken and do not allow vehicles to pass), a railway with a station near Lunzu township where passenger service is rarely utilized by villagers in he SA, 22 small ponds, 670 boreholes (465 people per borehole), four telephone / telegram centers, 164 primary and secondary schools (one per two villages), 8 clinics and 15 market places (besides 5 mobile clinics).

MASAF is by far the more important entrepreneur to provide villagers with social infrastructure inclusive of bridges, roads, boreholes. Recently it initiated countrywide social forestry as an aid component, in the light of the importance on the environmental conservation, because woodland can provide villagers with water sources for both surface water and ground water along with fuelwood and house construction materials.

Within the SA, MASAF selected six project sites to which Regional Forestry Office South gives technical planning advice.

Principal problems confronted by villagers include: lack of security especially the lack of police stations in contrast with many theft cases by armed bandits etc. The bandits take vehicles, cows, goats and pigs away from farmers and estate managers. The other problem include lack or shortage of medical facilities, of potable water sources, of transport networks especially in rainy season, of income earning opportunities and of fuel or house repairing materials. Shortage in arable land is acutely felt by villagers in southeastern part of SA., while lack of all-season roads is major concern in remote, northern part thereof.

Villagers have not yet been well-organized into active groups for community-based, grass-root, bottom-up activities due to lack of strong leadership, of pertinent supporting frameworks or of technical know-how. Even if some vocational attempt to produce or manufacture certain products for income generation is made, remoteness keeps people out of the access to outlet markets or effective demand for them would not arise from nearby target areas for marketing them.

2.2 General Aspect of Natural Condition

(a) Physiography and Geology

Topography of the SA is roughly divided into two parts, one forms a peneplain covering central~western part thereof and another does hilly and undulated areas covering the other part. The core of the Shire Highlands is a broad north-easterly trending ridge of high grade metamorphic / metasomatic rocks extending from Thyolo in the south to Zomba in the north. On its northwest it is bounded by the edge of the Rift Valley. The scarp edge is capped by a series of small hills such as Dimbi, Nkande, Maloa, Ndunde*, Chiripa, Chindenga, Mbati, Chiraweni, Namilango and the western part of Mt. Ndilande which apart from the last two are composed of charnockitic granulite. This hill range was formed along Shire Highlands Fault, running almost straight from Ndilande north to Zomba Mountain, with downthrow at the western side. Along this fault, basement rocks are linearly exposed as outcrop from south to north-northeast. Parallel with this fault, a synclinal axis runs in the west at the interval of 2 ~ 3 km from the fault. Lirangwe, Mlonbozi, Likuru and Lunzu rivers flow along and across these faults. Another smaller fault runs in parallel with this main Fault, 6 km in the eastern side (passing east of Nanjelo hill).

Elsewhere in the Highlands the highest hills are composed of perthosites and perthite-gneisses and are generally ridge-like in form. These include Chiradzulu (1,746 m), Lisau (1,537 m), Mzedi, Mpingwe (1,411 m), Soche (1,511 m), Bangwe (5,059 ft), Malavbi (1,518 m), though these are located out of the SA (but surrounding it), most of which are composed of basement perthosites, perthite-gneiss and granite at Ntonya or south of Zomba. Throughout the SA country gneiss-granulite covers except for hills and mountains, forming undulated and dissected topography except some minor lacustrine deposits where flat plains or dambo have recently been formed. Surrounding the SA, little Michiru mountains are located in the south of Matope bridge, composed of basement perthosites, perthite-gneiss striped with basic orthogneisses which is also found in Chingale hills, north of Mzeze and Mwinje hills. Michiru Mountains and Chiradzulu Peak are adjacent to the SA that is also composed of the same basement as in elsewhere. Shire river runs over the country gneiss and granulite layer, forming low cascades at the joints and faults like Nkula and Tezani.

As to the floor of the Rift Valley, the Chileka Plain varies in elevation from about 750 m at the foot of the scarp to 570 m near Lirangwe, forming a moderate relief. The fairly flat nature of the topography is interrupted by only a few hills such as Lunzu (929 m) and Mindale (790 m) except to the east of Lirangwe where a large group of hills descend southwards. Of these hills, all of which are composed of perthite-gneiss, Mzeze (1,263 m) and Nguluwe (992 m) are the highest. The rivers, apart from the Mlombozi flowing in a strike valley between Nguluwe Hill and the scarp and portions of Lirangwe flowing along strike along joint directions, flow in a predominantly north-westerly direction towards the Lirangwe trading center independent of the structural control. Apart from those named, the largest include the Chisenjele, Lunzu, Likuru and Chirimba. Geologically, Shire Highlands were formed in late Cretaceous age as remnant, whereas

Phalombe plain at the east side of the SA and Chileka hill at the southwestern edge were mid-Tertiary origin. The basement complex of the Rift Valley was derived from Pre-Cambrian to late Palaeozoic origin.

As geological structure, Shire Highland Fault forms the eastern wall of the Rift in the area. It runs trending NE, while The Lirangwe fracture runs trending NW. Major fault of structural main rift runs in parallel with Limbe ~ Zomba road, starting from Ndirande and keeping the distance of 8 ~ 10 km from the road, trending NNE, until it reaches southern edge of Lake Malawi. Several clear fractures are visible in the Lirangwe river where heads orient westwards at between 40º~ 60º whilst in the Lunzu river , the few fracture plains noted dipped westwards at steeper angles. Besides, Njili fault, truncating the easterly trending perthite gneisses that form Ntawira Hill, also runs in parallel with this road keeping the distance of 1 ~ 2 km. In proximity to the Shire Highlands Fault, calc-silicate granulites are most abundantly found (Also in Mt. Lunzu).

Laterite soils of high quality for the material of brick and conventional road pavement are abundantly deposited in northern piedmont of Ndirande mountain and also in Chileka peneplain. Limited amount of limestone is also available in the SA. With regard to groundwater regime, apart from stream water seepage available in and around the stream basins and dambos, limited amount of groundwater percolating into cleavage of pre-Cambrian basement rocks with as much longer time spun as decades exists in the SA. As inhabitants increasingly pump out this fossil water through tubewells, concern will be invoked on earlier depletion due to drastic changes in vegetation cover induced by tree felling, reclamation and forest fires.

(b) Meteorology

Rainfall

There are 7 rainfall observation stations in and around the SA. (refer to Figure. 2.2) Mean annual rainfalls at each station during last decade are shown in Table 2.2 ~ 2.4. Rainfall of each year is highly variable and fluctuates remarkably. Rainfall period ranges from the beginning of October to the end of April but the highest rainfall is recorded in January which accounts for about 30% of annual total rainfall. Generally, rainfall intensity is very high and duration of rainfall lasts for less than one hour. Annual rainfall in the SA shows about 700mm in the northwest and about 1,000mm in the southeast.

Table 2.2 Rainfall Station

No	Station Name	Sta. No.	Elev. at MSL(m)	Period of Observation
1	Chancellar Collage (C.C.)	15351017	886	1960/61~1998/99
2	Chingele	15351017	-	1989/90~1998/99
3	Makoka	15353035	1029	1964/65~1995/96
4	Zarewa Bridge	15342002	-	1960/61~1989/90
5	Chichiri	15353036	1132	1966/67~1996/97
6	Chileka	15344002	767	1940/41~1997/98
7	Chiladzulu	15353013	-	1993/94~1998/99

Table 2.3 Mean Annual Rainfall Records for Last Decade (mm/year)

Station	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	Mean
C.C.	1163.7	1182.3	1146.2	1312.3	755.1	875.8	1585.4	1560.1	737.2	1299.0	1161.7
Chingele	649.1	730.7	561.8	552.9	511.4	432.5	992.9	1275.8	1448.8	442.8	795.1
Makoka	1008.1	1030.5	579.3	977.7	538.5	595.2	965.7	1602.1	813.5	1018.7	912.9
Zarewa Brid.	602.5	na	na	na	Na	na	na	na	na	na	na
Chichiri	933.4	873.8	787.9	1604.0	1040.8	695.2	1262.3	1501.9	1034.2	1415.7	1115.0

Chileka	778.1	833.5	652.5	743.5	695.5	546.0	969.2	1431.2	986.3	954.8	859.1
Chiladzulu	na	na	na	na	797.9	821.6	1339.3	1298.0	1090.2	1487.2	1139.0

Table 2.4 Mean Monthly Rainfall Records for Last Decade (mm/month)

Station	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
C.C.	4.4	6.5	4.0	20.4	72.2	238.1	325.8	222.4	188.7	60.9	18.4	5.4	1161.7
Chingele	0.7	0	0.7	10.6	57.1	166.4	217.5	188.6	100.1	53.2	0	0	795.1
Makoka	1.4	1.8	0.4	7.9	51.1	198.6	255.8	205.7	117.7	63.3	5.9	3.5	912.9
Zarewa Brid.	Na	na	na	na	na	Na	na	na	na	na	na	na	na
Chichiri	5.9	6.9	9.6	18.3	92.3	215.9	301.6	218.8	133.9	89.8	8.9	13.0	1115.0
Chileka	0.2	0.9	4.1	24.4	82.5	160.1	245.8	191.6	96.5	44.5	6.3	2.1	859.1
Chiladzulu	0	0	0	25.9	79.5	247.9	380.1	250.0	129.6	26.1	0	na	1139.0

Meteorology

There are 3 Meteorological Stations in the SA namely, Makoka, Chileka and Chichiri (see Figure.2.2).

Table 2.5 Meteorological Station

No	Station Name	Stat.No	Elev. at MSL(m)	Latitude	Longitude
1	Makoka	67692	1029	15 º30’	35 º 13’
2	Chileka	67693	767	15 º40’	34 º 58’
3	Chichiri	67687	1132	15º48’	35 º 03’

General Condition of Meteorology

Mean monthly minimum and maximum temperatures are recorded at about 12 centigrade in June to July and about 30 centigrade in October to November, respectively. The farther one goes to the west, the higher the temperature rises in dry season and the lower in rainy season. Mean monthly maximum relative humidity shows about 80% in January to February and minimum shows 55% in September. Mean monthly hours of maximum sunshine indicate 9.2 hours in September and minimum gives about 6 hours in January. And wind velocity in Chileka is about two times faster than Chichiri. Maximum wind velocity occurs in October and minimum does in January.

The farther one goes to the west, the higher the annual evaporation is and vice versa. Maximum evaporation occurs in October and minimum shows mainly in June. Annual evaporation of Chileka shows the highest value of 2,212.9 mm/year, 1.4 times higher than the lowest of Chichili.

Table 2.6 Mean Monthly Minimum Temperature (degree)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
Makoka	18.5	18.1	17.8	16.0	13.8	11.4	11.6	12.5	14.9	17.0	18.3	18.3	15.7
Chileka	20.2	19.8	19.4	18.0	15.7	13.7	13.4	14.6	17.2	19.5	20.5	20.3	17.7
Chichiri	17.9	17.6	17.2	15.8	13.8	11.7	11.5	12.6	14.9	16.5	17.8	17.9	15.5

Table 2.7 Mean Monthly Maximum Temperature (degree)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
Makoka	26.7	26.7	26.5	25.7	24.4	21.8	22.2	24.4	27.4	28.8	29.0	27.1	25.7
Chileka	28.5	28.3	28.1	27.5	26.0	24.2	24.0	26.3	29.4	31.3	31.1	29.3	27.8
Chichiri	25.9	25.7	25.4	24.8	23.5	21.1	20.9	22.2	26.3	27.8	27.7	26.3	24.9

Table 2.8 Mean Monthly Relative Humidity (percent)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
Makoka	84	84	82	80	74	66	68	60	53	57	64	76	71
Chileka	79	78	74	74	66	66	60	54	51	54	61	71	66
Chichiri	84	85	85	82	77	73	72	63	57	59	68	81	74

Table 2.9 Mean Monthly Sunshine Hours (hour)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
Makoka	5.8	5.6	5.7	6.5	7.4	6.9	7.2	8.2	9.2	8.4	7.6	5.5	7.0
Chileka	6.6	6.8	7.1	8.1	8.2	8.0	7.4	8.6	9.2	8.9	7.9	6.7	7.7
Chichiri	6.0	5.9	6.3	6.8	7.8	7.1	7.2	8.4	9.2	8.2	7.7	5.9	7.2

Table 2.10 Mean Monthly Wind Velocity (m/sec)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.
Makoka	na	na	na	Na	na	na	na	na	na	na	na	na	na
Chileka	3.8	4.0	4.9	5.2	5.2	5.5	4.9	5.7	6.1	6.4	5.5	5.0	6.1
Chichiri	1.6	1.6	1.8	2.1	2.1	2.4	2.7	3.0	3.1	3.2	2.7	2.1	2.4

Table 2.11 Mean Monthly Evaporation (mm/year)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
Makoka	126.4	121.1	128.3	116.7	103.7	93.6	111.7	136.1	182.8	204.8	196.7	138.1	1660.1
Chileka	163.1	142.1	140.5	146.3	151.3	146.2	156.9	187.2	179.3	295.3	284.4	220.4	2212.9
Chichiri	79.7	106.0	135.6	105.3	88.1	78.2	112.1	160.1	182.7	219.7	171.4	132.0	1570.9

(c) Hydrology

Watershed

The SA is divided into two main watersheds, namely Lirangwe and Lunzu. Watershed area in Lirangwe River covers about 343 km^2 and river length extends to 57km, with two tributaries of Ndeka and Mlombozi. On the other hand, Lunzu watershed area is 327 km^2 and length of river extends 49km. Main tributaries are Nkokodzi and Likulu. Based on the Topography map (1/50,000), length, gradient and watershed area for each river is calculated in Table 2.12. Except for Ndeka and Nkokodzi rivers, river gradients are steeper than 1/100 (see next page). Because of population pressure and inappropriate agricultural practices, land degradation of watersheds have accelerated causing excessive loss of soils, leading to sedimentation problem that heavily affects stream flow.

Table 2.12 Summary of Rivers and Their Tributaries

Main River	Tributaries	Watershed Area (km^2)	Length (km)	River Gradient (1/xx)
Lilangwe	Ndeka	22.10	8.60	1/180

	Mlombozi	26.70	9.10	1/85
	Lirangwe	342.58	57.20	1/85
Lunzu	Nkokodzi	72.70	17.60	1/125
	Likulu	19.60	19.60	1/72
	Lunzu	327.17	49.30	1/75
Total		669.75	161.40	

River Discharge

Gauging Stations to measure river flows in the SA are located at only two sites, at Lirangwe river and Lunzu river. Flow discharges are recorded by neighboring farmers entrusted by the Department of Water Development. According to the last three-year observation records, maximum discharge was 7.4m^3/sec in Lirangwe River, 6.4m^3/sec in Lunzu. In rainy season river water turns so turbid that it is hardly potable while in dry season surface water in the rivers often underflows beneath the river bed.

Table 2.13 Gauging Stations of River

Station Name	TA	Grid Ref.	River	C.A.(km^2)	Period of Obsevation
Lirangwe RGS IC	Kapeni	YT 164823	Lirangwe	198	1989/1～ 1999/7
Lunzu RGS 109	Kapeni	YT 121759	Lunzu	163	1989/3～ 1999/7

Table 2.14 Maximum and Minimum Discharge during Last 3 Years (Unit : m^3/sec)

Station Name	Max.	Second	Third	Min.
Lirangwe RGS IC	7.360	5.201	5.048	0.003
Lunzu RGS 109	6.358	4.036	2.769	0.002

Figure 2. 1 Watershed on the SA

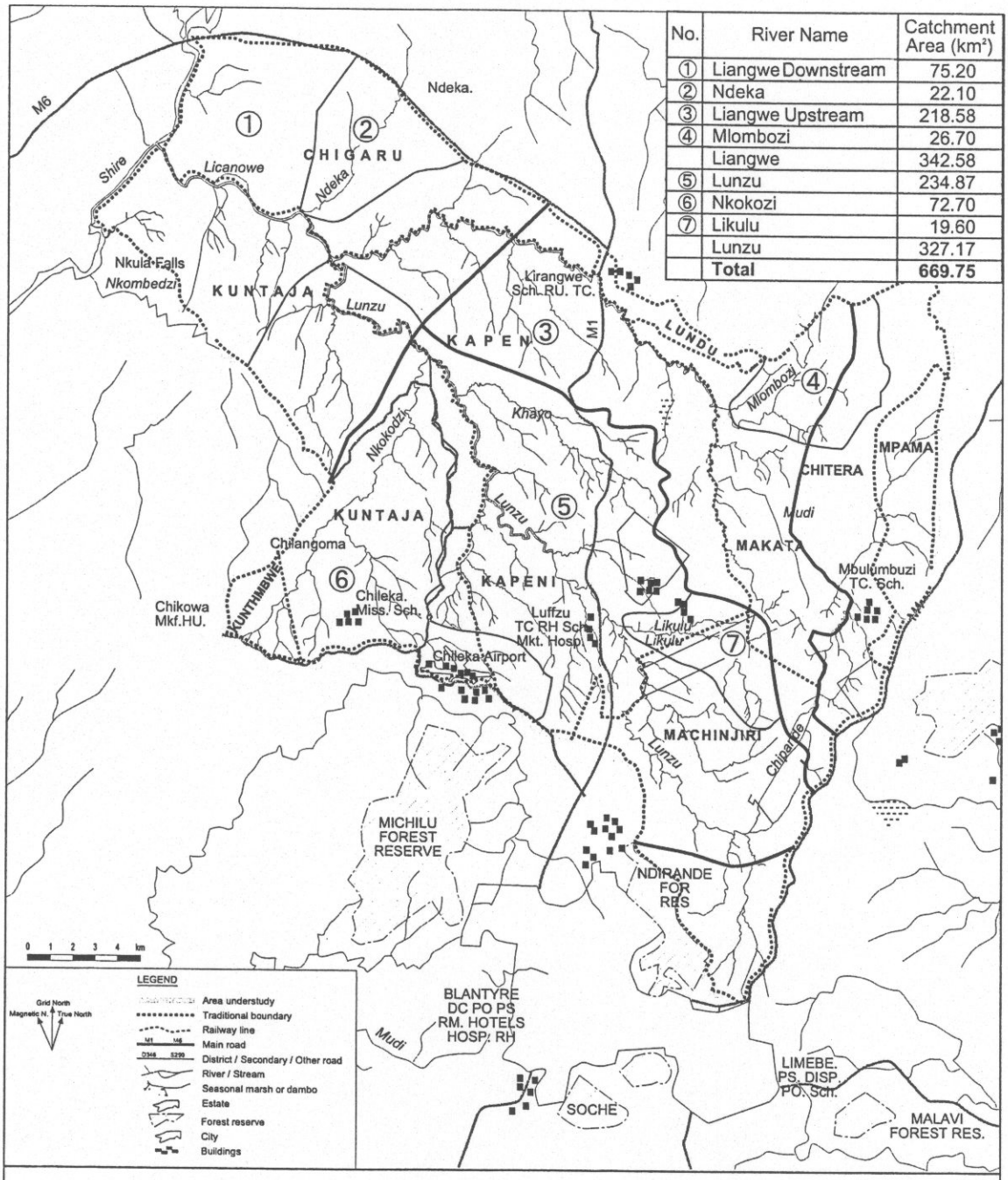
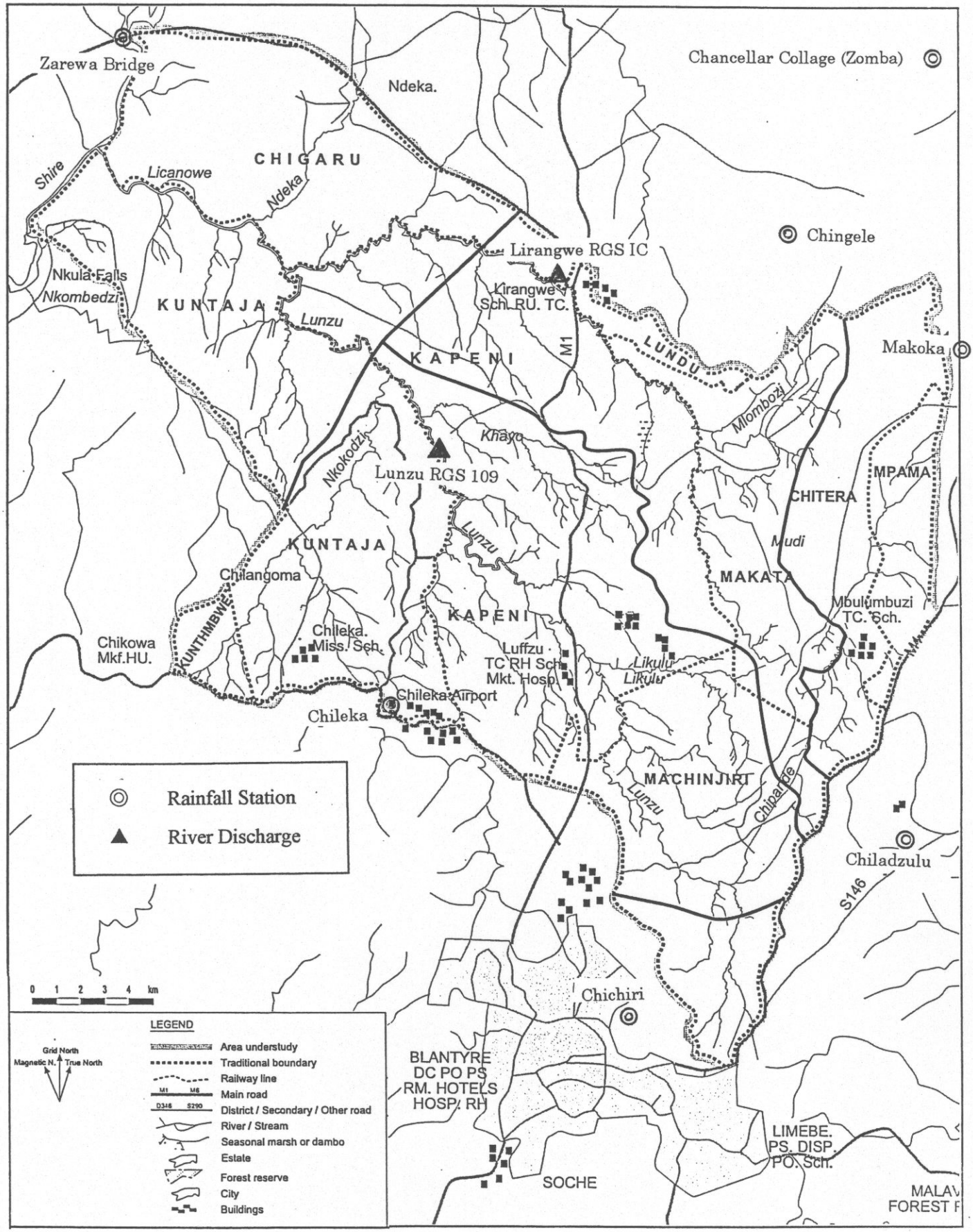


