INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

FUTURE HARVEST

EMMC

Farming in Tsetse Controlled Areas
Regional Component

Environmental Monitoring and Management Component

Project Number: 7.ACP.RP.R. 578

ANNUAL REPORT
(first year)

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Title of project: FITCA-EMMC

Project Number: 7.ACP.RP.R 578

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Summary

This report is covering the first year of activity of the project. The on-going activities implemented along this first period and the variations with the work-plan are reported in the first chapter of the report. Work-plan for the coming year is given at the end of this chapter.

The second chapter is devoted to the financial report

The strategy and tools, which are going to be applied for the monitoring and management of the environmental impact in the three countries, are developed and discussed in the last chapter of the document.

CHAPTER I: Progress of Work

A. **Purpose** – The project purpose is to increase the level of information and awareness of environmental change and increase the capacity to respond proactively to these changes among stakeholders in FITCA participating countries.

Objectively verifiable indicators of this purpose include the number of local, regional and international workshops held and the number of exchange visits between projects in the region.

B. **Objectives** - The overall objective is to increase the sustainability of natural resources and agricultural systems, through environmental monitoring and management, in participating FITCA countries.

The twin objectives of increasing productivity to improve human welfare and to sustain those gains over the long term are at the core of the objectives of the agricultural sector in each country.

C. **Implemented work:** according to the working plan, the detail of the implementation of the planned activities is described and given.

1.1 Major Achievements during the reporting period

i. ***Recruitment of the different permanent specialists***

The recruitment of the permanent specialists (regional ecologist, GIS specialist) was completed during the last term of 2001. Both of them have taken their respective position. From the first fieldwork, it appears obviously that the half time position for the ecologist will not permit, to achieve the different protocols needed by EMMC. A huge amount of contingency funds is available at the regional level; a small amount of it could be reassigned to EMMC for completing the permanent staff of EMMC.

The three community participation specialists (CPS's) are not yet recruited as far as their respective national institutions are still discussing the terms of the proposed contract (first draft version was submitted early July) KETRI is ready to sign the final version and is checking among its staff the potential candidate. Comments and replies are awaited from NARO (Uganda) and EARO (Ethiopia)

ii. ***Complete a rapid assessment of the environmentally sensitive areas within the project areas and select representative sites for detailed environmental monitoring***

This activity is under completion. Specific sites are identified in Western Kenya, Uganda and Ethiopia. Fieldwork on these different spots while start as far as local researchers and trainees will be available.

*iii. **Integrate environmental monitoring and management into FITCA national programmes***

Several seminars were held with FITCA national programmes. As the level of implementation of the 3 existing national components is hugely different in the three countries; the field work is starting in Western Kenya, hopefully will start during the last semester of 2002 in Uganda and monitoring documents will be prepared with the Ethiopian FITCA team

*iv. **Identify local capacity, capability and data for environmental monitoring***

At the regional, national and local levels, the database directory is under implementation.

*v. **Obtain remotely sensed imagery for all project areas, ground-truth images and create broad baseline databases to monitor environmental change (across FITCA control areas)***

This activity is on going; the preliminary field trip done with RSI experts shown a very complex landscape and land-use situation (Western Kenya and Uganda) The resolution of the current RSI available seems to be not enough accurate to take into account the highly fragmented rural area.
Some new tools are arising (very high resolution image), but their costs, their availability and the research inputs necessary to develop specific application for EMMC needs made these tools out of reach for EMMC.
EMMC team are considering some alternative techniques by (differential GPS mapping, participatory mapping...)

*vi. **Monitor changes in land-use and in environment in sensible areas***

The implementation of this activity is the key issue of this second year. This fieldwork within the more sensible areas of FITCA national programmes is going to involve FITCA-EMMC closely with communities. This is the focal point of all EMMC activities. Students will be mobilised on this monitoring.

*vii. **Stakeholder consultations***

As far as our CPS's are not yet recruited, unfortunately these consultations were not conducted. Specific meeting were held within our specific sensitive areas.

viii. Creation of information exchange network

A specific seminar was held in September at the regional coordination level, where it was recommended this information exchange network needed to be implemented and managed at the regional coordination office. Each component will provide information on its own activities.

ix. Development and dissemination of public awareness materials

See former comments on information exchange network

x. Report outputs of project activities to policy makers through OAU/IBAR

Regular meetings are held within OAU/IBAR to keep the RAO informed about the implication in terms of OAU/IBAR policy of FITCA components development.

xi. Conduct training needs assessment for project stakeholders

This assessment of needs aren't be finalized. EMMC will take the opportunities of FITCA national component seminar to carry out these courses.

xii. Training courses with national and local partners on environmental monitoring approaches and techniques

Due to late funding and the different implementation status of the FITCA country projects, training courses will be held in year 2.

xiii. Training field officers in the safe use and disposal of insecticides

These workshops are already planned and they will take place in April.

xiv. Identification of appropriate methods and ecological indicators to monitor NR in FITCA priority areas

Results from consultation and brainstorming with researchers will be published in the coming technical report. As soon as the CPS's will be available, consultations will be carried out with other stakeholders.

xv. Testing new adapted methodologies for environmental monitoring and management and developing appropriate environmental assessment guidelines for communities

There was no work under this activity in the first year.