Figure 2.2 Location of Meteorological and Hydrological Station



(d) Soils

Concerning soil distribution in the SA, the Study Team has conducted a limited soil survey on 85 sites. Each survey site represents 9 square kilometer (3km × 3km), taking account of limited study period, security risk and rather homogeneous distribution of few soil groups within the SA. The main objective of this survey lies in the verification of what was surveyed in the "Land Resources Evaluation in Malawi in 1990, focusing on surface soil erodibility. Soils formed by the weathering of such parent igneous or pyroclastic intermediate rocks as gneiss, granulite and syenite of Precambrian basement complex, predominate in the SA. These soils are classified as Latosols, Cambisols and Lithosols by USDA soil taxonomy, but according to FAO - UNESCO classification generally employed in Malawi, they are classified as Eutric-fersillic and Paralithic soil groups including soil families of chromic, haplic and eutric Cambisols, Lubisols and Pheozem.

In general, the former has deep layers with medium permeability, while the latter has shallow layers with skeletal, weathered rocks below them, with poor permeability. Very few hydromorphic soils are found in dambos in watershed 4 and 5 and also along stream terraces of Shire and Lirangwe rivers in watershed 3,5 and 6. These are Vertisols and Fulvisols, but by FAO classification they are classified as Lixisols and Gleisols. They have been formed and developed through sedimentation and quite stable against water erosion. Major soil distribution within the SA and their representative characteristics are summarized in Table 2.15.

Most soils found in the SA were formed through weathering of parent rocks like gneiss, granulite and perthite, except for sediment, hydromorphic deposits in dambos. Principal soil formation includes 2:1 clay mineral formation from primary minerals under moderately warm and humid climate and formation of secondary minerals by feeble weathering of mica, or iron~silicification. However, lateritic formation or ferro-sialification can be observed in limited part in which 1:1 clay minerals are derived under high atmospheric temperature through complete weathering. In either formation process quartz gravel remain unweathered in soil layers, even remaining in the soils subject to heavily sheet erosion. Soils with shallow top-soil are formed where soil formation process proceeds in parallel with soil erosion. Soil formation through sedimentation accounts for only a few percent of the area in the SA, found in two large dambos where some saline topsoils are observed and fluvial terraces of Lunzu and Rirangwe Rivers. Soil profiles are shown in Annex F-2.

Table 2.15 Distribution of Soils in the SA

Soil order	Paralithic	Paralithic	Eutric/Fersialic	Eutric/Fersialic	Eutric/Fersialic	Paralithic	Gleyic
Sub-order	Chromic Cambisols	Eutric Cambisols	Cambsols / Ferralsols	Chromic Luvisols	Haplic Lixisols	Skeletic Cambisols	Eutric Gleysols
major existing soil series	Lulwe Mbulumbuzi	Malamulo, Walker-Ferry	Mikolongwe Mbulumbuzi	Mbulumbuzi	Bvumbwe	Walker- Ferry	Upper Lirangwe
USDA Taxonomy	Xerochrepts	Tropaquents	Ustox, XC	Haploxeralfs	Haplustolls, U.	Dystrochrepts	Tropaquepts
distributed area	7,900	4,600	14,120	15,330	5,250	16,750	1,550
The data below we taken from the survey of the Study Team							
top-soil thickness	74 cm	82 cm	70 cm	74 cm	87 cm	68 cm	77 cm
top-soil	L	SL	SCL	SL	SCL	SL	SL

texture							
parent material	gneiss	complex	syenite, granite	gneiss	gn. granulite	gn. syenite	complex
major location	r.v. convex	c/n piedmont	c/e lowland	c.peneplain	Chileka Dambo	western dambo	eastern db.
Erodibility	5 ton/year	5~27 ton/year	5 ton/year	2~35 ton/year	3 ton/year	5 ton/year	0, sediment
Topography	hill side	piedmont	rift valley	undulation	dambo lowland	peneplain edge	dambo

Note: Besides, rock outcrop extends over 1,475 ha. abbr.; XC: Xerochrepts, U: Ustox, gn; gneiss, complex; basement complex, L; loam, SL; sandy loam, SCL; sandy clay loam, r.v.; rift valley, c/n(e); central~north(east)ern

Most topsoil layers contain quartz gravel which are more resistant to weathering than other primary mineral constituents in parent rocks. Formation of gullies begins with a crack cleavage along roads, concave bare-land where montmollilonite or gibbsite is rich in clay minerals that readily forms cracks during dry season, often observed in watershed 5. If downstream side of the crack is broken by torrential runoff, the crack develops into rills and eventually gullies. Collapsing of soil walls along stream banks is fostered by the edges of ridges through which runoff discharges frequently overflows, often found in watershed 5, 6 and 7.

From the site boring survey it was revealed that soils in the SA contain very few humus, resulting in futile ones with high content of such un-weathered primary minerals as quartz. This is attributable to lack of applying organic manure like forest litter and livestock droppings since land has been reclaimed. This is because such organic matter had been consumed as fuel, while fallow period was increasingly shortened and surface of farm plots was kept barren where rainwater caused sheet erosion and deprived of clay from topsoils. Thus, depletion of humus or clay minerals has led to such disadvantage as loss of soil fertility or higher erodibility on farming environment. Hence, countermeasures to rectify such undesirable development are acutely needed from the viewpoint of sustenance of farm productivity.

It is difficult to clarify soil chemical properties without conducting sample analysis but the following could be imagined from the site and vegetation observation. The fact that *Bauhinia sp*. and *Colophospermum mopane*, so-called acid-philic plants, predominate in scattered woodlots as indicator trees implies that the top soils are fairly acidic in character of topsoils. Plant-available phosphorus is not sufficient because calcium is contained in base rocks at the rate of 5~10% though they contain 1.2% equivalent of apatite as a source of phosphorus (to form insoluble phosphoric acid salts). Crop yields are liable to get affected by this low phosphorous level especially in prevailed rainfed cultivation without any fertilizer application.

Sheet erosion is evidently caused by tillage regardless of whether ridges are built or not, even if they could prevent vertical downward development of gullies. The proof of soil loss can be observed in between two adjacent ridges where run-off water flows away from the plot, leaving gravel accumulation on soil surface, because clay and silt are easily dissolved in water and carried away therefrom. During dry spell in September ~ October, strong gale blows which also deprives clay of already ridged, completely dry field surface through wind erosion. Easterly wind predominates during this season, so soil loss by wind erosion can be heavier in plots where ridges are tilled in dry spell to east ~ westward. This is proven by the fact that desks in our office, surrounded by upland maize field, are covered with reddish clay dust every morning during this spell.

Tillage practice by farmers may curb soil loss from bare or planted fields, but unless ditches between ridges are partitioned with vertical ridges, runoff turbid water spills out from the edges of these ditches, resulting in soil loss. These box ridges are practiced by some farmers in TA Chigaru and TA Lundu (mostly watershed 1, 2 and 3) under semi-arid climate for the purpose of water harvesting. After repeated washing of ground surface by rain storms, coarse gravel mainly consisting of quartz grains has been left on the surface, which serves as buffer against the hitting of raindrops attenuating destructive action to soil aggregates. However, farmers disturb such natural barrier by hoes to build ridges before rainy season begins.

(e) Present Land Use

Current land use in the SA is taken from aerial photo (taken in 1995) interpretation, because of lack of available data thereon. Customary land accounts for overwhelming part of the SA, accounting for about 70 % of the SA, while private land under estates occupies only 8% of the SA. Villagers use and cultivate land allotted to them based on usufruct right [1/] inherited or allocated by their village chiefs. Privately owned land, mostly held by estates that are registered and liable to pay land tax, accounts for around 8 %. Available land to new public purposes now remains at less than 5%. Public land area is thus quite limited, accounting for 15% of the total area, including the land with easement like airport, forest reserves, fluvial basins, railway and metal roads, under-ground water pipeline, space of telecommunication facilities, local court yard and school grounds, accounting for 15% of the SA. Land use in the SA is summarized in the following table 2.16

Table 2.16 Current Land Use in the SA

Land Use Form	Area Occupied (ha)	share
cultivated land (variable from year to year)	21,504 ~ 39,500	32.1 ~ 44.0%
fallow land (variable from year to year)	3,277 ~ 11,273	4.9 ~ 16.8%
estate land	5,612	8.4%
Cemetry area and village space	656	1.0%
Individual woodlot and thatch-grass lot	4,503	6.7%
afforested area	742	1.1%
homestead garden	6,698	10.0%
road, railroad and stream / dambo	8,500	12.7%
rock outcrop	1,544	2.3%
total land-use	66,975	100.0%

T.A.	Arable	Cultivated *	Forests	Estate	Others	Total area
Chigaru	3,711	2,435	27	0	5,272	9,010
Kuntaja	6,465	4,045	39	16	8,450	14,970
Kuntembwe	370	243	0	24	506	900
Kapeni	8,684	5,042	0	1,264	8,712	18,660
Lundu	350	242	7	20	517	895
Makata	3,295	1,506	32	28	2,220	5,575
Machinjiri	4,671	3,721	638	2,848	993	9,150
Chitera	3,534	2,975	0	1,276	635	5,445
Mpama	1,697	1,295	0	136	537	2,370
SA Total	32,777	21,504	742	5,612	27,844	66,975

Note: * included in arable land, highly variable by year, figures as of 1998.

[1/] The right of using and enjoining the fruits or profits of an estate or other thing belonging to another, without impairing the substance.

Fifteen years ago, there existed far more space for communal use, however, the ever-increasing population pressure has limited the land for public utility, managed by TA chiefs, as a result of further land allotment by these chiefs to newly created village households.

In the SA, 36,000 households are estimated to hold useful right, accounting for 78 % of the total household. Average land holding size comes to slightly less than 1.3 ha, of which about two-thirds to 90% is annually cultivated under crop (0.7 ~ 0.9 ha per household). The rest is left fallow, mainly because of the climatic vagary during sowing period, the depletion of crop nutrient in the soils by continuous maize cropping. Another 10% of the SA is utilized as individual woodlot or grassland for the thatching material and the rest 20% accounts for rock outcrop, community forests and graveyards. Among the arable area, only 5% are distributed in dambo or marshy land where vegetables and sugarcane are perennially grown (called "dimba"). The rest can be cropped only during rainy season (115 ~ 140 days).

Cultivated land per capita is calculated at 0.17 ha from which 262 kg of grain maize is annually harvested. This is equivalent to their annual per capita grain consumption, implying that climatic vagary may threaten self-supply of staple food. From this fact it seems that current land use in the SA has already reached the limit of population carrying capacity. As regards fallow area, rate of fallow highly varies from year to year depending on climatic condition during sowing period. Besides, there is a wide discrepancy on the rate between the observed fallow rate (1/3 in 1999) and cropping data by the SEBS that gives over 90% of cropping on land held by households. This may be attributable to farmers ignorance of accurate metric units, lack of measuring scale or of experience of surveying their own land, bias in sampling, etc.

Fairly high percentage of farm households cultivates every sloping lands, and actually most of hills have already been cultivated up to the summits. According to the result of SEBS, 32% of sampled households have their plot on steep slope and 62% of them cultivate on gentle slope. Also, the result indicates that 83% of the surveyed households are accustomed to make high ridges with hoe (Khasu), or low ridges with or without high ridges with hoe (48%). Field burning prior to land preparation is not commonly practiced.

Many farmers pick up and evacuate stones and boulders from the tilled plots, and in some cases on steep slope they create stone terraces where stones are heaped to build walls so that they may support soil steps. Some of the inhabitants shifted from Mozambique to the SA long ago and again removed from Kapeni to Kuntaja a few decades back where idle but stony land was still available to them at that time. Cultivation on steep slope is commonly observed in Machinjiri where estates have occupied flat and stone-less land and stony steep slope has been left behind. Gullies have developed with land exploitation, down the hills on steep slope. Slope cultivation is also distributed in hilly areas of Mpama and Chitera, but eroded fine soils are deposited over Lirangwe dambo where dimba cultivation has become popular with vegetables and paddy raising. In Kapeni, Kuntaja and Makata TAs, most of the arable land is distributed on rather flat peneplain without escarpment, and a part of eroded soils are sedimented in Chileka dambo where similar land use is found to that of Lirangwe dambo. However, small tributaries of Lunzu river are dissecting this peneplain, most probably as the result of heavy land exploitation for reclamation, forming small to medium gullies towards Lunzu river basin. Accelerated gully development takes place both Kuntaja and Kapeni sides of this stream. In these three TAs fewer hills are found than others and less tillage is observed on them though they have been stripped to bare land.

In these three TAs, many dimba plots are found along perennial tributaries of Lunzu river where small reservoirs have been constructed and sugarcane or vegetables are grown. Similar land use can be observed alongside Nkokozi River, flowing through undulated hilly areas where arable patches have emerged among natural Brachystegia brushes that are suffering from over felling for charcoal production.

As to Chigaru, Lundu ad Kuntembwe, only a small part of each TA is included in the SA. Many hills and undulated parts intervene in these TAs, but natural tree canopy still remains over most hills while cultivated land is only found in flat tracts and on gentle slope at the foot of hills, owing to less population pressure. Some parts of these hillside Eucalyptus has been planted as individual or village woodlot by DF and villagers, just because land for afforestation is still available but fuelwood resources have become depleted by charcoal production. Some households in these TAs are still engaged in charcoal production since some material trees are still available and charcoal sale can bring them a good profit.

Some farmers in these three TAs began to introduce land use under agroforestry since their land holding is not so tight as compared to those prevailed in southern TAs. An ardent forest extension agent earnestly

persuades leading farmers to adopt contour planting of *Leucaena, Sesbania* etc. among tracts on gentle slope.

Current vegetation in the SA is observed and analyzed in the following manner. Distribution of vegetation, especially canopy coverage is estimated from the result of field observation, aerial photo-interpretation through monochromic film taken in 1995 and stand inventory surveyed at representative 42 sites of individual woodlot. Major reserved forests are located surrounding but out of the SA. Only some afforested lots planted by DF and those created by BCFP still remain in Kuntembwe and Kuntaja TAs. Only one reserved forest, Ndirande R.F., is located at the southern boundary of the SA, however, it had completely been denuded by severe felling and branch cutting by urban people living in this area by 1995. The principal source of daily fuelwood supply to the inhabitants of the SA is woodlot allotted to individual households where Eucalyptus and other fast-growing tree species have been planted by the household members, and most stands in this woodlot are located near their houses and in their homestead. Scarcely remaining community forests, those transferred from DF to the villages concerned serve as supplemental sources of fuelwood. Here, some fuelwood is commercially transported from nearby TAs in Mwanza District etc., while some inhabitants can obtain fuelwood from reserved forests located in the vicinity of SA with the (prepaid) permission through the management office.

Density and distribution patterns of the vegetation cover are heavily dependent on rainfall distribution and topography. Generally, the sparser the coverage becomes in the northwestern side of the SA, the denser it tends to be in the southeastern side. Population pressure also influences the vegetation cover, driving devastation, particularly in the southern, urbanized areas of the SA. In the central ~ northwestern side of the SA where vegetation has become sparse scattered tree stands are found in / along stream basins and dambos. While in the northeastern and southeastern sides where denser vegetation is commonly observed stands reserved or afforested in the estates as well as those planted as individual woodlots contribute to richer canopy cover. However, even in these areas with denser canopy cover hilltops and steep slopes have mostly become barren land due to population pressure. The following table shows the distribution of canopy cover by standing trees of zone and by annual rainfall, where on average throughout the SA canopy covers 2.2 % (on average) of the ground surface.

Table 2.17 Distribution of Canopy Cover in the SA

Zone	Zone area	canopy cover	annual rainfall class	Canopy cover
Zone A	3%	1.3 %	700 mm or less	0.8 %
Zone B	38%	2.5 %	700 ~ 800 mm	1.5 %
Zone C	12%	3.9 %	800 ~ 850 mm	1.7 %
Zone D	22%	2.0 %	850 ~ 900 mm	2.3 %
Zone E	25%	1.2 %	900 ~ 950 mm	3.0 %
			950 ~ 1.000 mm	4.3 %
Total SA	100%	2.2 %	1,000 mm or more	2.6 %*

Note:* in this class canopy cover has been affected by urbanization. As to zones, refer to chapter 7.

As to distribution of tree species, *Eucalyptus camadulensis* predominates, accounting for over half of the total stands, followed by mango and guava (fruit tree species), and these three species constitute major part of scattered stands. Indigenous species generally found in regenerated Miombo forests are only observed in village grave-yards and estates where felling or cutting of trees by inhabitants is traditionally banned.

According to the woodlot inventory survey carried out by the Study Team, predominant species constitute *Bauhinia thonningii, Brachystegia sp., Acacia polyacantha, Terminalia sericea*. Also, species not suitable for producing charcoal, such as *Adansonia digitata*, *Steculia quinqueroba*, *Ficus natalensis* tend to remain as independent stands in the central ~ northwestern parts of the SA*s*. Similarly. such vigorous regenerative and thriving species as *Toona ciliata*, *Cassia siamea* are commonly found in scattered or independent stands throughout the SA. Nevertheless, botanical diversity has been seriously damaged by excessive exploitation, leaving only the species with low quality for fuelwood or for material of charcoal as well with high

regenerative nature. Those indigenous leguminous tree species which DF recommends villagers to plant in their woodlots, for example *Afzelia quanzensis* and *Faidherbia albida* have not yet become popular in individual woodlots for fuel because of inavailability of seedlings or seed, of sluggish growth and other reasons.

Mean age of planted trees in individual woodlots is estimated at 14 years (more than twice of coppicing practiced by the woodlot owners) with a stock of 0.1 m^3 per stand, an average of tree height at 7.8 m, and that of Dbh at 15 cm. Mean number of trees found alive in an individual woodlot counts at about 26 stands. From these figures it may be deduced that individual woodlot can hardly meet the owner's household fuelwood demand even though annual household consumption can be saved at as low as 1 m^3 by utilizing improved type of stoves (baula). Then, how much stands are necessary to fully meet annual firewood demand per household? Judging from poor growth of fuelwood species, about 170 stands, or 6.5 times as much as existing number will be able to meet annual requirement. The supply~demand balance is further argued in detail in 2.6.

(f) Deteriorated Watershed Condition

The following is the summary of deteriorated status in the SA based on the watershed map as stated above.

Watershed 3 and 4 are located in the eastern side of the SA, where annual precipitation is the highest (around 1,000 mm) in the SA, and estate sites are concentrated here. In these estates coffee and tobacco are planted with irrigation, the farm tracts are surrounded by natural (secondary) forests where bamboo bushes and indigenous deciduous trees like *Bauhinia thoningii* still remain. Afforestation of wind breaker belts is also systematically practiced here, with the vegetation cover reaching 5 ~ 8%, highest in the SA, so that this area can be deemed as the only one watershed where the function of forests to recharge ground water still exist. However, anywhere else in the SA, for example in watershed 1 and 2, deforestation rapidly proceeds on due to charcoal production and in other watershed areas by firewood collection for brick production or land reclamation for expanding crop fields. A drastic disappearance of vegetation cover found through our site observation as compared with the aerial photographs taken in 1995 on which the cover is identified in the same place where the Study Team surveyed in 1999 literally implies the rapid development of bare land in the SA. The fact tells us that not only the SA but neighboring areas like Mwanza District and Kuntembwe / Somba T.A. also suffer from deforestation despite of the administrative efforts such as banning of charcoal production and sale by non-licensed villagers and sustainable vigilant monitoring by DF staff. Likewise, forest fire is another major cause of watershed degradation.

Natural regeneration of forests after felling or field burning depends heavily on the dominant species and moisture regime of forest soils. Vigorous recovery of natural vegetation is often observed in stream basins, slope on banks and dambos where groundwater level stands nearer to the ground surface. In particular, regenerated stands of *Cassia siamea, Toona ciliata* and of other exotic origin are often seen in watershed 1, 2 and northwestern part of watershed 3 and 5. In these areas scattered open forests of *Steculia quinqueloba, Acacia polyacantha* that are not suitable for producing charcoal still remain amidst the felled patches. Here, all the species appropriate for charcoal production, such as *Colophospermum mopane, Brachystegia boehmii, B. floribunda* has completely been exploited, turning the land into barren strip.

As to the status of occurrence of soil erosion within the SA, highly erosive areas are distributed over watershed 5 and 7, as observed in erosion hazard map (draft, refer to Chapter 6), including the central part of TA Machinjiri (southern highly erosive patch), southeastern part of TA Chigaru ~ northern TA Kapeni ~ central part of TA Kuntaja (central highly erosive patch) and along the rift valley (eastern highly erosive patch). The distribution pattern of this erosive patches fairly coincides with that of undulation and soil factors that are adopted in the formula for estimating erosion by SLEMSA, but it is poorly correlated with canopy coverage distribution. This is why the SLEMSA employs crop cover as the factor of raindrop interception instead of natural vegetation. Anyway, storage effect of rainwater by forests can hardly be expected in the SA in so far as the extent of canopy cover remains at 2%. Particularly, large amount of annual soil loss likely takes place in crop field with steep slope (steeper than 8°), where top-soil texture ranges sand ~ sandy loam with the thickness of effective solum (in which rain water can be stored as moisture) thinner

than 50 cm. Major form of soil erosion observed within the SA constitutes sheet erosion. It was identified through verbal communication with the inhabitants that annual discharge is concentrated on a period from mid January to end of February, because soil pores in cultivated layers are saturated with rain water during this period. Amount of soil loss from inclined crop fields and concentration of SS as measured at streams where SS is flowing in are being measured by the counterparts to whom the Study Team entrusted measurements. The marginal velocity of run-off of rain water is 50cm / sec on a slope with the gradient of 3° at the rainfall intensity of 100 mm / hr. Assuming that mean annual rainfall ranges at around 800 mm and run-off coefficient in the watershed is measured at 10%, the amount of run-off from one hectare is limited within 5 tons per annum. This amount, calibrated from the estimation of erosion hazard by SLEMSA, comes to about 300 thousand ton or less, annually discharged from the entire SA. Then, it follows that the concentration of SS dissolved in runoff water is calculated at the order 5,000 ppm. This is equivalent to the marginal concentration of SS that can be carried by run-off water at the assumed run-off velocity. By the way, measured concentration of SS in stream water amounts to less than 3,000 ppm, according to the result of measurement as stated below, and the difference between two different concentrations is possibly deposited on the stream bed or watershed catchment.

The results of aerial photo interpretation and site survey imply that in most cases the type of erosion found in arable tracts in the SA is confined to sheet or rill erosion. But in some cases, weakly developed gully erosion is also identified at seventeen sites including boundaries among cultivated parcels, on slope developed at the side of dissected valley, on hillside slope etc. The developing process of gully originates from the repeated swelling and shrinking cycle on the barren ground surface where soils containing clay minerals like montmorillonite and gibbsite cover, lead to the formation of shallow crack. Then, the crack to get widened by run-off water resulted from torrential rain until it is developed into a strip of gully. The Study Team so far identified about 100 stripes of gully in the SA, and the density of occurrence is estimated at 1.5 stripes / 10 km^2 within the SA.

Table 2.18 Location of Gully Erosion

TA Name	Location	No. of Gully	Dimension B x L x H (m)	Remarks
Machin.	Namilango Hill , Western slope	3-4	1.5 x 50 x 1.0	In undulated field
Machin.	Nanjero	5-6	2.5 x 200 x 2.0	
Machinjiri	Chididi~Mpati Hill side	5-6	1.2 x 100 x 1.5	Border of Fields
Machinjiri	Daniel Village	2-3	1.5 x 180 x 1.0	Road Surface
Kapeni	Maleule Town North	5-6	1.2 x 100 x 0.7	
Kapeni	Along the M6 Right side Fields	2-3	2.0 x 20 x 0.8	
Kapeni	Willian Village Lunzu side	2-3	2.5 x 150 x 1.5	
Kapeni	Nozomba Village	3-4	2 x 150 x 1.2	Hill foot
Kapeni	Whayo Village	1	6.0 x 20 x 1.2	Rural road aside
Kunthemb	Nkokodzi river downstream			River slope
Makata	Mlombozi upstream	5-6	1.0 x 50 x 0.7	
Chigaru	Far North West of SA	1	2.0 x 40 x 0.6	
Kuntaja	Chilangoma Hill side	3-4	1 x 200 x 1.1	Boder of Fields
Kuntaja	Salem Village Lunzu rever	4-5	1 x 200 x 0.5	
Kuntaja	Nkula- Chileka Road	4-5	20.0 x 100 x 1.5	Used by Gabion
Chitela	Below escarpment	2-3	1 x 100 x 0.7	Road side
Chitela	Mlombodi river terrace	5-6	1.5 x 200 x 0.8	Boder of field

The reason why the frequency of occurrence of gully erosion is still low in the SA is explained in the

following way. As mentioned above, the frequency of gully appearance is estimated at 1.5 stripes / 10 km^2 only. The sites of observed gully mostly coincide with the zone of higher erosibility on erosion hazard map, and it is anticipated that further development of gully erosion likely takes place though the extent is presently confined to small scale.

- Period of exposure as bare land is still short, in other words only a decade has elapsed since reclamation,
- Fewer cases of large scale tracts of farmland are so far developed except for commercial estates,
- Soil depth is generally so shallow that bottom of gully cleavage soon reaches the floor of bedrock, and
- Run-off amount flowing out of crop fields is limited by fairly popularized practice of contour ridge.

Another factor that fosters deterioration of watershed lies in wild fire or forest fire incidents. Since there is no obligation of reporting occurrence of fire at both sides of customary land and private land, statistics on the number of occurrence or extent of damages are not available except those that takes place in the reserved forests. Fire is mostly caused by burning grass for hunting cereal rats, hares and wild fowls, though there are some minor cases like thunderbolt and slush-and-burn for land preparation over bare fallow, or accidental fire missed by forest rangers. Eucalyptus woodlot is often caught in fire and burns out easily during dry season because the bark contains inflammable essential oil. Dozen of burnt patches can be observed in woodlot sites along main routes in the SA. Damages are also observed in adjacent areas of the SA, such as afforested lot of Michiru by DF and trial plots for reforestation in ICRAF near TA Mpama, totalling to 11 cases, damaging 1,119 ha per annum. Few damages take place in secondary forests kept in private estates where no trespassing is allowed, partly also to the tendency of predominant fire-resistant tree species that can survive even after heavy wild fire. Recently, wild fire tends to occur at higher sites like hillside and hill summits rather than in the plains, because the habitat range of wildlife tends to shift into the area located in higher altitude as population pressure rapidly increases.

Finer particle size, less than 500 μ in diameter, predominates the particle size distribution curve of SS judging from the site observation results, since over 90% of the flood sediments deposited along the river terraces of two major tributaries running through the SA consist of silt and clay, while higher clay content was identified in the accumulated mud dredged from the bottom of Nkura Dam. This estimation is consistent with the fact that quartz gravel covers ground surface in between tilled ridges on slope, after losing finer particles washed by rains, very often observed in the SA. Topography of the SA is inclined towards north-west, the highest part of which lies in Machinjiri (Mt. Ndirande and Mt. Lunzu) while Shire river flows in the lowest part, with the altitude ranging from 1,610 m to 380 m or the mean gradient of river bed equivalent to around 1 %. Mean gradient of riverbed of tributaries in the SA is measured at about 0.4 %, where thick accumulation of fluvial sediment deposits have filled the stream bed.

Since annual soil loss through runoff of the entire SA is estimated at less than 300 thousand ton at the average rate of 5 ton or less per hectare. About 100 ~ 200 thousand ton reaches Shire River though the rate varies with flooding patterns (the rest fills stream bed of tributaries).

Under such circumstance, to elucidate the state and mechanism of soil runoff in the SA, the Team entrusts the counterpart(s) to continue to observe or measure Suspended Soil (SS) and Soil Loss on sloped land or degraded fields at representative sites for further study (See figure2.3). The methodology of the study is described as follows:

Measurement of SS in River Flow

In the light of the site investigation results, two sites were selected for measurement of SS, namely Lirangwe RGS IC and Lunzu RGS 109 where discharge flow is readily measured using gauging staff. Stream flow and SS are measured twice a month during 2 months of December and January at the above mentioned sites. Measurements are desirably made a few hours after heavy rainfall. In the measurement sampled water at each site is filled into mess-cylinder with the capacity of one liter while scrambling the sample, then volume and weight are measured. The quantity of SS can be obtained from the mean weight.

Soil Runoff from Collapsed (Heavily Degraded) Patches

In order to estimate soil loss from the collapsed patches, the study sites were investigated through aerial photo-interpretation and reconnaissance. Finally, sheet erosion was observed at almost all parts of SA, while rill as well as gully erosion were found several places and river banks. Because most part of SA is located on Precambrian metamorphic rocks with stable ground, slide or liquefaction of soil is unlikely to take place. By the above-mentioned reason, the collapsed patches in the SA could hardly be found.

Soil Loss from Cultivated and Sloped Land

For the purpose of estimating soil loss from cultivated and sloped land from degraded fields with poor vegetation cover, square wooden frame of the size 1.2m x 1.2m x 0.3m was installed at the bottom side of slope. Here soil loss from cultivated and inclined land is regularly measured by sheet and rill erosion until the end of November. Ten sites for measurement are determined by comparing such factors as topography, soil type, vegetation and slope. Measurements are desirably made a few hours after heavy rainfall during December 1999 to January 2000. The Team will employ and entrust measurement to counterpart(s). Particle size distribution of runoff soil samples is also analyzed by the similar way to that mentioned above by means of soil sieves. Location and condition of soil loss measurement sites is shown in Table 2.19.

Table 2.19 Location and Condition of Soil Loss Measurement Sites

No	TA	Village Name	Catchment Name	Area (m^2)	Slope (%)	Soil Type
1	Chigaru	Muyangevi	Lirangwe right	250	3	Sandy Lithosol
2	Kuntaja	Kabango	Lunzu left	5,000	3	Sandy Lithosol
3	Kuntaja	Goweza	Nkokodzi right	225	4	Chilela Latelite
4	Kapeni	Manyombe	Lirangwe right	810	6	Sandy Lithosol
5	Kapeni	Nazombe	Lunzu left	400	1.5	Latelite
6	Makata	Fred	Lirangwe right	320	4	Sandy Clay Loam
7	Machinj	Daniel	Lunzu left	700	8	Sandy Loam
8	Machinj	Likhoswe	Lunzu right	1,050	5	Sandy Loam
9	Chitera	Nanvenya	Molonbozi left	380	5	Sandy Clay Loam
10	Mpama	Nakhwala	Lirangwe	5,000	8.5	Entisol

According to the National Environmental Action Plan in 1992, by World Bank, level of suspended solid load in the SA are as reported below. Discrepancy between these data and studied results shall be checked during the coming Phase II study.

Shire River at Kamuzu Barrage 100~200 mg per liter
Lunzu River at Whayo 200~300 mg per liter

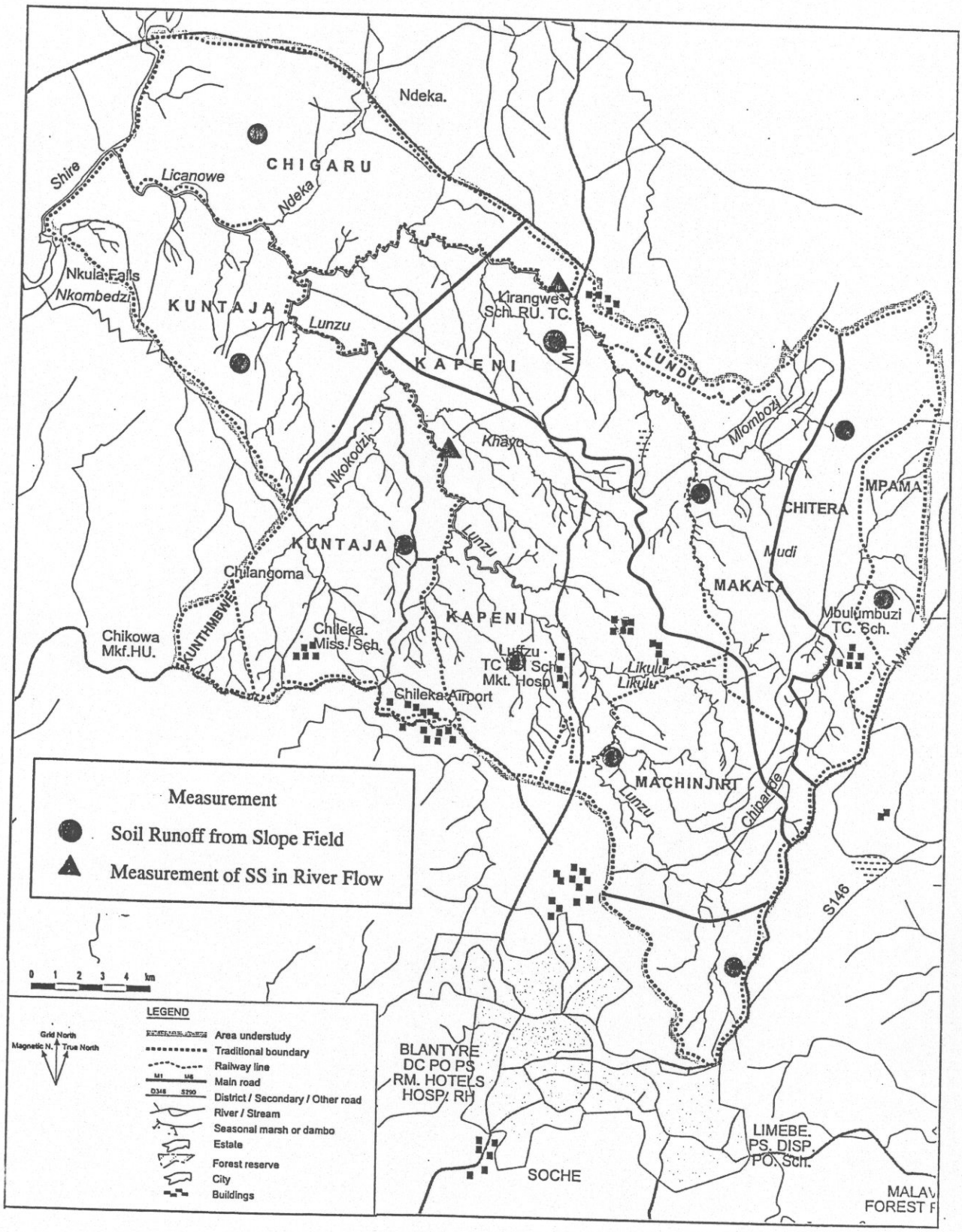
Also, the study to identify sources of siltation in the Middle Shire Watershed reported in 1996 by British High Commission, estimated erosion and sediment delivery mentioned below. Soil runoff from the Lunzu-Lirangwe to the Shire River was estimated at 760,000 ton/year. If the surface runoff percentage is assumed as 10%, mean annual rainfall as 800mm/year and soil density as 1.6 ton/m^3, suspended soil density is estimated at about 89,000 ppm. The flow velocity in the watershed ranges 1 to 3m/sec in rainy season and it is hardly conceivable for such a low velocity to convey so high density of suspended soil.