CHAPTER II: FINANCIAL REPORT

	Budget Item	Description	Itemised Expense #	Time(m or d)		Costs/unit	TOTAL 1	TOTAL 2	Report 1+2
Fees									
A.1	ILRI Long Term Experts	Regional Ecologist		3	m	4750		14 250,00	14 250,00
A.2	ILRI Short Term TA			3	m	9700		29 100,00	29 100,00
A.4	Support Staff	Secretary		3	m	333	999,00	999,00	1 998,00
		Data Entry		3	m	333		999,00	999,00
		GIS /RS		6	m	1 131		6 786,00	6 786,00
	sub-total					**€**	**999**	**52 134,00**	**53 133,00**
Direct Costs									
B.2	Accomodation			6	m	1 500	9 000,00	9 000,00	18 000,00
B.3	Vehicle Costs - ILRI			6	m	1 700	10 200,00	10 200,00	20 400,00
B.4	Vehicle Costs - Co-ordination			6	m	850	5 100,00	5 100,00	10 200,00
B.5	Per Diem			22	d	95	2 565,00	2 090,00	4 655,00
	sub-total					**€**	**26 865**	**26 390,00**	**53 255,00**
Reimbursables									
C.1	Airtickets - D Bourzat	TA 6229	1	386			613,00	439,38	1 052,38
	Airtickets - J Maitima	TA6228	2	355				404,10	404,10
	Airtickets - J Maitima	TA6255	4	355				404,10	404,10
D.1	Procurement	Computer - econocom invoice	1					2 991,50	2 991,50
		Table - jacky's invoice	2					555,24	555,24
		CD Writer	3	406,34				462,54	462,54
		Garmin GPS 12XL andheld	4	1361,21				1 549,47	1 549,47
D.2	Field and Co-ordination Costs	Tel/Internet/E-mail	1				1 203,00	2 255,32	3 458,32
	Field and Co-ordination Costs	Stationary	2	747,3				1 705,98	1 705,98
	Field and Co-ordination Costs	Taxi, Phone and A.Tax - DB	3	444,74				506,25	506,25
	sub-total					**€**	**1 816,00**	**10 767,62**	**12 583,62**
Administrative Costs									
	ILRI Administrative Costs		5,70%				1 692,00	**5 089,62**	**6 781,62**
TOTAL						**€**	**31 372,00**	**94 381,24**	**125 753,24**

21. Budget analysis

i. ***Fees:*** The expenditures on this item reaches only 53 133,00 € on 166 617,00 € budgeted (32 %).
A.1 item (ILRI Long term experts) was engaged for only 3 months due to late arrival of funds and ILRI's recruitment procedures
A.2 negotiations of the term of the contract with NARs have not allowed to proceed recruitment of these local experts. Due to this postponed action, ILRI's STC are a little bit above the budget (3 months /4.5 months)
A.3 SEMG experts did 140 days short-term TA in February and March 30 more days had to be postponed to June. As the final reports were not yet completed by the end of the on-going AO, these STC will be paid under the second year of the Service contract.
A.4 same remarks as for A.1

ii. ***Direct costs:***
The different budget lines are used according to the work plan. As field activities are just beginning, the difference in between budgeted amount and realized one is due to lower vehicle costs and per-diems.

iii. ***Reimbursable:***
These budget lines are mainly dealing with field costs, training, procurement and travel costs. As it appears clearly in the table, the main expenses were engaged in the last 6 months of the project.
C.1 SEMG team air tickets have not yet be charged to ILRI
D.1 Technical equipments (differential GPS, RSI...) have to be defined with SEMG experts. The orders were launched last weeks.
D.2 Field costs are lower as expected for the reasons reported above.

iv. ***Conclusion***
The experience after one year of implementation of the FITCA-EMMC shows that the service contract will be better implemented if the balance between expertise and operating costs is modified in favour of the latter. For this reason an addendum was submitted to take into account the two following points:

- Delays in recruiting the different regional and national staff, allowed adjusting the true period of performance of local expert and support staff.
- A further assessment of the SEMG Short Term Consultancy shows the objective could be fulfilled with a lesser amount of man/month; The fixed cost for vehicle line B2 is adjusted accordingly

The savings on the above lines is credited to the reimbursable parts of the contract.