These data will be refered to and compared with the results obtained from the Phase I Study. Then the draft Erosion Hazard Map will be prepared.

Lunzu- Lirangwe River

Severity of Erosion	Area in km^2	%	Gross soil loss (t/year)	Delivery (t/year)
Slight	2	-	2,000	(ratio - 0.2)
Moderate	112	16	336,000	
Severe	408	60	2,244,000	
Very severe	161	24	1,207,500	
Total	683	100	3,789,500	757,900

Figure 2.3 Location of Soil Runoff Survey



2.3 Water Resources

(a) Water Resources Availability

Available water resources in the SA comprises of surface water and groundwater. In order to estimate the quantities of these resources it is required to analyze the water balance. This is estimated by examining groundwater storage capacity in the watersheds concerned, based upon river flow data, results of pumping tests for calibrating groundwater recharge, depths of impermeable base-rocks, year to year observation records of groundwater levels in addition to such ordinary meteorological data as records of diurnal rainfall /evaporation. However, these data are not available in the SA due to lack of data accumulation. Hence, surface run-off, groundwater recharge and annual evaporation were estimated here with reference to Water Resources Master Plan carried out by UN in 1986, as well as State of Environment Report for Malawi summarized by EAD in 1998, in the following way for the estimation of water resources. As a result, the amount of surface run-off was estimated at 57 MCM, and that of groundwater recharge was forecast at 11.4 MCM, with the rate of water loss through evapo-transpiration at around 90%.

Table 2.20 Water Balance in the SA

Factor of Water Balance	Ratio	Catchment Area (km^2)	Runoff	
			mm/year	MCM
Annual mean Rainfall (850mm/year)	100	669.75		
Surface Runoff	10		85	56.9
Dambo				14.0
Small Ponds				0.8
River				42.1
Groundwater Recharge	2		17	11.4
Evapotranspiration	88		748	501.0
Total	100		850	569.3

(b) Utilization of Surface Water

Out of the total run-off of 57 MCM, 14 MCM is stored in two major dambos, while about 0.8 MCM is kept in reservoirs and the rest 42 MCM is estimated as the quantity of flow in the streams in the SA. Period of water storage in dambos lasts only three months from February to April, then the major part of stored water is discharged into streams within a month. Only little amount of surface water is utilized during dry season as fountain water. Besides, small scale cropping of green maize and vegetables is practiced during dry season making use of soil moisture inside dambos after the discharge of surface water. Though water stored in reservoirs belonging to estates is used for irrigating tobacco and other crops grown therein, ponds in customary land within TAs are in the most part left idle. In spite of the existence of some promising sites for creating reservoirs in the SA, these sites have already been used as crop fields due to heavy population pressure, and land acquisition by expropriation makes new construction of reservoirs awfully difficult. Also, stream water turns out too turbid during late rainy season (from mid-January), which can not be used as potable water. Hence, transparent surface water for drinking is only available during dry season. Since surface water is presently not rationally used, its efficient utilization, especially use of limited water resources in dambos, reservoirs and major streams should be studied in future.

(c) Use of Groundwater

Average yield of borehole wells drilled into aquifers of weathered bands in the SA is estimated at 0.5 liter / sec, referring to the design covering a beneficiary with 250 persons per borehole. It follows that annual pumpage from these borehole wells comes to about 3.5 MCM based on the number of boreholes in the TAs

concerned, accounting for 31% of the total capacity of groundwater deposited in aquifers. On the other hand, no accurate number of shallow wells is available due to lack of statistics or registry data. In this regard, number of households using shallow wells are reported at 22% of the total sampled households by SEBS. The estimation takes this rate as a base, along with an assumption that mean yield of a shallow well is equivalent to a half of the yielding capacity of a borehole well, and that available period thereof only lasts for half a year during or post rainy season. Total annual water supply by shallow wells is thus estimated at 0.2 MCM, equivalent to around 5.5% of total annual yield from borehole pumps. From the estimation mentioned above, there seems enough room for further exploiting groundwater in the SA. In this context, an interview survey by the Study Team has revealed that ground water level in the watershed concerned fluctuate in a range 15 ~ 20 cm below ground surface. However, in many shallow wells the water level falls down during dry season to such an extent that users can hardly pump up enough water by hand-pump (refer to Annex E).

2.4 Agriculture

(a) Current Conditions

1) Agricultural development policies

The GOM has formulated the Agricultural and Livestock Sector Development Strategy. in 1995. The four important points in the strategy are (1)poverty alleviation, (2)a participatory approach in linkages among research, extension and farmers, (3)macro-economic stability through sound fiscal, monetary and exchange rate policy, and (4)resource allocation through market mechanism with minimum government intervention.

Macro-economical strategies and measures in the policy framework have been worked out for the period from October 1998 to September 2001 by the government with collaboration of IMF and the World Bank. The followings are focal points of the strategies for the agriculture in the national level.

- Implement reforms to improve the efficiency of land utilization and develop a land market,
- Develop maize markets and increase the supply of maize by strengthening incentives for private storage and trade of maize,
- Ensure that all government-funded intervention agencies sell maize at no less a price than the import parity price,
- Prepare and implement the commercialization and privatization of ADMARC,
- Replace the strategic grain reserve with an autonomous National Food Reserve Agency subject to rule-based intervention,
- Safeguard the autonomy of the Malawi Rural Finance Company and enforce recovery of the loans.

The SA is under the jurisdiction of the Blantyre ADD. Field level policies applied in the Blantyre ADD aim at increasing yields per unit area so as to maintain self-sufficiency in food requirements both at household and national level. Planned outputs to fill these objectives in the respective sections are as follows:

- Increasing number of trained and skilled extension officers and master farmers through farmers' course training, creation of demonstration plots and meetings for promotion campaign where tobacco, maize, cotton, soybean and pigeon pea are deemed as key crops to endeavor improvement,
- Increasing supply of organic manure (compost) through the same measures and
- Increasing seed supply by establishing seed farm and meetings for promoting campaign

2) Crop production

Statistical crop production data were obtained from crop statistics in Blantyre, Shire highland RDP and EPAs situated in the SA, namely, Ntonda, Mombezi and Lirangwe.

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Statistical crop production data were obtained from crop statistics in Blantyre, Shire highland RDP and EPAs situated in the SA, namely, Ntonda, Mombezi and Lirangwe.

The most important crop in the SA is maize followed by pigeon peas, groundnuts, soybeans, kidney beans, sweet potatoes and cassava (refer to Annex Table D-1). Soybeans and tobacco increased their importance in the small farm crop production. Sweet potatoes and cassava also increased their planted areas for the improvement in subsistence of small farms. According to the related RDPs and EPAs, farmers plant 0.7 ha in total consisting of 0.4 ha for maize, 0.1 ha for pigeon pea, 0.05 ha for groundnuts, 0.05 ha for soybean, etc. Besides, there seems to be considerable fallow plots due to absentee land ownership and to failure of germination.

Crop yields have remained at very low levels, e.g. in 1998/99, maize; 1.71 ton/ha, pigeon pea; 0.53 ton/ha, groundnut; 1.2 ton/ha (Annex Table D-1). Crop calendars prevailing in the SA are shown in Figure 2.4.

Before 1998/99, crop yields had been very low due mainly to low fertilizer application. Farmers have been too poor to buy chemical fertilizers. However, in 1998/99 crop yields substantially increased owing to the implementation of the starter pack scheme, which supplied fertilizers and seeds free of charge to farmers. Participating farmers each received 10 kg 30:21:0 compound fertilizer, 5 kg urea, 2kg hybrid maize seed and 2kg soybean seed per household.

Crop productions in the recent years are shown in Annex Table D -1. There are remarkable increases in tuber production such as sweet potatoes and cassava, which give more stable yields than maize in spite of erratic rainfall conditions. This is a favorable sign of sustainability improvement for livelihood of small farmers.

Manual cultivation by hoes and knives constitute the major tillage practice in food crop cultivation of small farms. There is shortage in draught power or there has been lack of tradition to use it. Farmers have to expand period of hand plowing up to 3 to 4 months. Farm machinery in small farms number11,530 in the Blantyre ADD as of March 1999 broken down as follows:

Table 2.21 Number of Small Farm Machinery(whole Blantyre ADD)

Small Size Farm Machinery	numbers held	Small Size Farm Machinery	numbers held
Ploughes	61	Ox-cart	81
Ridgers	62	Draught oxen	156
treadle pumps	9	Jacto sprayers	63
power tillers	3	Knapsack sprayers	618

Source: Blantyre ADD

Crop protection using chemicals is rarely practiced except for vegetables and cotton. Main pests and diseases of crops are:

- weevil and rodents for storage crops,
- leaf eater and stalk borers for maize,
- aphids, cut worm, nematodes for tobacco and tomatoes,
- locust, monkeys and army worm for all crops
- blight disease for tomatoes,
- mosaic virus for cassava,
- end rot for banana,
- fusarium wilt for pigeon peas, and
- bushy top disease for tobacco.

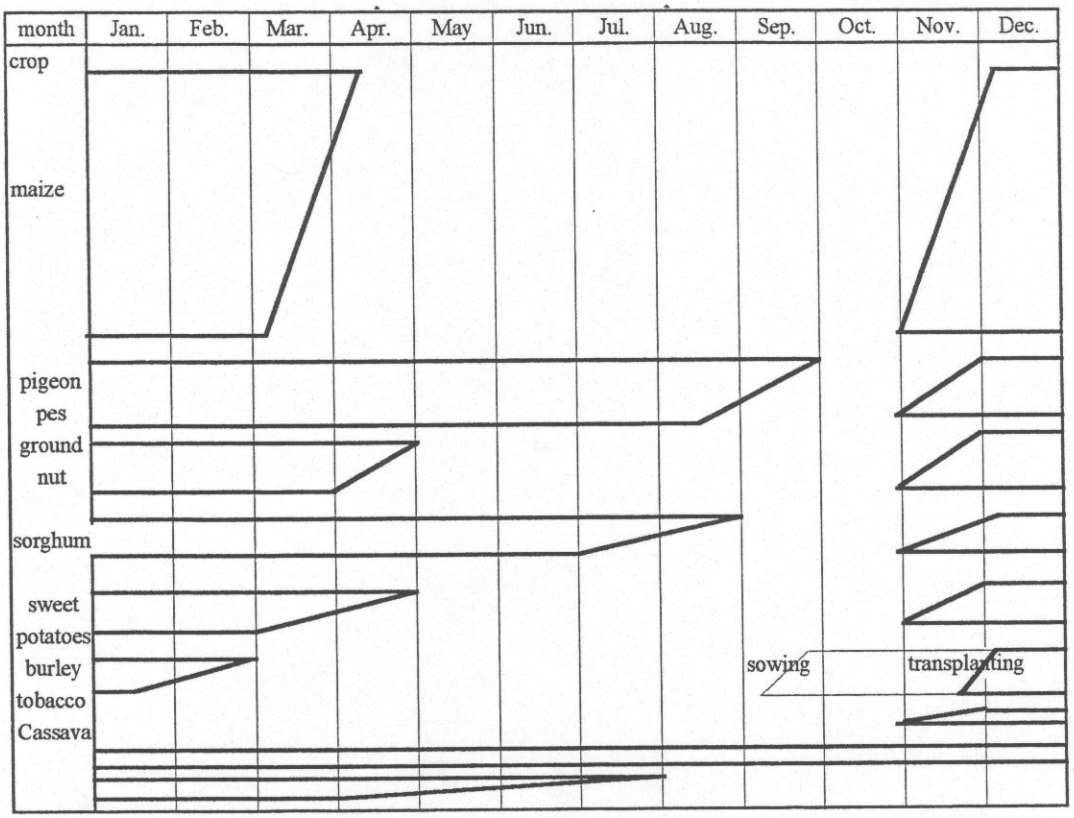
3) Livestock production

Year-end livestock heads in the SA were estimated based on the district data of the Blantyre-Shire Highland RDP. There are no complete statistics on the number of animals in the concerned EPAS. Numbers of animal from 1994 to 1998 are given in Annex Table D - 3.

The dominant livestock are chicken followed by goats, pigs and cattle. Number of large animals such as cattle, pigs and sheep have been decreasing due to diseases and thefts. Goats and chicken have shown drastic fluctuations in numbers due to respectively tick borne diseases and New Castle disease.

For individual farmer, animal husbandry plays only a minor economic role because of its negligible size of animal holding as shown in Table 2.22. Their draught power and manure as well as their products such as meat, egg and milk have not been substantially exploited.

Figure 2.4 Crop Calendars



Crop Calender in the northwestern part of the SA

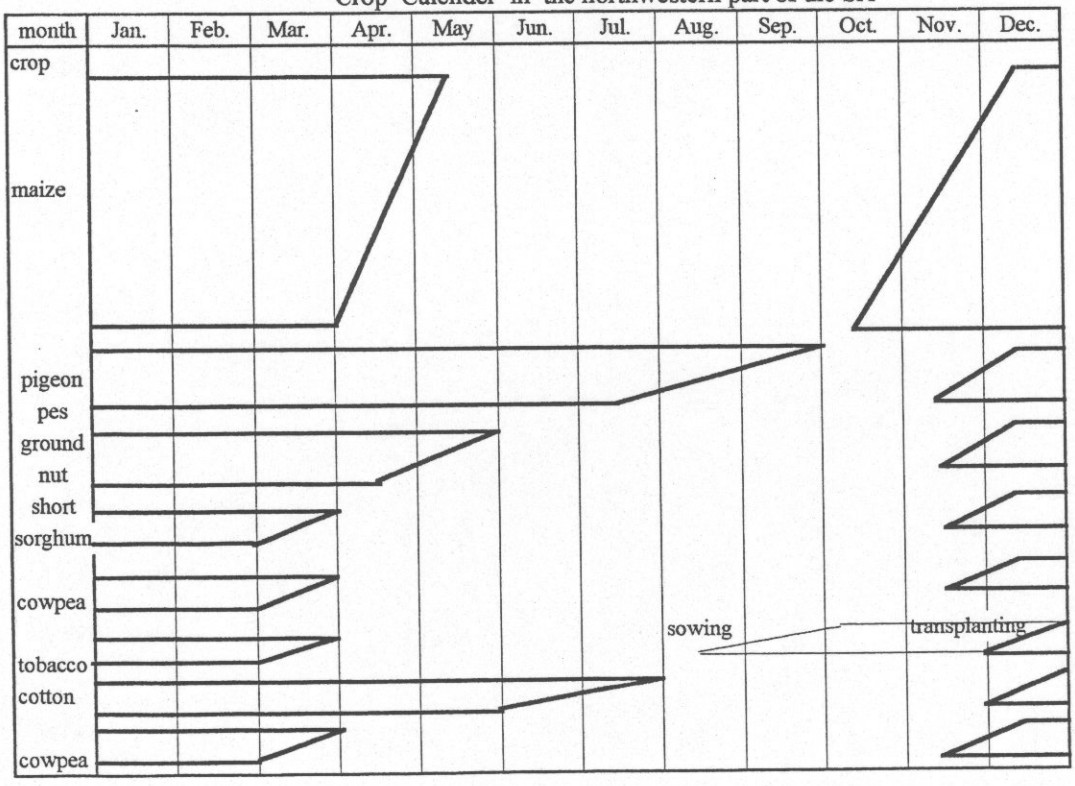


Table 2. 22 Livestock Holding per Household

Livestock Specie	head per household in 1998
Bovine	0.078
Pigs	0.037
Sheep	0.011
Goats	0.647

Source: Blantyre-Shire Highland RDP

Dairy cattle are composed of cows (44.1 %), heifers (18.3 %), male calves (19.2 %), female calves (15.2 %), steers (2.5 %) and bulls (0.7 %) according to statistics of the Blantyre ADD. Twenty percent of the cattle are grown in diary estates. Marketable surplus of milk per milking cow is 72 liters per year. Napier grass is the most popular artificially grown pasture in the SA followed by Rhodes grass and Luecaena for feeding milch cows (mostly kept in estates). Planted area to fodder crop still remains very small because of small landholding of farmers. Livestock are sometimes fed with such supplements as cut grasses, crop residues, maize bran and beer brewery residues. Farmers seldom pasture dairy cattle in the SA for fear of cattle theft.

Beef cattle are the main components of the cattle covering 84.5 % of the total. Improved breeds such as Brahman have been introduced but their coverage is very small of 4.5 % of the total beef cattle. Some farmers grow steers from Friesian and Holstein breeds. Customary land, particularly dambo provides the main source of feeds for beef animals. Stall-feeding is practiced by a few farmers using the steers. Armed banditry is rampant in the SA, robbing and slaughtering cattle, pigs and goats. There is no promising prospect of the development of animal industry without solving the security problems. Existing police force has little trust from farmers because most police release the thieves even if farmers captured and deliver them to the police, according to Malawi Police Public Perception Study * by the center for social research in 1999.

Improved breeds of pigs account for 12.1 % of the total pigs. Most of the pigs are grown in pens due to theft problems. There is no substantial production of feeds specialized for pigs, because feed manufacturers are mostly Indian Muslims, who hate any business related to piggery. The most serious epidemic problem of pigs is African swine fever, which killed about 80 % of affected ones in one incident.

Most of the chicken stem from local breeds, accounting for 90 % of the total. Specialized breeds such as layers and broilers cover only 3.8 % and 2.7 %, respectively. Black Australorp, which was introduced from Australia for its high adaptability to local conditions covers only 3.5 %. There is shortage in the supply of Black Australorp, which commands high demands among farmers. Frequent occurrence of the New Castle disease is the single most serious problem in chicken industry in the country. When the disease once breaks, mortality reaches to about 80 %. Only 1.16 % of the vaccine demanded are met due to short supply of vaccine and its high prices for farmers, MK 1.65/dose.(price of vaccine: MK 120.00 / 500dos / bottle) Four doses are necessary per year per head.

4) Marketing

Present Conditions

In the SA, marketing commodities constitute agricultural products and agricultural inputs, which are predominant commodities in the Area. Main agricultural products are tobacco, maize, pigeon peas, beans, sweet potatoes and groundnuts. As harvesting periods of those are concentrated on the period between February and April except tobacco because of the weather conditions, ADMARC has markets to buy and handle those products and if necessary, establish seasonal markets from March to September to deal such commodities with better marketing access. Farmers, if necessary, sell their products to private traders for cash. Private traders are subject to register at the Ministry of Commerce and Industry for trading. Marketing volume of the agricultural product is limited because the yield of the product is very low, cultivated area per

household ranges 0.5 to 0.7ha per household in the SA and almost all of agricultural products are self-consumed. Some farmers are obliged to sell their products for daily cash and suffer from hunger for a few months before next harvest and it is hard for them to buy input materials such as seeds and fertilizers for next season. Buying and selling prices of the grain vary depending on accessibility and places of handling, but those are usually based on the prices set by the ADMARC who decides the monthly buying and selling prices of grains, taking current inflation rate and price indices into consideration.

Table 2.23 Prices paid by ADMARC to Farmers Unit:MK

Crops/Year	1990/91	1993/94	1996/97	1997/98
1. Tobacco, NDDF	3.35	-	12.00	18.27
2. Chilies, Grade 1	2.55	2.40	-	36.08
3. Maize	0.26	0.43	1.25	3.44
4. Groundnuts, Grade A	1.00	1.50	4.00	7.26
5. Paddy, Grade A	0.35	0.47	2.5	5.43
6. Cotton Seed, Grade A	0.81	-	1.00	7.44
7. Beans, Pure	0.65	1.15	1.50	8.57
8. Soya Beans	0.60	1.23	1.70	4.26
9. Sunflower, Pure	0.55	0.43	0.70	2.60

Source: ADMARC Head Office, Blantyre

Table 2.24 Prices Fertilizer & Seeds by ADMARC Unit:MK

Input/Year	1990/91	1993/94	1996/7	1998/99
1. C.A.N. (50kg)	38.00	72.63	270.00	695.00
2. Urea (50kg)	40.70	64.20	342.00	840.00
3. 23-21-0	45.00	81.48	350.00	895.00
4. D. composite (50kg)	50.50	179.00	330.00	905.00
5. S. composite (50kg)	45.00	162.00	320.00	725.00
6. Maize seed (hybrid, MH18, 10kg)	-	-	-	606.00

Source: ADMARC Head Office, Blantyre

ADMARC has one “Area Market and office”, three “Unit Markets” and eight “Seasonal Markets” for buying and selling activities in the SA. These usually stand on the township along the main roads and the railway for better accessibility. Only one seasonal market in Matama (TA MAKATA) is located far from the main road. Liberalization of marketing has been started six years ago and the number of private traders is increasing. Supermarkets in the Cities are found to sell seeds and fertilizers and diversification of marketing is going on.

Farm perishables and livestock products are not handled by the ADMARC. Almost all of those are dealt with the private traders. Small scale farmers are vending to pedestrians along the main roadsides their agricultural products or products bought from other farmers such as tomatoes, sweet potatoes as vegetables and banana, mangoes and papaya as fruits for sustaining their livelihood.

Daily prerequisites and other commodities are sold in fairs and permanent markets (by traders). They are usually handled at temporary fairs in the main towns twice a week. Generally, clothes are sold at said fairs, however, items of agricultural products are limited.

Blantyre and Limbe, biggest markets in Malawi are located near the SA. Almost all handled products are traded in these markets. Aqua products from Lake Malawi in Upper Shire area are brought and farm

perishables from Thyolo and Chikwawa of Lower Shire area are also delivered to these markets.

Problems and Constrains

There are many problems and constraints in the marketing system in the SA. Since productive land is located on the hill or undulated area, accessibility is poor. Development of roads and bridges remains scarce. Handling charge is very expensive because of high fuel cost for vehicles (gasoline MK30.5/litre as of November 1999). Handling volume of agricultural products is limited and its system is poor. Farmers groups are not active enough to collect and handle the marketable volume of the products. Market mechanism of pricing remains primitive because the suitable information systems are not yet established for efficient handling and marketing. There are many competitors in the lower Shire River.

5) Agricultural research

Agricultural research in Malawi has been developed under the control of Department of Agricultural Research for field crops and crop husbandry, Tea Research Institute for tea, under the umbrella of MAI. Agricultural Research and Extension Fund has been in charge of research for tobacco, while Sugar Corporation has dealt with that of sugar cane.[2] Other than these research institutes, University of Malawi and Bunda Agricultural College extend research activities on crop and animal husbandry. In the SA, tests and trials to verify adaptation of new varieties to local environment have been conducted by extension wing mainly on the following subjects:

- adaptability tests for fertilizer application
- maize (ordinary local varieties) trials on demonstration plots
- demonstration on the use of organic manure
- verification trials of recommended cropping practices on farmers' plots

There has not been any authority in local government to specifically handle farm management, agricultural sale and marketing. Bvumbwe research institute handles horticultural researches.

(b) Potentiality, Issues and Problems

1) Potentiality

Limited land resources

Land resources have been almost fully exploited for crop production even in non-arable land such as steep slopes. The average landholding size is only 0.7ha per household according to the EPA data that is equal to cultivated area in 1998/99 per household. The average family size is estimated at 4 persons in SEBS. This landholding size is too small to support 4 persons. It would be very difficult to raise the family income to a satisfactory level only through crop production.

Poor educational backgrounds

According to SEBS results, only 25% of the household heads in the SA graduated from primary school. The others are assumed to be illiterate. Most farmers have difficulty in reading of extension messages, instructions and in calculating acreage, necessary farm inputs and accounts. They lack basic knowledge and skill in farm management and would be impossible to autonomously develop themselves without outside

[2] see Chapter 2.5 Agroforestry as for research on fruit

assistance.

Abundant untapped water resources

The SA has an annual rainfall of 700-1000mm. Total irrigated area is only 19.8 ha, which corresponds to 0.03% of the total area. There are 22 dams for irrigation and water supply, but these are now mostly filled with sediments. Thus, water resources in the SA have not been substantially exploited. There are much potential of water resources for irrigation and aquaculture development.

2) Issues and problems

Theft

Security problems are the biggest bottleneck to production in the SA. Livestock holding declined to only 0.7 heads per household and fruit industry and aquaculture in the small farms have not been substantially developed due largely to theft damages. Without addressing these problems, any trials for the development would eventually end up in vain. Nobody is expected to invest in animal or crop production, if the outputs or cash income will be robbed or be stolen. People perceived the police as being ineffective, corrupt and not dedicated to their duties. Causes of these problems are commonly believed as weak security system in local areas, inadequate personnel, lack of human and material resources, inadequate training etc. Although animal transport is controlled by the livestock department, and the transportation of animal needs permission to prevent removal of stolen animal and to prevent spread of diseases still this system does not work well due to the indifference of the implementors.

Hyper-inflation

The inflation was 56.1 % in 1999 in the SA. This condition normally favors those who can boom up the prices of their products such as fertilizers and chemicals in proportion with the inflation. But, small farmers can not adjust their prices of their farm produce nor labor wage because of middlemen, traders and employers who are privileged to operate these prices. The cause of hyper-inflation may lie in too much monetary circulation in the country through the banking system.

Diseases and pests

Animal industry has also been constrained by rampant occurrences of diseases such as the New Castle disease of chicken and the swine fever. There is no sign of subsidence of these diseases because to no effective measures have been taken against them. Crop diseases such as cassava mosaic virus also hinder the increase in crop production. The extension of resistant varieties of minor crops is insufficient because of insufficient knowledge and information on the part of officials in charge, who develop and propagate resistant varieties, poor genetic sources to develop resistant varieties and low development in privatization in seeds/seedling businesses.

High fertilizer prices

Fertilizer prices are too expensive compared with these of farm produce. For example, the nitrogen-maize price ratio is as much as 9.4. Crop production for the domestic market is far from a profitable business. Subsistence farms can sustain themselves only with meager application of fertilizers. Fertilizer traders make good profits, often enjoying a high margin by as much as 50 % of the retail prices.

Insufficient government support for marketing and farm management

On the government side, the marketing of the agricultural commodities is regarded as a business of the

private sector. There is no systematic monitoring and study on the marketing activities by the government. In the marketing field, small farmers without any knowledge and little funds and without firm solidarity among them are at the mercy of traders with abundant information and funds and their networks. There is no special organization either handling farm management in the government nor monitoring of financial conditions of small farms or estates.

2.5 Agroforestry

(a) Definition and Effects of the Agroforestry

Agroforestry (hereinafter referred to as AF) has been given many elaborate definitions by scientists in the past. The Study defines agroforestry as a comprehensive land use system that integrates crops, trees and livestock in one land management unit. Currently, the SA is suffering from serious poverty after converting most of the formerly forested areas into cultivated land. Uncontrolled exploitation of the agricultural land has resulted in severe soil erosion, hence less land productivity. In the meantime, denser population demands more cultivable land for maize and other crops for subsistence. AF is considered one of the most important strategies to solve farmers' problems because it can play the following roles,

Improvement of agricultural environment

- Prevention of land erosion
- Supplemental supply of soil fertility
- Provision of canopy shade
- Conservation of humidity and wind break

Improvement of Productivity

- Improvement in productivity of maize and other crops
- Supply of fruit and materials for cottage industry
- Promotion of animal husbandry
- Production of energy and fuel (fuelwood, grasses, weeds, etc.)

(b) Current Agroforestry

1) AF development policies of Malawi

GOM actively promotes tree planting in farms mainly for provision of fuelwood and building material. In particular, the MNREA has a policy of actively promoting trees in farms with the aim of providing alternative sources of wood, a policy which aims at reducing deforestation of the limited forests in the country. A new Forestry Act has been enacted to implement forestry development policies particularly outside the Forest Reserves in the country. Among the provisions of the new Forestry Act are provisions of community participation in forestry development.

The MAI also has a deliberate policy of promoting agroforestry (hereinafter refered to as AF). Land Resources Conservation Department (LRCD) and Agricultural Extension Department of MAI particularly undertake this. LRCD has formulated a conservation policy in line with its duty of monitoring land use and establishment of nurseries to raise vetiver grass and trees for soil erosion control. Under the umbrella of this department, the policies of the Ministry are implemented by institutions such as Promotion of Soil Conservation and Rural Development (PROSCARP) whose objective is to improve small-scale farming through adoption of AF practices.

2) Country wide AF extension

Pursuant to the policy of AF development, the Ministry of Natural Resources and Environment has strengthened forestry extension under the FD so that staff perform duties of promoting tree planting in areas outside the Forest Reserves. At national level, over 80% of the Forest Assistants- the cadre of people who are truly the frontline staff for forestry development - are deployed in AF development (One hundred ninety nine Forest Assistants are in Extension while 49 are in Forest Reserves development). Additionally, the Ministry has handed over a number of retail tree nurseries to VNRMC for raising tree seedlings, for planting in farms besides support to many other tree nurseries initiated by individual farmers and NGOs. Particularly during the 1980s, DF actively encouraged planting of many Eucalyptus trees in farms and urban areas to cater for energy and housing needs.

Other major players include ICRAF and several other NGOs. At national level, considerable research has been undertaken by the ICRAF, an institution, which has a global mandate to spearhead AF research. In the past few years, some of the techniques exploited by ICRAF in collaboration with many other institutions cover: improved fallow, relay cropping, alley cropping; mixed intercropping, fodder production, domestication of indigenous fruits, and soil stabilization on steep hills. So far, the most promising technology is that of mixed intercropping using maize with *Gliricidia sepium*. Most of the ICRAF pilot areas are outside the SA namely, Blantyre and Chiradzulu Districts.

Several NGOs undertake activities scattered in the country. Most of the NGOs activities are not well sustained and are heavily dependent on donor funding. Although some NGOs are mentioned as working countrywide, in fact, they operate only in some districts. In some cases, these Districts are mentioned only for the purposes of registration and official permission to operate. Hence, activities may be nominal or missing altogether. Though small in nature, they are however important as they deal with grass root organizations and farmers with considerable multiplier effect on capacity building. Some of the major NGOs in the field of AF development are: Chitukuko Cha Amayi M'Malawi (CCAM), World Vision International (WVI), Action Aid Malawi, Evangelical Lutheran Development Programme (ELDP), Oxfam GB Malawi, Plan International (PLAN), and Wildlife Society of Malawi (WSM).

Although there are apparently many institutions reported to be active in AF, the finding of SEBS indicate that only 3 respondents mentioned Rural Development Project, 3 others mentioned NGOs and 8 said there were none.

Bvumbwe Agriculture Research Centre of Malawi (BARC) under MAI covers horticulture development which include: screening of fruit tree, propagation and grafting techniques of promising fruit tree varieties, such as apples, peaches, grapes, kiwi fruits, litchis, mangoes, guavas, avocados, etc. BARC is located at south of Blantyre and working on fruit tree species, propagation and raising fruits tree seedling since mid 80s. The researcher recommended several fruits species as a result of their 15 years efforts. Table 25 shows the recommended Mango species by BARC as an example. Further study will be provided during the 2nd phase of the Study

Table 2.25 BARC Recommended Mango varieties

No.	Variety	Color
1	Pommy Atkin	
2	Kent	Red
3	Haden	Red
4	Daves Haden	Red
5	Zill	Pelican/yellow

Other than the Mango, Guavas, Avocados, Oranges, Papayas, Apples, etc. are selected as possible fruits species to the SA. Production technology of those species seedlings are developed by the center and

extension plan of the technology was published in April 1999 by the MAI as policy. Actual budgeting or assignment of the extension officer who will execute to the plan will be prepared in the near future[3].

3) Current AF practices in the SA

Overview of current AF practices in the SA

The tree variety is mainly confined to Eucalyptus tree species. Other more recent AF technologies are very rare in the study area. Only a few AF practices were confirmed in the SA for instance:

- Banana and sugar cane cultivation along with temporal stream
- Vetiver and bananas cultivation as hedgerow and / or along the contour line
- Compost made of crop residue by advanced farmer (it is very rare case, by rich and big farmer)
- Raising grafted Papaya and Mango seedlings supported by NGO or MAI extension officer
- Raising Eucalyptus at individual homestead for fuelwood

Other than above mentioned AF examples, there are no other AF practices in the SA. There are many cases of scattered local Mangoes whose fruits were due to be harvested. Unfortunately, the fruits from these local Mangoes are not easily marketable to generate the much needed farm income and hence the need to introduce improved Mangoes as recommended by BARC.

To understand the status of AF in the SA, three main studies were undertaken.

- a socio economic study which had some components of AF and forestry
- a detailed survey of AF technologies and practices
- inventory of tree resources in the farms in relation to the households population needs

AF sector by Socio-economic baseline survey

Results of socio economic survey indicate that although 60% of households interviewed said that they had heard about AF, only 10% said that they practiced it. Most of subsequent questions on AF were based on this 10% of households. It should however be noted that in fact more than 10% of households practice some kind of AF when it is borne in mind that any tree planting in farms is itself a part of AF. Response on simple technologies such as alley cropping, hedge tree planting, vetiver grass planting indicate a very low level of technology adoption as seen in Table 2.26.

Table 2.26 AF Technologies Practiced (Household Interview Survey)

AF Techniques	No.of respondents	% of practicing AF	% against total household
Alley cropping	5	36 %	3.0 %
Hedgerow	4	29	2.5
Cultivation pigeon pea, velvet beans	5	36	3.0
Others	1	7	0.6
None AF households	147	-	-
	162		

[3] Comment of BARC Director to the interview

Farmers practice AF for a number of reasons. Felt needs of farmers on the reasons and income benefits obtained from AF is evident from Table 2.27, based on 14 respondents who gave the information.

Table 2.27 Major Uses of Trees and Plants as perceived by Farmers

Benefit	No of Household	%[1] (multiple)	Mean Income (MK)
Fruits	5	36	300.00 (N=3)
Fuelwood	7	50	400.00 (N=4)
Protection from erosion	6	43	-
Preserve soil humidity	2	14	-
Improve soil fertility	7	50	-

Notes:1.Percentages is calculated among 14 respondents who practice AF

2.N* is number of effective answer by households (remaining number of households did not answer about income).

AF technologies and practices

The information on SEBS is based on what the various respondents said in regard to four broad AF practices. In a further detailed survey of AF practices, 42 sites, randomly selected through vegetation survey and socio-economic survey, were visited and interviews held with cluster of farmers in each site. Most of the information in this case was based on the conversation with farmers and observation of various existing AF practices against a checklist of 11 known AF technologies, namely: Alley cropping, woodlot planting, Scatter trees, Boundary planting, River crack protection, Galley tree planting, Compost mulching, Windbreak,, Home compound, Hedgerow, Mixed intercropping between tree species and vegetables. In addition to the information on AF practices, data on status of soil erosion, crops grown fruits and the sources of AF awareness were obtained. Detailed AF information is contained in Annex C-1.

Effectiveness of AF is measured by how much the adopted AF practices respond to the various constraints and problems encountered by farmers in the study area. Table 2.28 indicates frequencies of the different technologies meant to address mainly the issues of soil fertility, fuelwood and construction wood requirements among others.

Table 2.28 Rate of Adoption of AF Technologies in the SA

AF Technologies		Frequencies	% (multiple)
Alley cropping	(AC)	0	0
Woodlot planting	(WP)	7	23
Scatter tree planting	(ST)	23	77
Boundary planting	(BP)	11	37
River crack protection	(RP)	0	0
Galley tree planting	(GP)	0	0
Compost mulching	(CM)	1	3
Windbreak	(WB)	0	0
Home compound	(HC)	1	3
Hedgerow planting	(HR)	0	0
Mixed intercropping	(MI)	0	0

There were a total of 30 sites where a representative farmer responded to the questions. Hence, theoretically each technology had 30 chances of taking place. It is evident from the above table that scatter tree planting is the most commonly applied with 77 % of respondents. Next is boundary planting with 37% of respondents. Woodlot planting had 23 % while compost mulching and home compound each had 3 %. Other technologies are rare or non-existent.

Survey of tree resources in farms

A third study dealt with detailed measurements of trees in the study area covering 42 representative farmers in all the TAs. To avoid bias, a first farmer was selected on a map and subsequent farmers were randomly selected by counting a fixed number of homesteads. Hence farmers with a lot of trees were encountered while in other cases farmers with very few planted trees were also sampled.

The first major finding is that tree variety is very low and most of trees planted are eucalyptus tree species and these seems to have been planted in one period around early 1980s in response to energy crisis campaign. There were indeed very few trees planted before then or much later, indicating unsatisfactory situation of none-sustainability of most of the tree planting activities. Fortunately, the eucalyptus trees coppice abundantly and can hence continue being used.

About 4000 trees were surveyed in all representative zones. Eucalyptus species appeared 590 times and was clearly the commonest tree species in the SA. Next most common plant was mango, which appeared 170 times. Other tree and fruit species preferred are as indicated in the Table 2.29.

Table 2.29 Major Species and Frequency by AF Field Survey

Species	Frequency	Species	Frequency
Eucalyptus	590	Oranges	24
Mangifera indica (Mango)	170	*Azadirachta indica* (Neem)	17
Cassipoura malosana (Mdondoli)	86	Jack Fruit	8
Melia azedarach (India)	50	Mtumbu	6
Gmelina arborea	42	Avocado	5

Yield and Standard of management of trees in farms:

On the whole, the average number of trees per farmer was quite low at about 102 tree with wide ranges as indicated in Table 2.30. The volumes of trees were low partly because the harvesting age was about six years. Annual yields from the trees measured are given in Table 2.30

Table 2.30 Volume and Yield of Individual Woodlot

TA	No of trees of the plot	Volume m^3	Yield[1] m^3/yr	Yield[2] m^3/yr	SPH m^3/hse/year	SHA m^3/ha/yrea
Kapeni	28	1.048	0.175	0.389	0.334	0.233
Makata	97	3.350	0.558	1.245	0.943	1.595
Kuntembwe	110	2.373	0.396	0.882	0.834	1.176
Lundu	152	9.049	1.508	3.363	3.217	2.857
Chigaru	37	2.267	0.378	0.843	0.811	1.197
Kuntanja	136	4.264	0.711	1.585	1.576	0.957
Machinjiri	47	3.931	0.655	1.461	0.937	0.546
Mpama	263	4.781	0.797	1.777	0.925	0.652
Chitera	50	1.824	0.304	0.678	0.268	0.287

Footnotes 1： Six years rotation

Footnotes 2：yield 2 includes lower vegetation and residue

Footnotes 3：SPH is average annual yield by household

Footnotes 4：SHA is average annual yield by hector

Main observation is that the tree resources are not enough not only for various other AF benefits but also to meet fuelwood requirements. Typically wood yield were found to be very low and higher tree yields could be obtained if proper AF practices are put in place.