This minor reframing of the budget equilibrium does not change the objectives, goals and philosophy of the project, but will enhanced the capacity of the coordination team to fit more closely to the demand and needs of the NARS, Communities involved and FITCA country components and will permit fieldwork conducted by student.

CHAPTER III: Methodological approach

3.1 Introduction

Control of trypanosomosis increases the efficiency of oxen so those farmers can plough more land in areas with low compared with high disease prevalence. In many cases, control of animal trypanosomosis acts as magnet for human migration. People move to new lands after they are freed of the tsetse fly.

If this disease is controlled, there are almost certainly environmental consequences resulting from the expansion of cultivation and livestock numbers, such as habitat loss and species extinction, a net release of CO_2 *to the atmosphere and loss of vegetative cover that protects soil structure and fertility. Farmers often burn vegetation in the process of clearing land, which further releases harmful greenhouse gases. Land cover changes can also affect regional-scale hydrology and climatology.*

These general environmental concerns apply to the specific project areas in the different countries as follows:

In Kenya and Uganda, much of the proposed project areas are already densely populated. The landscape is heavily used for agriculture and the potential for further agricultural expansion is limited. However, there are other small patches of vegetation that people have avoided using, principally because of the threat of contracting diseases. These areas, which experience low use, include riparian corridors, swamps and wetlands. These are the very habitats that are richest in species and can become overused when the constraint of trypanosomosis is lifted. These areas will be one of the first focuses of the environmental monitoring (environmentally sensitive areas) of indirect impacts at the Kenyan and Ugandan sites.

In Ethiopia farming systems in tsetse-infested areas are poorly developed, with 10-25% of the land area cultivated, but are adjacent to highland areas with high population densities. The principal indirect impact of tsetse control concerns the effects of the expansion of cultivation and grazing into areas that have a history of low use. Trypanosomosis forms a strong constraint on agriculture in southwestern Ethiopia, thus changes in agricultural systems after disease control will probably be rapid. In this region, highland and gallery forests are biologically rich. There is great potential for impacts in these vegetation types if more intensified use follows tsetse control. There are several endemic species in the area and these should be given special attention in impact studies. Soil fertility impacts will be low initially because soil fertility is high.

"Monitoring of project impacts needs to feed directly into strengthening the ability of communities to take action to sustain their natural resources. Without this connection, monitoring has no impact on the rural poor. A series of techniques have been developed to involve communities in monitoring and to empower them to better manage their natural resources. The overall objective is to increase the sustainability of natural resources and agricultural systems, through environmental monitoring and management, in participating FITCA countries. The twin objectives of increasing productivity to improve human welfare and to sustain those gains over the long term are at the core of the objectives of the agricultural sector in each country.

The EMMC project purpose is to increase the level of information and awareness of environmental change and increase the capacity to respond proactively to these changes among stakeholders in FITCA participating countries."

Several entry points are available to achieve these objectives. After exchange and brainstorming with colleagues from SEMG, ILRI and national FITCA programmes, it appears, landscape will be the most accurate entry point for EMMC

3.2 Material & methods

i. ***Epidemiological and landscape contexts of the national FITCA projects Kenya and Uganda***

Surfaces covered by FITCA areas are very different in Kenya (5 districts for 7,300 km^2, Fig. 1) and Uganda (13 districts and 26,000 km^2, Fig. 2). A large documentation is available to describe sociological and agricultural trends (crop and animal farming) in Kenya and Uganda, at the district or even lower levels. These references are very useful to grasp a basic understanding or the rural contexts. However, some data sources are rather old (for example the last human census in Uganda was carried out in 1991). Moreover, aggregation level is different according to the kind of data and the country; it is difficult to know how the indicators were computed and from which basic data. Obviously, a large amount of work is needed to harmonise and homogenise the data within each country, and still more for a between-country comparison.