Tree management in farms

In the course of survey of tree resources in farms, observation was made on current management practices of trees. Admittedly there were few cases of well-managed trees in farms like those woodlots near Mangweru forests, because of retirement officers support. On the whole, management of individual trees needs considerable improvement. In many cases, far too many coppices were left on the stump and such congested coppices will not produce large size wood. Harvesting of coppices should also be undertaken when tree can easily sprout.

The other issue related to tree management is that of site preparation for trees in farms. Most of the trees were planted in poorer rocky sites of farms and growth in such cases was rather difficult unless site was drastically improved. A benefit of soil erosion prevention by planting hedgerows on steep areas was not evident in the study area.

AF development depends on sustainable source of tree seedlings. Most of the surveyed tree nurseries had very few varieties - mainly eucalyptus species. Apart from the issue of low variety, the stocking was very low to meet requirement of the seedling demand of the study area. Indeed some tree nurseries were there only by name but had ceased to function well, particularly where market for tree seedlings were not easily available.

Fruits trees in the farm

Percentage occurrences of fruits tree of total trees encountered through AF survey is shown in the Table 2.29 where local mango accounts for 60%, guava 13%, oranges 10%, pears 7% and apple, jack fruits, avocados 1% each, respectively. Fruit trees are an integral component of AF and have been promoted with the aim of meeting nutritional requirements as well as being source of cash income for farmers. In the SA, considerable number of fruit trees such as local mango, guava, papaya, etc have been planted widely in homestead gardens where they also serve as shelter tree crop. Although local mango is quite common, there are many farmers who have not planted fruits mainly because seedlings of the right type are not available and in other cases awareness is lacking.

Market survey of income generation activities at Zomba and Limbe public markets founds that apples are imported from South Africa and oranges and red mango are from Mozambique. But any statistical data was

not found at market level, from distributor, retailers except price information. Retail prices of those imported fruits are more or less MK 10 that is 10 times of a price of local mango.

(c) Role of AF in the SA

1) Analysis of current AF status of the SA

Before the 1980s the SA was covered by thick vegetation and people had been practicing slash and burn farming in the forest. Inhabitants in the SA have long history behind slash and burn-farming, in contrast with current AF practice. Those farmers in the SA did in fact understand AF as knowledge, but not as an essential farm technique for future generations.

GOM and/or donors have been working on AF extension mainly from the beginning of 1990s for land or farmland conservation. Meanwhile current status of AF has stagnated because the GOM has very limited financial resources and the limited staff in the SA.

AF benefits may effect from 2nd year after its initiation and the effects gradually increases. It never appears in a short time. There is no attractive model of AF that can dispose observers to introduce into their fields. These are reason why AF is still not common in the SA.

2) Recommended measures for AF extension

- Big campaign for promotion of AF
- Development of sustainable AF techniques by farmers or their groups
- Development of marketable AF products such as cash crop
- Development of certain area of AF blocks
- Development of model AF practices where the above cited items are incorporated

3) Plan for AF extension as an important factor of WRP

- Plan for campaign and training about AF
- Plan for development model AF and nursery
- Plan for development of adequate AF variety and combination
- Plan for formation of farmers' group for marketing and shipping AF products, etc.

2.6 Forestry

(a) Forest Management in Malawi

The Forest Department, under MNREA, is the Government agency mandated to manage forest resources in Malawi. Based on the management systems, Forests of Malawi can be classified as per Table 2.31.

Table 2.31 Management of Forest in Malawi

Management of FD	Forest category
Direct	Forest Reserve
	Forest Plantation
	Natural Forest
Support	Village Forest
Support	Local Authority Plantation; LAP
No management	Grave yard forest
	Private forest[4] (Individual woodlots / estate forest, etc)

FD has built offices in each forest reserve to cater for management of commercial forest plantations and the indigenous forests thereof.

Village Forests (VF) are located in customary land and consist of both the man-made plantations and remnants of indigenous forests. Local Authority Plantations (LAP) are put under the management of local authorities such as city or district council of Blantyre city, Blantyre district. FD supports LAP for production of fuelwood and poles, etc.

(b) Forest Area of Malawi

1) Current forest area

In 1988, forest area in Malawi covered almost 40 % of nation's land area, half of the forests were located in customary land[5]. By 1995[6], half of customary land forests had been destroyed although forest areas at national parks or forest reserves remain the same (see following table). Estate forests in most of the districts have also remained almost at the same level. Forests under the national parks and forest reserves have however survived better and the extent of this category of forests is indicated in Table 2.32.

Table 2.32 Forest Area of Malawi

Land area	1988		1995	
	area (mil ha)	Percentage	area (mil. ha)	Percentage
National land area[7]	9.43	100	9.43	100
National park	1.09	11.6	0.85	9.0
Forest reserves	0.73	7.7	0.73	7.7
Village forest / Private forest	1.70	18.0	0.89	9.4
Total forest land	**3.52**	**37.3**	**2.39**	**25.3**

Table 2.33 indicates forest areas by region of Malawi based on "Inventory Data of Bio-mass Growing Stock and Supply in Major Cities and Towns of Malawi 1996"

[4] Owned by timber company, tea and tobacco estate for processing and individual private forest
[5] Source: Malawi Forest Policy Review (1993, FAO/WB cooperative program)
[6] Source: FRIM Indigenous Woodland Management Strategy Area (FD data records national forest area as 3.51 million ha on the "Inventory data of Bio-mass growing stock and supply in Major cities and towns of Malawi, 1996". The Study team chose a data of FRIM because forest area at the SA is decreased to almost 20 % after 80s at least.
[7] Source: National Statistical Data of Malawi, 1998

Table 2.33 Forest Area by Region (1996)

Region	Area[8]	Indigenous Forest		Plantation		Total		Population (reference)	
	X 000 ha	X 000 ha	%	X 000 ha	%	X 000 ha	%	X 000	%
North	2,690	1,329	49.4	75.60	2.8	1,405	52.2	1,227	11
Central	3,560	1,035	29.1	25.15	0.7	1,060	29.8	4,186	39
South	3,180	1,035	32.5	10.90	0.3	1,045	32.9	5,350	50
Total	9,430	3,399	36.0	111.65	1.2	3,510	37.2	10,763	100
Total	9,430	3,399	36.0	111.65	1.2	3,510	37.2	10,763	100

It is evident from the table that North Region has the highest percentage of forests at 50 % and it is also the area with highest forest plantation development. One of the main reasons for the higher forest covers lies in the low population density in the region. The Central and South regions have retained almost the same area of natural forest but with the Central developing almost twice the area of plantation than the South. It is estimated that 48,000 ha of forest, equivalent to 2.0 % of current forest area, are lost every year[9]. The rate of forest loss varies from region to region, mainly dependent on human activities. Historically, commercial center of the South is estimated to be losing 2000 ha of forests every year. New political center of the Central, with wider spreading activities has been estimated to be losing 32,000 ha of forests also. The North forest area has been dwindling at the rate of 14,000 ha every year. Causes of deforestation reside firstly in exploitation of fuelwood / charcoal material for commercial purpose and secondly in conversion of forests into reclaimed land.

Malawi Economy Statistics state the amount of forestry production contributing to only 0.02 % of the gross national product. This however does not take account of various forest functions such as national soil conservation, watershed forests protection and supply fuelwood for the inhabitants, etc.

2) The Study Area

Forests, especially their areas, have been affected by the pressure of population. During 1980s and 90s, forests of the SA have almost entirely been converted into farmland or residential area according to the information obtained from FD officers. It was also stated that forest area before the 80s was estimated at over 14,000ha[10] and 30 % of the forest had been lost in 80s, and 90 % of the surviving forests were also cut down during 90s. Such disaster is mainly attributed to the three spells of severest drought during 80s and 90s. During these calamities, villagers failed maize and other crop harvest without any alternative source of livelihood except cutting and selling forest resources.

There is no significant indigenous forest in the SA[11]. There are only 124 ha of VF that have been developed by FD and subsequently ownership thereof was handed over and management responsibility was also transferred to the VNRMCs concerned. In addition, there is Ndirande forest reserve (600 ha) in the southern border of the SA[12]. Besides the current forests, there is 941 ha of planned forest area whose land acquisition for afforestation was completed (see Annex B-1: Summary of Forest Area in and surrounding the SA and Annex B- 2: Current Forest Location Map in the SA). In view of shortages of forest resources in the SA, tree harvesting sources for commercial fuelwood have been shifted to TA Kunthembwe[13], and Muwanza district, both of the areas located outside the SA.

[8] Source: National Statistical Data of Malawi, 1998, excluded Malawi Lake
[9] Source: Malawi Forest Policy Review (FAO/WB,1993)
[10] 18 years career as FD officer charged to the Blantyre District
[11] Remaining 15 ha of indigenous forest at Chilangoma hill in TA Kuntaja
[12] New FR established at 1992
[13] Illegal charcoal production area from Shire river to northwest

Table 2.34 Forest Area in the SA (ha)

Item	Area of SA	Forest Area (A) + (B)	Planned Area (B)	Current forest area (A)			
				Total	FR	VF	LAP
Area	66,975.00	1,682.28	940.30	741.98	600.00	59.70	82.28
Ratio		2.51%	1.40%	1.11%	0.90%	0.09%	0.12%

Note: Excluded estate and scattered woodlot

Source: FD Regional Office of South

Other than the reserves mentioned above, the SA is surrounded by several forest reserves: by Zomba in the northeast, by Chiradzulu in the east, by Michiru and Chigumula in the south and by Namisu in the west (see Annex B- 2)

3) Forest reserves

In the South Region 29 forest reserves covering 291,619 ha have been established for the purpose of forest production and conservation of indigenous forest. Zomba Forest Reserve legally gazetted in 1913 has the longest history in Malawi. After 1910s New Forest Reserves were established every decade except 60s. Table 2.35 summarizes Forest Reserves in Malawi.

Table 2.35 Area of Forest Reserves by Region

Region	Forest Reserve		%	Area of Region	Ratio
	No	Area (ha)		x 000 ha	%
North	17	189,234	26.4	26,900	0.70
Central	23	235,541	32.9	31,800	0.74
South	29	291,619	40.7	35,600	0.82
Total	69	716,394	100.0	943,000	0.75

Source: Registry of Forest Reserves in Malawi (FD, 1993)

In addition, GOM established 4 Wildlife Reserves and 5 National Parks for conservation of nature.

(c) Forest Conditions[14]

1) Forestry survey

Forest conditions were surveyed by following measures

- Survey of woodlots owned by individual farmer[15]
- Aerial Photo Survey
- VF, LAP and Forest Reserve Survey

Woodlot survey was undertaken in randomly selected 42 plots covering 600 ha. In each plot, standing trees were measured with such variables as height, dbh, specie, age, canopy, planting pattern, vigor, and stand management. Computation of volume and yield therefrom was followed. Forestry survey was conducted at 12 points[16] and found stands, tree age, yields, rotation and volumes.

[14] Forestry survey was provided outside the SA for findings a possibility of afforestation that can not be difficult to obtain through survey inside the SA

[15] See Annex Forestry 6: Summary of agroforestry and woodlot survey、and 7: Survey point

[16] See Annex B- 5: Summary of forestry survey and B-7: Survey point

2) Specie, tree height, age, volume and yield

Species

The woodlot survey in the SA found that tree species varied between the semi-arid northwest area and humid east and south of the SA. The following planted and natural tree species were found during the survey.

- Eucalyptus camadulensis at E zone of semi-arid area of Shire river side
- Eucalyptus saligna and E. grandis at C and E zone of relatively humid area over 900 mm annum rain fall located east and south area of the SA
- Pinus Patura, P. Kesya, Cypress at Chigumula FR[17]
- Miombo forest under monitoring by BCFP comprise following species at Mirale and Lirangwe: Brachystegia floribunda, Pterocarpus angolensis, Dalbergia melanoxylon, Colophospermum mopane, Buttadavya nyasica and Khaya antotheca
- pure Eucalyptus forest by: Eucalyptus camadulensis, E. tereticornis and E. urophylla (in VF)

D.B.H., height, tree ages, etc.

Most of the trees of VF and LAP were planted 6 years ago or earlier and it appears that there has been no later planting since then. Hence, the trees appeared to have very limited variation in age. Most of the sampled trees had quite small diameter. Weighted data indicated diameter of 5 cm and heights of 9 meters. In the VF where the forest site was handed over to the VNRMC or LAP has been made, most of the trees were harvested before reaching the planned harvesting rotation age of 8 years.

Most of trees are of even age. Clear felling of the seed trees and subsequent coppicing has resulted in even-aged structure. The trees are harvested quite young at below age of 6 years, the minimum period the coppices are supposed to grow to add on reasonable volume.

Stocking of various plantations was measured by counting stands in circular plots of 0.03 ha. On the whole, establishment was quite good despite the rocky poor sites on which these forests are located. Taking a spacing of 2.5x2.5 m as standard spacing for eucalyptus, one would expect 1600 standings per hectare. Weighted observed number of trees per ha were 803 or a stocking of 50%.

In some cases, growth estimation was derived from data given by the local forest officers who witnessed the first harvest, while in other cases, expert judgment was made based on the state of the plantations. On the whole, growth ranged from $2m^3$/ha/yr to $10m^3$/ha/yr for Eucalyptus plantation. Total annual yield from Eucalyptus plantations is $7,324m^3$, equivalent to a rotational yield of $58,593m^3$ assuming 8 years rotation. Based on the observed sizes and using tree volume equation with a form factor of 0.5, total current stand volume is 28,710 m^3 of the sampled eucalyptus plantations. This is about 49% of the expected rotation volume if trees were allowed to mature.

(d) Afforestation Activities

1) Species recommended by BCFP and FRIM

BCFP recommends *Acacia auriculformis* and *A. leptocarpa* for VF afforestation. FRIM recommends also the following species for in the SA through discussion with the Study Team.

[17] FRIM recommends *P. Kesya* because of its yields and tolerances to diseases than *P. Patura*

Table 2.36 FRIM Recommended Species for SA

Exotics	Indigenous	
Azadirachta indica	*Burttdavya nyasica*	*Tamarindus indica*
Senna siamea	*Milicia excelsa*	*Cordyla africana*
Gliricidia sepium	*Faidherbia albida*	*Kirkia acuminata*
Sesbania sesban	*Sterculia appendiculata*	*Acacia tortilis*
	Adansonia digitata	*Lannea stuhmanii*

2) Tree seeds production

Under FRIM, the Malawi Tree Seed Center is undertaking tree seed production and distribution for the afforestation activities throughout the country. The Center is also working for research, technology development, education and training on issues pertaining to tree seeds. According to the information obtained from the Center, demand for tree seeds in the country is increasing because of many activities in afforestation, watershed management, and AF projects supported by donors and the NGOs.

The Center is distributing tree seeds to almost all afforestation activities in the country in over 400 projects. During the period 1993~1999 total seed supply amounted over 30,000 kg to agents such as FD, research institutes, estate, etc (See Annex B- 9: Tree Seed Demand and Supply 1999 of the FRIM). For many years, there has been shortage of *Gliricidia sepium* and *S. siamea* seeds due to poor harvest from the their seed trees. Table 2.37 indicates demand versus supply over the six years.

Table 2.37 Demand and Supply of Tree Seeds (FRIM 1993~99)

Year	Demand (kg)	Supply (kg)	Deficit (kg)	No. of species
1993	383.502	383.502	0.00	49
94	2,317.659	1,794.879	522.78	68
95	4,922.037	3,008.706	1,913.331	83
96	3,692.581	3,379.330	313.251	68
97	4,235.335	4,231.835	3.5	71
98	18,792.170	10,593.960	8,198.203	88
99	3,938.512	3,885.842	52.67	57
Average	5,468.828	3,896.865	1,571.962	69
Total	38,281.796	27,278.054	11,003.735	-

3) Tree seedling

Three types of nurseries are currently producing tree seedlings in the SA. These are FD directly operated, VNRMC and private nurseries supported by FD and NGO. "Annex B-4: Summary of salient features of tree nurseries in the SA" summarizes list of nurseries in the SA (except TA Chitera and Chiradzulu district), capacity and actual seedling production, etc. The summary is based on the interviews with the FD officers in plantation forestry (South Region Office), forest extension officers, and the VNRMC who are supporting various tree nurseries in the SA. Though the total capacity of seedling production exceeds one million, current number of seedling production is estimated at around 270 thousands. VNRMCs are operating nurseries largely for commercial purposes whose outputs are mainly targeted towards public afforestation projects. Hence the nurseries are serving as a source of income generation to the farmers in SA. A small quantity of tree seedlings from these tree nurseries are used by framers for their individual homestead planting

FD nurseries produce seedlings mainly for plantation development and maintenance of indigenous forest in

the FR e.g. *Pinus. Patura, P. Keshya, Khaya Anthoteca, Brachystegia bohemi* etc. Other than those commercial activities, the nurseries raise Christmas tree, ornamental trees, etc. for commercial purpose. Eucalyptus seedlings account for almost 60% in the production at VNRMC nurseries[18] for MASAF, and BCFP projects etc.

FD is supporting VNRMC nurseries by technical and administrative support. It also supplies nursery seedling production materials like polyethylene pot. Seedlings are raised in polyethylene pot after transplanting from germination bed. Normally VNs, transferred after the establishment by FD, are fenced with screens made of dried Elephant Grass and partly covered with screen ceilings made of the same grass. Based on interviews and observations, seedling quality still needs to be improved and so does the survival rate after transplanting. Survival rate of the planted seedlings is estimated at less than 30 % on average after one year (with one dry season.)

4) Afforestation activities

The FD is promoting village level afforestation (mostly reforestation) activity through the formation of VNRMCs over customary land. Currently there are 59.70 ha of VF (including 15ha of indigenous forest at Chilangoma hill) (See Annex B-1: Summary of Forest Area by the TA of the SA). VNRMC afforestation activity is supported by FD and NGOs separately or jointly.

In the SA, there is only "Ndirande FR". The FR is located adjacent to the Blantyre City at uppermost stream of Lunzu River. The FR Office is responsible for afforestation, for plantation and water resources management activities, also poverty alleviation activity, drilling bore holes, etc as a package assistance. According to the FR Office, area of the FR covers 1,710ha, out of which, 1,018ha are under pine plantation while 692ha are covered with broad leaf trees. The forest is subject to severe population pressure. For example, inhabitants felled all the trees by 1995. After 1995, afforestation efforts have been struggling with almost equal pressure of residential cultivation and construction. Current vegetation cover of the FR ranges from 30-40% (500 - 700ha) but according to the District Forest officer, there are only 600 ha of forest remaining in the SA.