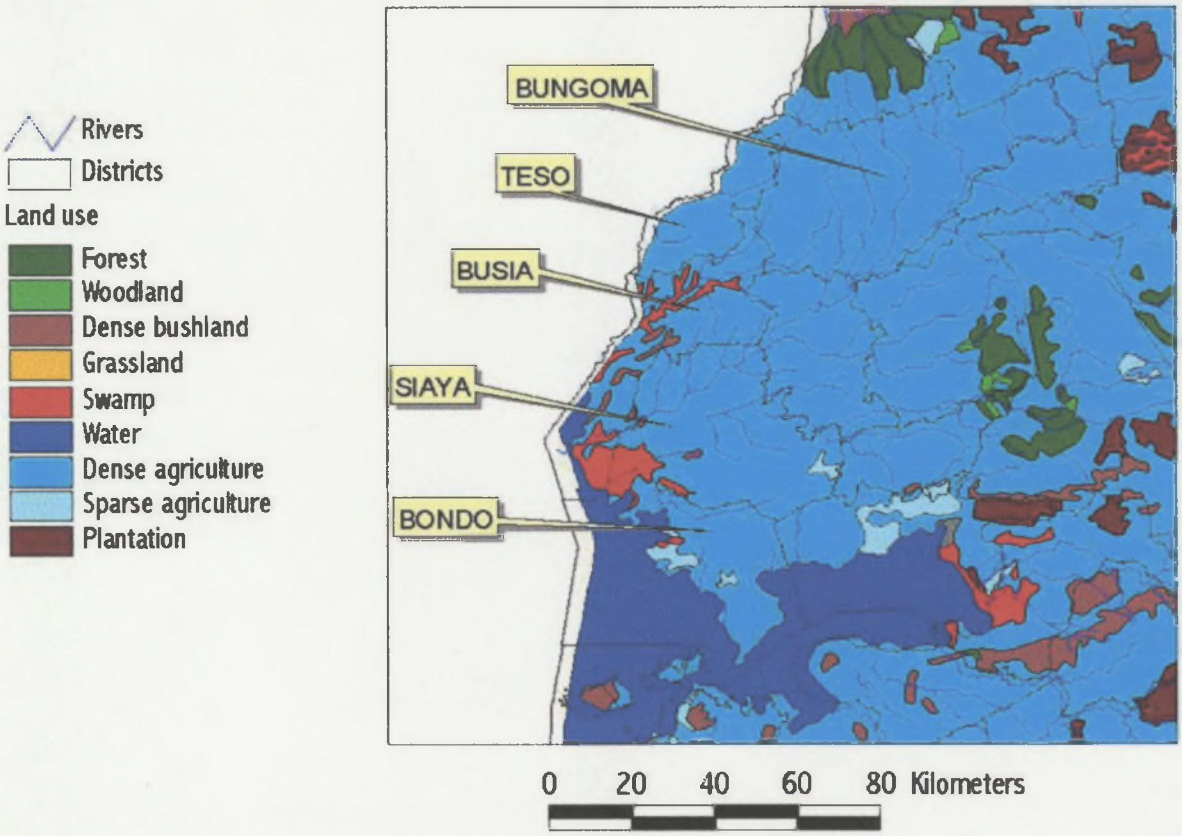

Fig. 1. Land use (unknown date) in FITCA-Kenya area.

Data source: ILRI (from an unknown source). Limits of the FITCA districts are drawn in black.

Kenyan and Ugandan FITCA areas are implemented in two adjacent areas intensively used for agriculture and livestock rearing. In both countries, FITCA areas correspond to rural landscapes where fields and grasslands (including fallows) cover more than 90% of the land. Smallholdings on both Kenyan and Ugandan sides of the border occupy the integrity of the landscape and agro-pastoral activities have left virtually no natural vegetation cover in the respective FITCA areas. Live hedges of exotic woody species (*Eucalyptus, Grevillea, Nem,* *Juniperus,*) and secondary growth on old fallows (*Lantana camara, Tithonia diversifolia*) constitute the spontaneous vegetation in these areas.

In Kenya, this intensive land use is historically based on the clanic, customary allocation of land by Luhyas agriculturists and the progressive settlement of Tesos pastoralists. Both have evolved toward private, entitled tenures encouraged by the national policy of freeholds since the 70s. In Uganda, similar agro-pastoral transformation of land cover was achieved under customary tenure and absence of *de jure* private property of land.

In both FITCA areas, rural livelihoods are based on subsistence crops (cassava, maize, banana, millet, groundnut, etc.), cash crops (cotton, tobacco, coffee), animal rearing (cattle, small ruminants, pig, poultry), and various and important non-agricultural activities (fishing, trade, shops, crafts, local or external employment). These activities support the highest densities of rural populations in each country, with 200 to 300 inhabitants km^{-2}. Field visits during this mission tended to show that land use along the border was less intensive in the Kenyan side, with more trees and larger areas under old fallow and hedges than in the Ugandan side.

These elements indicate a limited variety of landscapes in Ugandan and Kenyan FITCA areas, in terms of environmental situations and epidemiological patterns. Nevertheless, the situations observed in the field are varied and complex. Impacts of human and animal trypanosomosis on livelihoods and landscapes, reaction of villagers to disease situations, and control measures show important differences. Moreover, the area covered by FITCA – Uganda is much wider than in Kenya. In particular, pastoral-oriented systems seem to be more frequent in its northern part (Fig. 2).

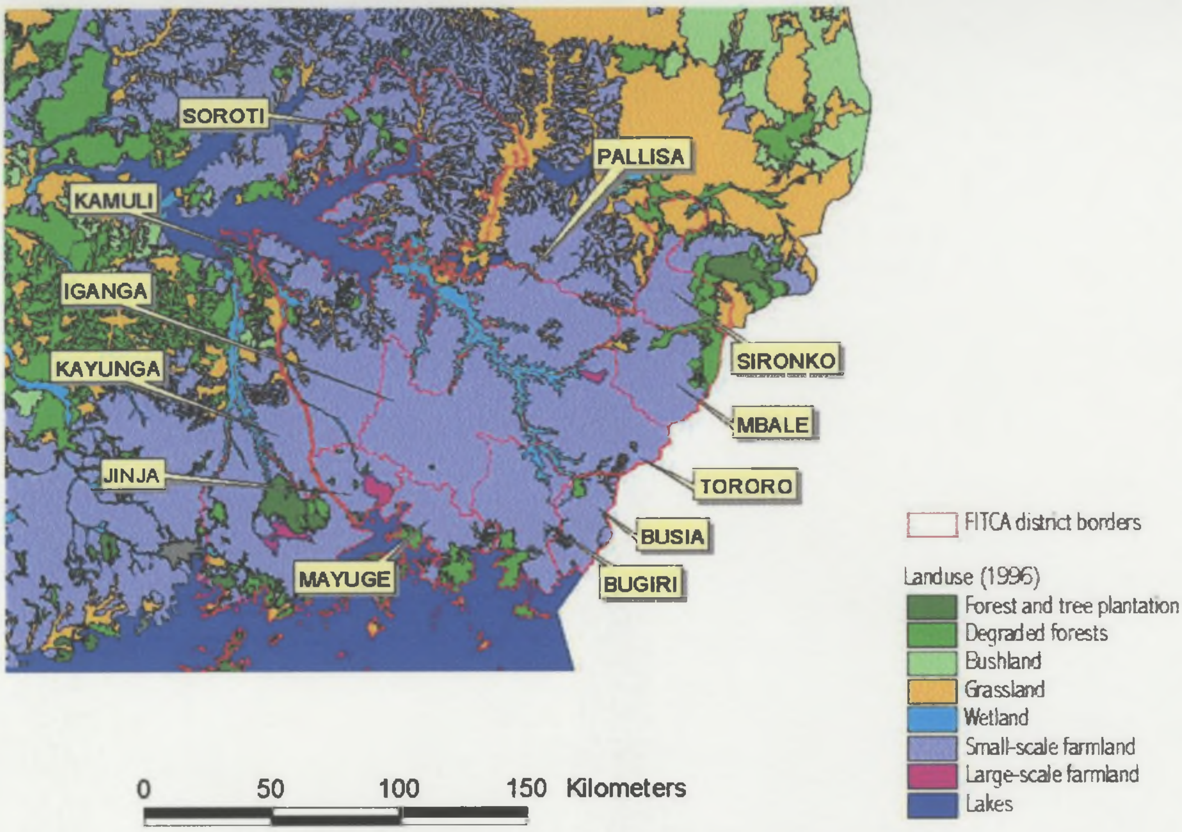

Fig. 2. Land use (1996) in FITCA-Uganda area.

Data source: National Biomass Study, Department of Resource (Uganda, 1996). Land use was determined with an analysis of SPOT satellite images supervised with fieldwork. Limits of the districts involved in FITCA-Uganda are highlighted in red.

ii. Relationships between trypanosomosis, local livelihood, and land use

In the three visited countries, all the farming systems highly rely on cattle. There are used for animal draught (ploughing and any agricultural hard work), soil fertilisation (e.g. management of *della* location in Ethiopia), landscape maintenance (prevention of heavy bush encroachment in fallow lands), human nutrition (milk and by-products, meat), saving and capitalisation. Livestock is an essential component of the social cement (loans, dowry, compensation...). Any disease with a high impact on cattle health - like trypanosomosis, is likely to induce severe consequences in terms of system sustainability.

a. Tsetse distribution

i. Historical considerations and field observations

Bourn et al. (2001) indicate a drastic reduction of the typical riparian *Glossina fuscipes* habitats in the last 40 years in Busia district (Kenya). In contrast, he discusses the possibility that *G. pallidipes* might have found new niches in the bush-regrowth of long fallows present in these rural landscapes.
Field observations in Angurai location (Teso district, Kenya) strongly support the hypothesis of an animal trypanosomosis epidemic with severe mortalities from 1998 to 2001 (87% animal losses according to statistics of the livestock services). In this area, the importance of old, secondary re-growth fallow lands would confirm an epidemic situation associated with *G. pallidipes*. Across the border, in