There are also private forests and estate forests. Farmer's plantation activities were started in 1980s through afforestation campaign by GOM for fuelwood production. Eucalyptus tree species were chosen for the plantation programme because of its rapid growth, excellent ability to coppice, and capacity to tolerate diseases and drought.

[18] Retail price of those seedling at range of 1-20MK by pot scale

Table 2.38 Area of Woodlots by TA (ha)

TA	Area of Woodlots / Grass land
1. Chigaru	635
2. Kuntaja	1,055
3. Kuntembwe	63
4. Kapeni	1,316
5. Lundu	63
6. Makata	393
7. Machinjiri	645
8. Chitera	384
9. Mpama	167
Total	4,722

5) Nursing

Most of VF is composed of pure Eucalyptus plantation and located on stony non-arable land. Low pace of growth with poor vigor is salient feature of these forests. Normal nursing activities e.g. weeding, pruning, thinning or cleaning cut, are not practiced even though they are essential maintenance work of the forests. Only forest patrol is understood as necessary forest management work. More frequent forest patrols are required against illegal cutting and intentional or accidental fire from hunting of small animals that is a common feature. This is however constrained by shortage of budgetary allocation.

FR has completed a preparation of necessary forest management plans for each forest reserve. In the meantime, actual forest management works are delegated to adjacent local people who enter the FR for fetching thatching grasses, lower branches, etc. Hence most of the activities are restricted to utilization while nursing duties have been mostly neglected over the last 15 years.

FD manages pine plantation on 25 year's rotation when trees attain height of 25m and 25 cm dbh. Forest patrol is also very important management activity with respect to FR. The FRs are also subject to the same population pressures as the VF especially during the night. More frequent patrol has also been requested.

6) Forest fires and prevention plan

FD is also engaged in prevention of forest fire, an important activity in forest development and management. Data of forest fires in the FR are gathered and analyzed mainly to determine the causes of such fires and prevention measures to take. Low frequency of forest patrol, and by implication less forest fire detection in early stages, was cited as main causes of forest fire. Chigumula FR Office has a plan for prevention of forest fires comprising patrol, fire extinguishing combat team, fire control equipment plan, firebreak line construction plan, monitoring tower construction plan, etc. Meanwhile forest fires have been destroying over 1,000 ha of forest area every year in relatively well-patrolled FR and also the VF. Record of forest fires of FR in the South region at 1989/99 is shown below.

Table 2.39 Forest Fires in FR in the South, 1998/99, FD

District	Name	Area burned (ha)	Species Affected
Blantyre	Bangwe	141.0	*E. cam*
	Chigwaja	8.0	*E.t.r*
Michiru	Michiru	11.0	*P. Kesiya*
	Mirale	2.5	*E. Saligna*
	Chigumula	50.6	*E. Microris, E. saligna, P. Kesiya, P. Patula*
Phalombe	Fortlister	87.6	*P. Kesiya*
Machinga	Nauko	100.6	*Eucalyptus*
Zomba	Chivunde	484.6	*P.patula, Cupresus*
	Ngondolo	52.7	*P. patula*
	Basin	51.3	*P. patula*
	Zos	129.5	*P. patula, P. ooc. P. tecum*
		1,118.84[19]	

Note: The data is not includes forest fires in the VF

(e) Forest Production

1) Forest reserve

The main products of FR are listed below. All incomes from the FR is credited to the national revenue except certain afforestation projects that allow appropriation of income for the project expenses.

Table 2.40 Revenue of Chigumula FR (1990/91)

Products		Unit	Unit Cost (MK)	Q'ty	Amount (MK)	Amount ($)
Fuelwood	Stacked	m^3	5.70	6,285	35,835.46	796.34
Fuelwood	Headload	Each	0.12	64,837	7,741.30	172.03
Poles	Sawn	m^3	48.24	296.001	14,280.44	317.34
Seedlings	Nursery	Each	0.22	38,762	8,353.12	185.62
Poles		Each	1.35	10,550	14,247.50	316.61
Christmas tree		Each	3.59	204	732.02	16.27
Bamboo		Each	0.12	890	109.96	2.44
Other		-		-	482.44	10.72
Sow dust		m^3		4.795	Domestic use	
Total					**81,782.24**	**1,817.37**

Area of FR	Ha	**622.00**
Planted area	Ha	**560.89**
Pinus kesiya	Ha	253.98
E. saligna	Ha	196.77
P. patura	Ha	76.43
Others	Ha	33.71

Notes 1 : Calculated unit cost

Notes 2 : Data is for 90/91 of 10 years ago estimated 10 % of current price.

Notes 3 : Balance is a area for indigenous forest, residential area, road, water body, etc.

[19] equivalent 0.4 % of 291,619ha total forest reserve area in the South Region

2) Hunting

Wildlife poaching takes place in all types of forests, namely FR, VF and LAP. People use dogs, traps, fires to catch rats, rabbits, snakes, deer, etc. Forestry contribution in bush meat was not reflected in the result of SEBS.

3) Forest utilization as fuelwood and others

The main sources of fuelwood are woodlots/grass lands, farmland, fallow land, and partly from the FR. The fuel types are tree leaves, stems, branches, thinning and pruning products from forest management, agricultural residues, and grasses, etc. According to SEBS, 5.6 % of households are involved in fuelwood and charcoal production as a commercial undertaking. Fuelwood in the SA is generally self-supplied. See Table 2.41

Table 2.41 Households with Available Fuelwood Sources

Forest	No of Household	% (multiple)
Forest in the Customary land	23	28.2
Customary land	13	16.7
Individual woodlot	39	50.0
Others	4	5.1
No answer	84	Missing
Total	162	100.0

SEBS also surveyed utilization of forest resources other than fuelwood (see Table 2.42*)*. The responses did not include self-use products such as fuelwood.

Table 2.42 Main Forest Benefits

Benefit	No of Household	% (multiple)
Poles	62	38.3
Apiary	1	0.6
Collect medicine	31	19.1
Hunting	4	2.5
Collection of grasses (Elephant Grass)	9	5.6
Collection of fuelwood for sale	5	3.1
Harvest fruits	1	0.6
Others	6	3.7
No answers	43	26.5
	162	100

Currently, forest value for local people as source of commercial fuelwood still remains low. It is expected that fuelwood will become a more important source of income to the farmers in the SA after implementing proper land distribution and development in near future. For commercial purposes, forest yields should be raised to surpass their consumption as a first step. The SA has a comparative advantage in commercial fuelwood production area than the nearby Mwanza district.

(f) Fuelwood Demand and Supply

1) Fuelwood demand

Fuelwood demand is based on the results of forestry and AF survey[20]. SEBS noted that 86 % of households consumes wood for domestic energy and the average collecting time is three hours per week[21]. Households of the SA do not recognize the fuelwood collection or wood itself as a serious problem.

On the other hands, MEM survey reported that volume of annual consumption of fuelwood are 0.439 m^3/349kg and 464 m^3 / 369kg at Zomba City and Blantyre City, respectively. Table 2.43 gives estimation of fuelwood demand by TA based on the consumption rate in Zomba City.

Table 2.43 Estimation of Fuelwood Demand by TA

TA	Population		Consumption (m^3/yr/prs.)	Demand in m^3/yr	
	(1996)	(2006) projected		(1998)	(2006) projected
Chigaru	14,044	16,455	0.43	6,039	7,076
Kuntaja	24,378	28,563	0.43	10,483	12,282
Kuntembwe	2,892	3,388	0.43	1,244	1,457
Kapeni	72,365	84,787	0.43	31,117	36,458
Lundu	3,774	4,422	0.43	1,623	1,901
Makata	12,902	15,117	0.43	5,548	6,500
Machinjiri	45,104	52,847	0.43	19,395	22,724
Chitera	12,965	15,191	0.43	5,575	6,532
Mpama	7,925	9,285	0.43	3,408	3,993
Total	196,349	230,054		84,430	98,923

Notes 1:Demand 349kg/year (Zomba: Urban Household Energy Demand Side Strategy, 1996), includes all home energy e.g. Cooking, heating, and for home industries, poles, etc.

Notes 2:Conversion rate: 1 t = 1.26 m^3 (Eucalyptus)

Estimation of fuelwood demand by the Study was based on the consumption rate in Zomba City, or 0.43 m^3 per annum/person[22]. This figure refers to the standard for urban area. The SA is located in rural area and it is assumed that fuelwood consumption is less than in the urban area. The difference between fuelwood consumption as per the SEBS and that estimated by MEM survey can be attributed to the difference in consumption rates between urban and rural areas.

Result of accumulated data shows that only 26% of households can supply enough fuelwood, though SEBLS founds that almost all households were self-sufficient in fuelwood supply and consumption. The households are self-sufficient because of widespread poverty that does not allow even minimum supply of food requirements. Therefore, the estimation of household fuelwood consumption and demand need to be modified considerably, bearing in mind that there has been acute shortage of various types of foods to be cooked.

Namely, the Villagers are not feeling shortage of fuelwood in real life. In case if their food availability are improved, starvation from December to February in every year will be reduced and their fuelwood demand will be increased by 10% - 20%. Although there is a potential for reducing fuelwood consumption to half

[20] Annex Forestry 6 shows survey point
[21] 12 % of respondent answered as compost and 2 % are charcoal
[22] Source: Urban Energy Survey Demand Strategy, Ministry of Energy and Mining, Mar. 1996

through introduction of improved fire-place, it is anticipated at this moment that if they demand more fuelwood, the forest will be under the strong pressure of destruction by overcutting of trees. In consideration of fuelwood demand ratio of Zomba City where the demand is stable is adopted as a target for this research.

2) Fuelwood supply

Volume of fuelwood supply is estimated by summation of yields from FR, VF, woodlot / grass land, cultivation land and fallow. The estimates are provided by the following tables: Table 2.44, Area of Fuelwood Sources by TA, Table 2.45, Yield of Fuelwood Source by TA and Table 2.46 Estimated Volume of Capable Fuelwood Supply.

Volume of fuelwood from cultivation land is estimated as 2 ton of crop residue from maize, pigeon pea, stover and cob, etc. The supplemental energy type is light and its specific gravity is estimated as 0.4 by the time of their consumption as home energy. Thus, yield of fuelwood source from cultivated land is equivalent to 60 % of the woodlot/grass land production. Volume of fuelwood production at fallow is 0.38 m^3/ha/year based on a calculation from 1 ton of grass per hectare and branches and 0.3 of specific gravity.

Table 2.44 Area of Fuelwood Sources by TA (ha)

	TA	FR	VF	Woodlot/Grass land[1]	Cultivation land	Fallow[2]
1	Chigaru	0	27.00	348	2887	825
2	Kuntaja	0	39	463	4797	1565
3	Kuntembwe	0	0	46	288	82
4	Kapeni	0	0	1,828	5979	2344
5	Lundu	0	7	58	287	70
6	Makata	0	32	316	1786	1157
7	Machinjiri	600	38	684	4412	615
8	Chitera	0	0	547	3528	362
9	Mpama	0	0	210	1536	260
	Total	600	143	4,500	25,500	7,280

Note 1: Comprising woodlots (38.8% of canopy coverage) and grass land

Note 2: Fallow area varies by year depend on cropping condition (means figures)

Note 3: VF includes LAP.

Table 2.45 Yield of Fuelwood Source by TA (m^3/ha/year)

	TA	FR	VF	Woodlot/Grass land[1]	Cultivation land	Fallow[2]
1	Chigaru	4.40	3.18	1.20	0.72	0.48
2	Kuntaja	"	2.65	0.96	0.57	0.38
3	Kuntembwe	"	3.75	1.18	0.71	0.47
4	Kapeni	"	2.65	0.23	0.14	0.09
5	Lundu	"	2.65	2.86	1.71	1.14
6	Makata	"	3.75	1.59	0.96	0.64
7	Machinjiri	"	3.51	0.55	0.33	0.22
8	Chitera	"	4.40	0.29	0.17	0.11
9	Mpama	"	3.51	0.65	0.39	0.26
	Average	4.40	3.01	0.95	0.57	0.38

Note 1: FR, VF and woodlot/grassland yield was calculated based on the field survey result.

Note 2: Supplies of fuelwood from FR are weeds, lower story branch, thinned wood through management activity

Table 2.46 shows a estimation of possible fuelwood supply by TA based on the yield.

Table 2.46 Estimated Volume of Capable Fuelwood Supply (m^3/year)

	TA	FR	VF	Woodlot/Grass land[1]	Cultivation land	Fallow[2]	Total
1	Chigaru	0	86	418	2,079	396	2,978
2	Kuntaja	0	103	444	2,734	595	3,877
3	Kuntembwe	0	0	54	204	39	297
4	Kapeni	0	0	420	837	211	1,468
5	Lundu	0	19	166	491	80	755
6	Makata	0	120	502	1,715	740	3,077
7	Machinjiri	2,640	133	376	1,456	135	4,741
8	Chitera	0	0	159	600	40	798
9	Mpama	0	0	137	599	68	803
	Total	2,640	461	2,676	10,715	2,303	18,795

3) Balance of fuelwood demand and supply

Following are estimates of fuelwood demand and supply by TA for current (based on a population of 1998) and year 2006 (based on population growth). TA Kapeni is in the worst condition of 4% while TA Makata records 47% in the high self supply.

Table 2.47 Fuelwood Demand and Supply (m^3/TA/year)

	TA	Rate of self-supply (2006) proj.	Volume of Supply (1998)	Volume of Demand		Deficit	
				(1998)	(2006)proj.	(1998)	(2006) proj.
1	Chigaru	42%	2,978	6,039	7,076	-3,061	-4,098
2	Kuntaja	32%	3,877	10,483	12,282	-6,606	-8,405
3	Kuntembwe	20%	297	1,244	1,457	-947	-1,160
4	Kapeni	4%	1,468	31,117	36,458	-29,649	-34,990
5	Lundu	40%	755	1,623	1,901	-868	-1,146
6	Makata	47%	3,077	5,548	6,500	-2,471	-3,423
7	Machinjiri	21%	4,741	19,395	22,724	-14,654	-17,983
8	Chitera	12%	798	5,575	6,532	-4,777	-5,734
9	Mpama	20%	803	3,408	3,993	-2,605	-3,190
	Total	26%	18,795	84,430	98,923	-65,635	-80,128

2.7 Livelihood Improvement, Education and Extension

(a) Livelihood Improvement

Present condition

In the SA, there are many kinds of activities for livelihood improvement as income generating activities (IGAs). Livelihood improvement, including all human activities, may be classified as that of primary industry such as agriculture, livestock and fisheries. Those activities are conducted by various funds. Supplied from MAI, MCI, MOWYCS and international or local NGOs to farmers or small scale private enterprises.

Three EPAs, located in Lirangwe, Ntonda and Mombedzi, render extension service under the MAI, covering the SA with FAs, mostly graduates of technical school. Commanding areas of EPAs are divided into sections while each FA is stationed in each section to provide farmers with agricultural techniques, to instruct how to

establish the groups or how to obtain a loan. Thus, MAI is the most closely and actively linked to the farmers' activities than any other agencies. Income generating activities supported by MAI consist of rearing of chicken, cows, goats, planting vegetables and others in the field of primary industry. It has orgnized block areas where an FA instructs and guides all farmers. While MAI supports farmers to establish a group with 10 to 25 farmers, to transfer techniques and whenever necessity arises orients them on how to obtain a loan from MRFC that was rearranged into a parastatal of MAI from three years ago. See Table 2.48

Table 2.48 Present Income Generating Activities Supported by EPA unit: number

EPA	Lirangwe	Ntonda	Mombezi	Total
1. Chicken Rearing Club	2	-	1	3
2. Milk Bulking Group	2	-	2	4
3. Vegetable Club	19	1	7	27
4. Goat Rearing Club	4	-	6	10
5. Seed Multiplication Club	9	5	7	21
6. Mixed Ordinary Club	194	10	99	303

Source: EPA Lirangwe, EPA Ntonda and EPA Mombezi

Group activities in the SA are, in general, more oriented to the sale of farm produce rather than to collective production except rearing of cow. It may be considered easy to control a group activity when they cooperate to use their land. However, it seems difficult when the quality and volume of products from their own land cannot be measured with the designated standards. This is because individual production at his disposal is far easier than joint production where conflicts with other members more often take place. Sizable chicken or cows has been kept near the city of Blantyre / Limbe and has become popular, though there are some problems and constraints such as thefts, lack of marketing facilities and poor access to loan. Vegetable production needs water sources that are limited in the SA, but it has also been expanded step by step using the limited water sources by means of treadle pumps introduced by ADD under MAI. Producing seed of ground nuts and rooted cuttings of sweet potatoes is conducted as IGAs and has become popular. IGAs supported by EPA started in 1994 and 1995/96, still continuing up till now. Funds may be essential for farmers to start IGAs, for which MRFC under MAI has been providing loans though the amount is limited. See Table 2.49

Table 2.49 Loans supplied by Government through MRFC (whole country)

Type	Year of commencement	Clients	Terms	Interest rate	Admin. Fees
1. Mudzi Business Loan (10-25 members groups)	1995/95	7,093	6-18 months	52%	1.5%
2. Mudzi Seasonal Loan (20 members group)	1995/96	25,455	one season	52%	1.0%
3. Collateralised Business Loan	1994	11,000	1-36 months	52%	1.5%
4. Collateralised Agricultural Loan	1994	160,000	one season	52%	1.0%

Source: Project Document by Microfinance Task Force for the Government of Malawi, December 1998

MRFC's loan activities in whole country are shown in Table 2.49, where MRFC in EPA Lirangwe covers majority of the SA. This EPA covers approximately 72% of the SA by the number of farm families. MRFC supplied loans to 6 small groups, 4 large groups, 54 clubs, 4 estates and 4 individual farmers in the SA. Maximum loan amount granted per person is MK8,000 for small group and gross loan amount reached MK1.5 million in 1999. This amount is too little compared to the number of farm families, implying that the loan activities are not expanded enough to meet overall demand. Offices of MRFC are located in each EPA, however, they are too far, their accessibility is too poor, interest is too high and their productions are too unstable on account for erratic climate changes for majority of farmers to borrow the loans.

Table 2.50 Present Income Generating Activities by Women Club Supported by MOWYCS

unit: number

	Chigaru Kuntaja Kunthembwe	Kapeni Lundu Makata	Machinji Chitera Mpama	Total
1. Soap Manufacturing	-	3	2	5
2. Bakery	3	4	7	14
3. Sisal Bags Weaving	1	3	1	5
4. Mat Making	1	1	-	2
5. Pottery Making	-	-	2	2
6. Furniture (cushion, chair) Making	-	-	3	3

Source: Blantyre District Office, MOWYCS

These activities by MOWYCS have so far been less fruitful than those by MAI because of limited funds and insufficient training period to farmers by CDAs who mostly are not residents in the responsible sections but only stay in and around Blantyre and Limbe.

Other funding agencies, such as Parastatals under the MCI, NGO, etc. provide loans to farmers as well as to small scale and medium scale enterprises.