Tororo District (Uganda), the more intensively farmed landscapes with less bushland and few long fallow lands[1] seem to constrain disease transmission to the riparian systems associated with *G. fuscipes*. These observations are consistent with the results of recent studies on *G. pallidipes* distribution in the area[2]. In this later situation, trypanosomosis pressure related to the riparian system can prevent farmers from keeping animals, while sleeping sickness occurs among villagers settled in too close contact with these landscapes. Compared to Busia (Kenya), the intensively farmed interfluves of Tororo (Uganda) look safer. These empirical observations point to changes in *G. pallidipes* habitat linked to intensity of farming (pattern of fallows and hedges etc.) as an important factor in the occurrence and development of animal trypanosomosis epidemic. On another hand, as its traditional habitat disappears, *G. fuscipes* looks able to adapt to peri-domestic vegetation and scrub remainders in rural landscapes. Consequently, the geographical distribution of this tsetse species is probably wider than 10 or 20 years ago. This was confirmed by recent entomological studies in Uganda (Okedi, personal communication). The timing and location of recent sleeping sickness epidemics (see Fig. 2 : 1970s on the shores of Lake Victoria, 1982 in Kamuli, 1984 in Mukono, 1989 in Soroti, 1990 in Southern Apac) seems to be related to the collapse of public animal and human health services (70s), in a socio-political context marked with mass human and cattle movements, linked to cattle raids occurring in the northern part of the country (Fèvre & Okedi, personal communication). The present distribution of *G. fuscipes* seems to extend to all main waterways and tributaries between Lake Kyoga and Lake Victoria (Okedi, personnal communication). Field work and retrospective studies should assess these general impressions (precise map of *G. fuscipes* distribution and accurate description of epidemiological situations).

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[1] This should be confirmed with diachronic remote sensing (historical aerial photos and contemporary images) and field surveys.

[2] Okedi, L.M.A., Abila P.P., Katabazi B.K., 2001. Re-description of *Glossina pallidipes* distribution belt in South-East Uganda under FITCA Uganda. NARO-Livestock Research Institute.Uganda. Paper Presented at the ISCTRC – Ouagadougou 2001.

In FITCA area, two tsetse species are predominant for sleeping sickness and Nagana transmission: *G. pallidipes* (*Morsitans* group) is a savannah fly, which was often found abundant in schrub vegetation. *G. fuscipes fuscipes* (*Palpalis* group) is a riparian species spread in valley lowlands and on the shore of the lake Victoria.
Besides these trends, field observations show that these two species have loose ecological needs. Consequently, it looks difficult to define, a priori, typical habitat landscapes for these flies. To broadly summarise the current (and still somewhat empirical) knowledge of flies distribution in FITCA areas:
G. pallidipes is found:
- in Kenya at the North of the FITCA area and in a residual pocket in the Busia district,
- in Uganda, near the lake Victoria and in some eastern areas located at its North

G. fuscipes fuscipes:
- is found in Kenya on the lake shores and along main rivers in Busia district,
- is widespread in Eastern Uganda.

iii. *Effects of trypanosomosis on rural livelihoods*

In Angurai (Kenya, Teso district), cattle owners mention the drastic drop in herd size and draught power in 1997/98 to explain the extension of secondary-growth bush land of *Tithonia diversifolia* and *Lantana camara,* a putative habitat for *G. pallidipes.* Farmers in this area reported extension of fallow periods, old fallows and hedges, as well as the adoption of cash rather than cattle payment for dowry, and disappearance of large herds with more than 100 heads of cattle. These statements could confirm that, in this situation, reduction of animal numbers and subsequent landscape changes are caused by external factors (tsetse flies and trypanomosis), rather than the results of internal social or economic dynamics.
In visited areas were animal trypanosomosis mortality was low, such as in Butula and Mundika (Busia district, Kenya), direct links between presence of trypanosomes and landscape changes were not perceived by local actors and could be considered as of secondary importance. Considering human trypanosomosis, high prevalence of human sleeping sickness can be linked to scarcity of land, resulting in disadvantaged households being rejected to the periphery of safe interfluves, and previously grazing wetlands being cultivated or settled. This situation is probably aggravated by the lack of co-ordinated tsetse control measures at the national and local levels.
In addition, contrasted behaviours were reported at the community level, as a reaction to sleeping sickness and animal trypanosomosis epidemics. In areas, which were newly colonised by *G. pallidipes*, Nagana (cattle trypanosomosis) was little known. Its occurrence resulted in reactions of anger and confusion (Angurai, Teso district, Kenya). In endemic situations, villagers adopted low-risk management practices and coping mechanisms. In riparian or lakeshore landscapes, they settled away from the water, favoured trypanotolerant animals and limited their livestock farming activities (Ossiyeka, Bongo district, Kenya). In situations where Nagana prevalence was moderate and cattle mortality was low, villagers considered the disease as a constraint to animal productivity (animal draught, milk yield) and had a speculative behaviour, investing money in crush-

pen committees (farmers' organisation around a cattle retention corridor, a spraying crush pen and remanant insecticides) or protected zero-grazing units.

iv. Strategies for tsetse control and trypanosomosis preventive measures

The history of control interventions, the stages of FITCA implementation, and the policies adopted by each national component show contrasting situations with regards to the control of tsetse flies and trypanosomosis.

In Kenya, the first control measure implemented in areas with high tsetse densities and Nagana incidence is the settlement of a network of insecticide-impregnated targets, maintained by private, village-based and self financed "target attendants". Once the fly density reaches an acceptable level (as perceived by the farmers), it is replaced by the aspersion of cattle with remnant insecticide managed by village crush-pen committees: for each treated animal, the farmers are paying fees (20 KSh) to the committees. In peri-urban and market-oriented systems, the final control measures (corresponding to tsetse density < 1 fly $trap^{-1}$ day^{-1}) might be the implementation of protected Zero-grazing units.

In Uganda, priority is given to the control of small areas where sleeping sickness occurs, with mass detection of human cases and treatment of affected people. When this emergency measure is attained, more systemic, preventive control measures will be implemented, with large-scale tsetse control (impregnated pyramidal traps) and animal-based measures such as the implementation of crush-pen committees and protected Zero-grazing units. The control of sleeping sickness is devoted to national human health services, but all the remaining activities (tsetse control, animal treatments) are decentralised in each of the districts (13 in the FITCA area), in the frame of a statewide decentralization policy implemented by the Ugandan government.

Field observation have thus combined and dynamic territories of different vectors, varied impacts of epidemiological situations on rural livelihoods and landscapes, contrasted reactions to both animal and human trypanosomosis, different histories, methods and advancement in tsetse control measures. These findings point to differentiate control, palliative, and coping measures.

v. Concept and working assumptions

To reach the goals assigned to EMMC, a useful tool would be an information system able to store and manage the information describing the changes in tsetse flies and trypanosomosis challenges, control measures and landscape / land use along with the project. Because local communities would be both an information source and the main users and recipients of this system, they should be deeply involved in its design, and information returns should match their needs. This latter point is crucial to ensure the sustainability of the information system after the end of FITCA programme.

The need to take into account the simultaneous changes in disease risk and control measures in an anthropized environment, pushes this work in the field of system analysis. In this case, the system under study is the agro-ecosystem: tsetse proliferation, Nagana and sleeping sickness are considered as the manifestation of a system imbalance. Control measures must solve the trypanosomosis problem as well as ensure the sustainability of the agro-ecosystem: beyond the insurance of an acceptable situation in terms of human health and animal productivity, it is thus a matter of agro-ecosystem health (Faye et al., 1999).

On the other hand, EMMC is not a research programme and most of the available human and financial resources must be targeted to action rather than reflection. According to the acquired knowledge, available data and tools, this is a big challenge for the team. The first consequence of this situation is to restrict the work to fields directly related to trypanosomosis, its control and the hypothesised impacts on environment. We will consider impacts on landscape, i.e. indirect effects (Fig. 3). Tools for studying direct effects are well known.