Table 2.51 Loans supplied by Other Financing Sources

Supplier/Type	Started Year	Clients	Terms	Interest rate	Admin. Fees
1. MOWYCS/PHN	End. 1997	-	9 months	54%	-
2. SEDOM/Youth Credit Fund	Nov. 1997	6,000	12 months	15%	-
3. SEDOM/Microfinance Scheme	Early 1998	1,500	6-18 months	30%	3.5%
4. SEDOM/Individual Loan	1991	4,000	12 months	47%	3.5%
5. FINCA/Village Banking	1994	-	16 weeks	48%	2.0%
6.World Vision/Solidarity Group Approach	1997	2,170	6 months	54%	-
7. NABW/Solidarity Group Approach	1997	1,200	12 months	40%	-

FINCA, one of NGOs, extends a loan and transfers accounting skill for mainly women's groups in and near the Blantyre, where the number of coverage reached 267 groups in 1999. Activities have increased under the concrete instructions every week and repayment rate may be 100%. However, if a member cannot amortize due to sickness or by an emergency accident, he should retire from the group and his loan should be repaid collectively by the group. Hence, it is hard for a member who failed to amortize to resume the activities. Loans supplied by international NGOs, with shorter terms than others, give advantage to medium sized enterprises rather than individual farmers.

On the other hand, in TA Machinjiri, located near Blantyre and Limbe, in between the two out of three main roads in the SA, chicken / layer rearing, cabbage raising, onion production, bakery, etc. are conducted by groups. In TA Chitera and TA Mpama near the highhway running from Blantyre to Zomba, buying and sellling tomatoes and clothes, production of cuttings (scion) of sweet potatoes and chicken, milk cow or goat rearing are carried out. In TA Kapeni along the main road from Blantyre to Lilongwe, seed production of groundnut, manufacturing of soap, mat and furniture, preparation of snack have become popular. Distant from the main road, basket weaving and woodcarving are run in some places. In TA Kapeni located in the center of the SA and in northern part of TA Lunzu outside of the SA, apiary activities have been introduced. Inhabitants are engaged in chicken and livestock husbandry all over in the SA. Fruit tree growing is rare, but in TA Lunzu and TA Kapeni mango fruit growing are found in some spots. Banana trees used for protection of soil erosion are found in some places though very rare. There are 22 farm ponds in the SA, some of which store enough water, where fishery activities are tried but aquaculture is not so far introduced. Fishery department has been surveying the growth conditions of fingerling for fishery activities in three of the ponds. Other IGAs are brick making for housing and making pots and bowls, observed in some places in the SA.

According to the results of socio-economic survey, access to the different facilities is essential for farmers to sustain daily life. The distance they have to cover is long, 1.6km to deep well, 4.6km to transportation and 3.0km to maize mill, implying that access is not easy to them. However, number of deep wells and maize mills is increased year by year owing to supports of government and NGOs thus reducing considerably the travel distance.

From the fuel supply point of view the following gives overall current status. In whole country, petrol, electricity and coal are used, but firewood constitutes by far most important and popular fuel, accounting for 93% of the total state fuel consumption. In Blantire City, located adjacent to the SA, charcoal is principally used by the majority of the citizens along with firewood, briquette, gas and electricity. Table 2.52 gives daily fuel cost per household as of 1998.

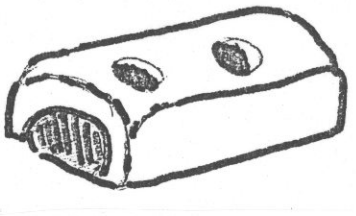
Table 2.52 Daily Fuel Consumption per Household in Blantyre City

Kind of fuel	daily expense per household (MK)	remarks (quantity etc.)
Firewood	9	0.4 headload per day (20kg = 1 headload)
Charcoal	13	MK 100 / bag, 4 bags / month
Briquette	20	MK 2 / briquette cake, 10 cakes / day
Elecctricity	13	MK 400 / month, (540 KWh)

Source: Malawi Industrial Research and Technology Development Center

On the other hand, local population in the SA relies mainly on firewood and crop residue, available around homestead, while they seldom consume expensive charcoal at home but offer it for sale. Since many households cannot afford to buy ceramic stoves exclusively provided for charcoal, around 86 % of the households in the SA use only fuelwood. According to SEBS, women (labor source for housewives and girls) are responsible for firewood collection in about 83 % of the households surveyed.

Efficient use of firewood is acutely needed, considering dwindling supply thereof and accompanying environmental degradation as well as ever-increasing chores by women. Currrently, majority of the households in the SA have been using traditional fireplace with three pieces of stone (mafwa). Mud-molded fireplace and improved stove for charcoal have been already tried and found to be more fuel efficient.



improved earth molded fireplace

Some CDA tried to instruct local people how to prepare an improved fireplace molded from earth taken from termite mounds and clay in and around the SA, but only few of them still continue to use this type. Reluctance of using the improved one may stem from the fact that this fireplace has lower position to feed firewood, the size of ceiling holes is too small to put cook pots and pans, eventually evolving too much smoke from firewood.

There is a women's group in TA Kunthembwe that manufactures ceramic stoves for charcoal. However, they are sold to urban clients consuming charcoal while the members of the group themselves still use traditional one, because they don't need to use charcoal but ample, free firewood is readily available to them.

improved stove for charcoal

Also there exists a village where manufacture of briquette was instructed by an NGO in TA Chigaru. However, this activity has been ceased on account of difficulty in procuring such materials as scrap paper (see Chapter 5 Alternative Energy Sources). The following are a summary of problems on livelihood improvement.

summary of problems on livelihood improvement.

Problems of agriculture

Agriculture is the mainstay and almost all families are engaged in it and agriculture-based activities. However, many problems and constraints are found in and around them as follows:

1) Cultivated area is 0.5 to 0.7ha per farm family, and most farm families cannot secure enough production of even the main staple, grain maize from their own farm.

2) Yield is very low because of soil degradation and lack of plant nutrition as a result of poor soil management and overcutting in and around the area.

3) Farmers can only cultivate once a year because of lack of water resources, poor irrigation development and rain-fed farming. Rainfall dramatically varies from month to month and year to year, so yield is also far from stable.

4) Input materials such as seeds and fertilizers are very expensive. Their current prices have reached more than ten times as much as those five years ago due to removal of government subsidy and rapid devaluation of currency.

5) Number of Farm Assistant (FA) is fewer compared to that of some sections in the EPA, to provide enough training and technology transfers.

Problems of livestock

Livestock is one of key sectors for livelihood improvement. Livestock species include cattle, goat, sheet, pig, chicken, guinea fowl and other animals and birds as well as layers. Problems and constraints of animal husbandry are as enumerated below:

1) There are many thieves who rob livestock in the SA. Burglars with shotguns hang around targeting at cattle, especially,

2) It is hard to feed livestock because of limited pasture. As feeds from grain mills are very expensive, individual, small holding farmers cannot afford to feed them.

3) Young birds / fowls are susceptible to contagious diseases. Usually farmers do not apply vaccines because of lack of access to them.

Problems of bee keeping

1) Traditional bee keeping does not give satisfactory honey yield because of insufficient comb space. Farmers do not have experiences to provide modern beehives.

2) Logs for preparing traditional beehives are not available any more because large trees have already been depleted in the SA.

3) FAs of EPA do not have enough experience / to train farmers in modern bee-keeping techniques.

4) Flower sources for nectar are limited because of lack of forest, woodland and vegetation.

Problems of home industries

1) Markets and marketing routes are not definitely fixed and demands are limited.

2) There are many competing manufacturers of merchandises as basket, mat and furniture in every two to three villages. There are many competitors.

3) For briquette making, such raw materials as waste paper and saw-dust become more expensive and scarce as they must be transported from distant places such as Blantyre or Limbe.

4) Cooking stove developed for briquette has too narrow inlet for farmers to use. Top plate between the holes is too fragile, and often broken down.

Problems of trading business (small scale enterprise)

1) There are many similar entrepreneurs in the SA. In some area, villagers are competing with each other.

2) Business activities are limited to such as buying and selling of tomatoes, vegetables and bananas.

Problems of inland fishery

1) Water resources are too limited for development of sizable aquaculture.

2) Almost all rivers and streams are torrential during rainy season while they are dried up in dry season.

3) It is difficult to construct dams and weirs in the basins because farm size is small and most of dam-sites have already been cultivated.

4) Fishery activities are not currently operating in the area nor is there any extension worker.

Problems of microfinance

1) MAI provides farmers with low interest (5%) package loan of input materials (10kg hybrid maize seed, 50kg urea, 50kg fertilizer) as APIP programme. However, loan amount is limited and said programme will expire this year after completing 3-year term.

2) Loan through MRFC has with high interest rate (52%).

3) Loans by other Government or NGOs also require repayment with high interest. Amortizing period falls too short that farmers hesitate to borrow.

(b) Education and Extension

1) School education

The people are so absorbed in gaining their livelihood that they face environment issues with little concern to food supply or income generation. On the other hand, pupils spend at least some hours at school on weekdays. So, it must be effective to penetrate important message through school lesson. In addition, pupils can play a role of the messenger after school to their playmates that fail to attend school lessons through play and to their family members through daily conversation. Considering the impact on environment in the future when children are grown up and become parents, children's education is important.

The Government of Malawi took the step of introducing free primary education as a key strategy in its poverty alleviation program in the country. In 1994, the Government under new presidency of Muluzi implemented Free Primary Education (FPE); abolished school fees at all levels of primary school to give every child access to education. It helped to increase enrolment of primary school for both boys and girls. Net enrolment (total number of primary school pupils aged 6-13 years old divided by total population aged

6-13 years and multiplied by 100) in 1993/94 was 64% (boy 62%, girl 65%) in Chiradzulu district. It also reached 76% (boy 77%, girl 76%) in Blantyre Rural, while it attained almost 100% in Chiradzulu district and 88.3% (boy 88.1%, girl 88.4%) in Blantyre Rural in 1994/95.

On the other hand, many problems came up because of the sudden increment of enrolment. In order to meet the demand for more teachers to accommodate the children, about 20,000 untrained new teachers were recruited in whole Malawi. Teaching ability is one of the big problems. Another problem arises from lack of facilities and materials such as classroom, desk, chair, textbook and school itself. Even though school enrolment increased sharply, drop outs and absentee students were many. In Blantyre Rural, about 10 % of boy and girl students dropped out from primary school in 1998. Main reasons for these are 1) early marriage and pregnancy, 2) to help parent in the daily chore, 3) to attend cultural event and 4) poverty. It can be said that some parents are still not giving importance to their children's education. Since the SA is close to big markets, many parents are commercial or business-minded at the expense of their children's education.

Concerning environmental education, some messages are included in General Study, Agriculture, Science and other subjects. However, these do not currently appeal to the population. Blantyre Rural District Office is considering to reform curriculum to provide more environmental education. Some schools have Wildlife Club supported by an NGO, Wildlife Society of Malawi, which provided an extra-curricular activity to appeal how important nature and planting trees are.

In general, it can be said that educational condition needs to be improved, and environmental education has so far not yet been actively introduced nor accepted.

Forestry extension

There exist eight Area Control Units (ACUs) in the SA. Unlike the agriculture extension system, there is no office at ACU level, but only district offices in Blantyre and Chiradzulu. Each ACU has one Forestry Assistant, some of Forestry Guards and Patrol Staff.

The ACU staff used to act as a policeman; patrol in and around forests and keep the people away from it. Policy on forestry management has changed in 1997 and those who managed forestry were shifted from government to community. As a result of policy alteration, forestry staff has now become extension workers even though there are only eight staff who had enough technical training, while others do not have enough knowledge to help farmers. In recent years, they began to attend training course to learn participatory approach as well as the technical matters depending on the financial availability and projects supported by foreign donor agencies and NGOs.

Based on the new policy of co-management of forestry, DF is trying to organize Village Natural Resource Management Committee (VNRMC) at every village. It is indispensable to provide awareness creation, gender training, leadership training, etc. before and after the formation of committee with frequent visits to strengthen the community and to keep the committee active. In most cases, however, only a brief explanation is provided before the election of committee members and not many villages are visited by field staff quite often. As a result, their activities still remain inert.

Many farmers have the intentions of starting AF practices but they have problems on accessibility of saplings and husbandry knowledge. They do not have access yet to field staff.

Major problems are 1) insufficiency of staff, 2) quality of field staff, especially forest guard and patrolmen, does not still meet the service to be performed, 3) no means of transportation and 4) not enough fund to provide farmers with training.

Agriculture extension

Agricultural extension work in the SA has been served mostly by Extension Project Area (EPA) under Agricultural Development Division (ADD). Though demarcation of EPA was reformed in November 1999,

arrangement of Field Assistant (FA) has not been changed and some of the office buildings have not yet been prepared. The actual function still remains as is.

The SA has three EPAs (four EPAs under new system) namely Lirangwe, Ntonda and Mombezi. Each EPA has a Development Officer, an Assistant Development Officer, and as extension staff, Field Assistant (FA), Farm Home Assistant (FHA), Veterinary Assistant, Land Husbandry Assistant and Irrigation Assistant. EPA consists of some sections where an FA is assigned to each section. It is sub-divided into eight blocks where FA is supposed to visit each block at least twice a month.

In reality, however, many FAs are not able to fulfill their duties. The number of FA is decreasing because of death, retirement without assignment to fill up vacancy, therefore one FA has to cover more than one section. FAs do not have transportation means other than bicycle or on foot. Most of FAs purchased bicycle from the Ministry with low interest, but due to bad condition of road network, they can not cover all of their service areas.

Each block is supposed to have demonstration garden where extension activities are deployed mobilizing farmers in the block. Block committee is organized in half of the blocks in SA to help coordinating group meeting and diffuse techniques and information to neighboring farmers. However, not many farmers are interested to join.

Farm size is so small that demonstration garden tends to shift year by year depending on the land offered of voluntarily by individual farmer. Other than visiting demonstration garden, FA also visits individual farmers who need help, and clubs or women's groups to support them. Since any club is organized with the members of the same interest, it is an easier forum for FA to perform their service. In SEBS, only 11% of farmers answered that they learn farming techniques from FAs, and others are from parents (55.3%) and their own experience (31.1%).

Each EPA has a training room for FAs and farmers are to attend training courses. There is one Residential Training Center, but due to limited budget and new policy of the block-based extension, training course for farmers are hardly provided in recent years, though it can provide the course for office staff.

SEBS also indicated that 42 % of male-headed and 12 % of female-headed household are interested in introducing AF. Even they had no opportunity of starting AF, 69 % of them replied that lack of knowledge is the reason. Although farmers have keen interest in AF, it has not yet spread to many of the farmers due to insufficient extension service. FAs have fortnight training and meeting twice a month at EPA office, but they hardly have a chance to learn AF technigues there.

Major problems on agricultural extension are 1) number of field staff is not enough, 2) mobility of field staff is limited, 3) knowledge (especially about AF) of field staff is limited and 4) farmers' willingness to learn and apply new technology is not strong.

Community development

In addition to above agriculture and forestry extension staff, the SA has Community Development Assistant (CDA). Their activities cover various matters such as construction of school or bridge, adult literacy education, income generating activities, etc. and their ultimate aim is to improve community life by implementing projects through organizing and mobilizing community. They all finished a two-year course at Community Development Training College, and are assigned to each area. Even though more CDAs are required, the course opens only when fund is available from donor agencies. On the other hand, experienced staff is often pulled out by NGOs that provide him/her with more favorable employment condition. Responding to many CDAs willingness to improve their skills, refresher course will be held in the future, but the planned accommodating number is too limited to meet the demand.

Since the SA is close to Blantyre City, many of CDAs are wives of office workers in the city. Therefore, different from other areas, most CDAs are female who live outside of the SA (only four CDAs are based

within the target area in Blantyre district). However, transportation fee is not provided from the government, and most of them visit their service field only once or twice a week using mini bus, otherwise stay at the office and writing reports on their field work.

Illiteracy rate remains as high as about 40 % and Adult Literacy Class is organized by CDA. Besides literacy skill, students learn such subjects as agriculture, livestock, arithmetic, sanitation, nutrition, etc. as described in their textbooks. However, most of the participants are women because men are shy to attend the class and their dropping out rate is high (more than half) because many participants are busy doing their work. In spite of high demand for starting new classes in many villages, number of the class has now barely reached 80.

Major problems on community development stem from 1) insufficiency of staff, 2) knowledge of CDAs is limited and 3) mobility of staff is limited.

NGOs' activities

Because of limited financial and human resources available in the governmental agencies, NGOs in Malawi are acting that vital role in development activities in many places including the SA. Major NGOs extending activities in the SA are World Vision International, Concern Universal, FINCA and Wildlife Society of Malawi. NGOs and governmental agencies have been cooperating and ask for mutual assistance depending upon their needs. Since government experience in participatory approach to mobilize community is also limited, they often request NGO staff to provide training on the capacity building of community. They also help in terms of capacity building of governmental staff by providing training on gender issue, PRA, leadership, etc. On the other hand, NGOs are also asked for technical assistance from governmental staff. When a NGO conducts a training course on agriculture or forestry, an FA or forestry assistant is invited to provide lectures.

Some of them have been doing successfully by involving community from the first step of project formation and providing intensive training to community and committee members prior to and in the course of the project implementation to strengthen them. Therefore, the community can proceed forward even after the taking off from NGO. On the other hand, some NGOs have problems as to sustainability of the project. Some development in the community could be seen during the servicing period by an NGO. However, once it leaves from the community what has been created return back to the old style since no further financial support is available.

Some NGOs and foreign donor agencies have been offering allowance to the community members involved in their projects. This may lead to a negative outcome, for it makes difficult to let them later involve in another project, asking for their contribution without providing any allowances.

2.8 Lessons learned from Similar Projects

(a) Similar Projects

Apparently, there are quite a number of donors supporting a broad range of area in reforestation, soil conservation, watershed management for environment conservation, etc. Following are summary of the lessons learned through the survey of these projects.

(b) Poverty Alleviation

Similar projects in the country have been designed with local people participation as the key component of such projects. However, analysis of these projects indicates that poverty of the local people has indeed hampered progress of such projects. In particular, people in the SA experience severe hunger during pre-harvest period and this has led to suspension of project activities. Hence, the first step in a project is to cater for people's needs before anything else through various poverty alleviation projects accompanying with

bottom-up project activities.

(c) Necessity of Consideration in Delineation along Administrative Border

BCFP has experienced considerable delays in implementing some of their afforestation projects due to problems of coordinating different TAs. It is therefore necessary to confine projects within specific administrative boundary such as single TA, Group village, etc.

(d) Retaining Good Interrelationship between a Project Beneficiary and Adjacent Village or Villagers

The SA is the poorest area in Malawi where there is few infrastructure and all with limited accessibility. Project formation should be provided with careful consideration on the good relationship between projects beneficiaries and adjacent villages. To this end, project components suggested by the Study should be considered as a model that can be developed and maintained by villager's own efforts., and local people out of the beneficiary can follow the process achieved by the model project.

(e) FD Activity

According to the demarcation of duties among various Government Department, land acquisition for project execution is clearly the responsibility of FD. BCFP has however experienced that even this fundamental work has been delayed because of the FD constraints in budget and manpower. The Study should consider practical delineation of project area taking three factors into consideration: administrative boundary, project effectiveness in watershed rehabilitation and the FD capability.