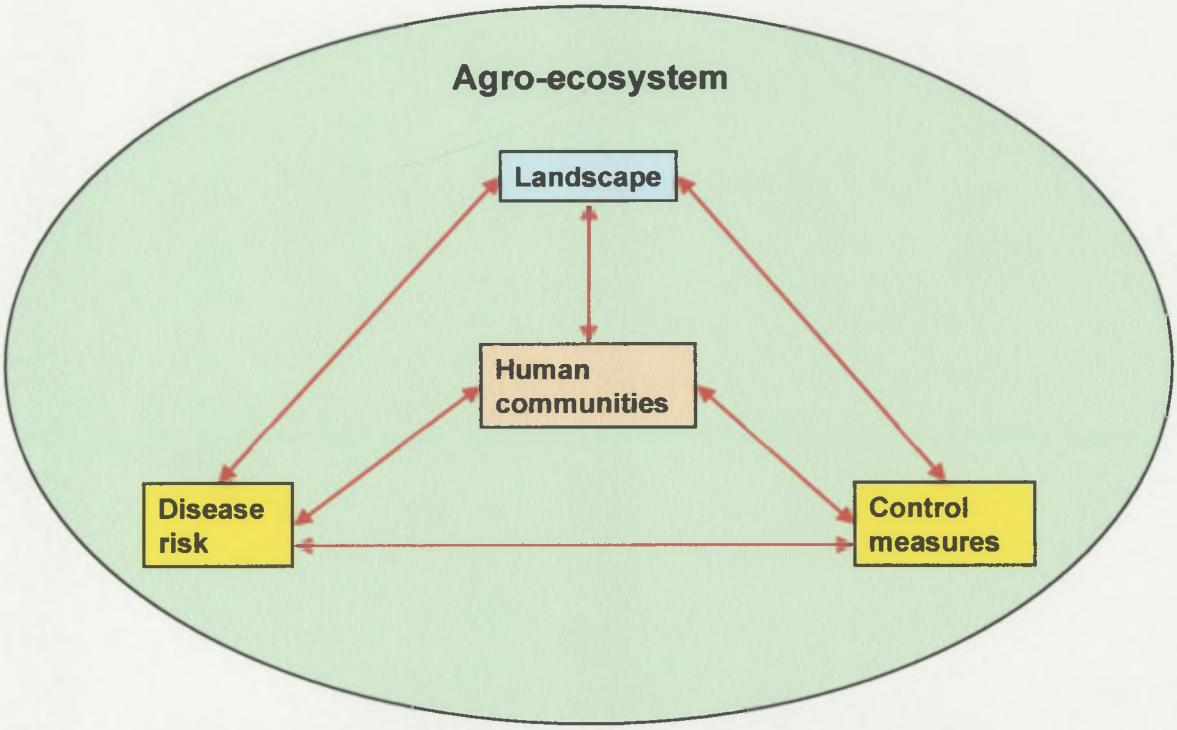


Fig. 3. Conceptual representation of the system under study

The main working hypotheses are symbolised by one or two-way arrows:

- Disease risk ↔ control measures: the bi-directional nature of the arrow is obvious and does not need further explanation. Different field situations may arise:

  ► No farming without farmers: a high risk of sleeping sickness leads to emergency control measures targeted at human health. An example is the mass detection and treatment of positive cases implemented in Uganda.

  ► No farmer without cattle:
  - Besides the emergency problem of sleeping sickness, a high risk of Nagana is associated with high tsetse density. This leads to control measures aiming at reducing the number of flies: insecticide-impregnated targets or traps.
  - When the risk of Nagana is still high but apparent tsetse density (ATD) is rather low (e.g. ATD < 10 flies $trap^{-1}$ day^{-1}), cattle-based control measures may be adopted: pour-on or spray insecticides (dipping is definitely stopped).
  - When tsetse density is very low (ATD << 1 fly $trap^{-1}$ day^{-1}), and more market-oriented systems are implemented (dairy production with exotic breeds or

crossbred cattle), other control measures might be useful, like release of sterile insects of net-protected Zero-grazing units.

- Disease risk ↔ landscape

  ► Disease risk ➔ landscape: a high prevalence of Nagana (e.g. $P_{ng} > 50\%$) is associated with high cattle mortality and might induce human exodus from infested areas. Such a situation seems to have recently occurred in the Angurai location (Busia district, Kenya). The consequence is the increase of fallow lands, caused by the lower human density and the lack of animal draught.

  ► Landscape ➔ disease risk: large trends are well known such as the association of *G. fuscipes* with wetlands and riparian forest. However, entomologists are currently unable to define typical habitats for the flies occurring in Kenya and Uganda. It would be an important outcome for the EMMC and the scientific community to monitor flies species and density together with an accurate characterisation of landscapes and their changes. A major issue would be to assess the adaptability of flies to new environment, and thus to avoid an underestimation of disease risk, e.g. in peri-urban or urban environments.

- Landscape ↔ control measures

  ► Landscape ➔ control measures: we will not overemphasise this aspect, which is related to limit situations, such as very abrupt and bushy slopes (e.g. in Ethiopia) preventing the use of impregnated traps or targets.

  ► Control measures ➔ landscape: this aspect is essential from the donors' viewpoint. It is also the most difficult to formally assess. Because many factors can have major impacts on landscape, disease risk and control measures (climate change, regional trends in rural economics, social disorders...), it is impossible to define treated and control areas (in the statistical wording), both for ethical and practical reasons, to obtain a quasi-experimental design enabling to draw valid inference from observed data. In our opinion, the proof of causal relationship between tsetse control measures and environmental changes is not the purpose of the monitoring, but rather the basic assumption which cannot be formally assessed given the development goal of FITCA. Instead, focus must be placed on picking up relevant indicators allowing to monitor the changes, and to provide local communities and policy makers with adequate information for decision making, in the spirit of ensuring system sustainability.

- Human communities

Interactions of human communities with each of the three components (disease risk, control measures and landscape) are obvious and need not be detailed here. However, the occurrence of confounding factors might result in unexpected dynamics. For example, a high incidence of malaria or infectious diseases like AIDS, or the collapse of an economical speculation (milk, sugar cane, cotton...) could lead to a negative balance of human demography or rural exodus. Therefore, many cultivated fields might turn back to fallow lands and favour the return of tsetse flies. An analogous mechanism was invoked in Uganda, where the present sleeping sickness epidemics is thought to be related to the collapse of governmental health and livestock services after a period of social troubles (cattle raids, etc.) and mass population movements.

vi. Data domains

After developping concept and working assumptions, we tried to define different data domains to be described with specific indicators. These data domains and their relationships are shown in the graph below (Fig. 4).

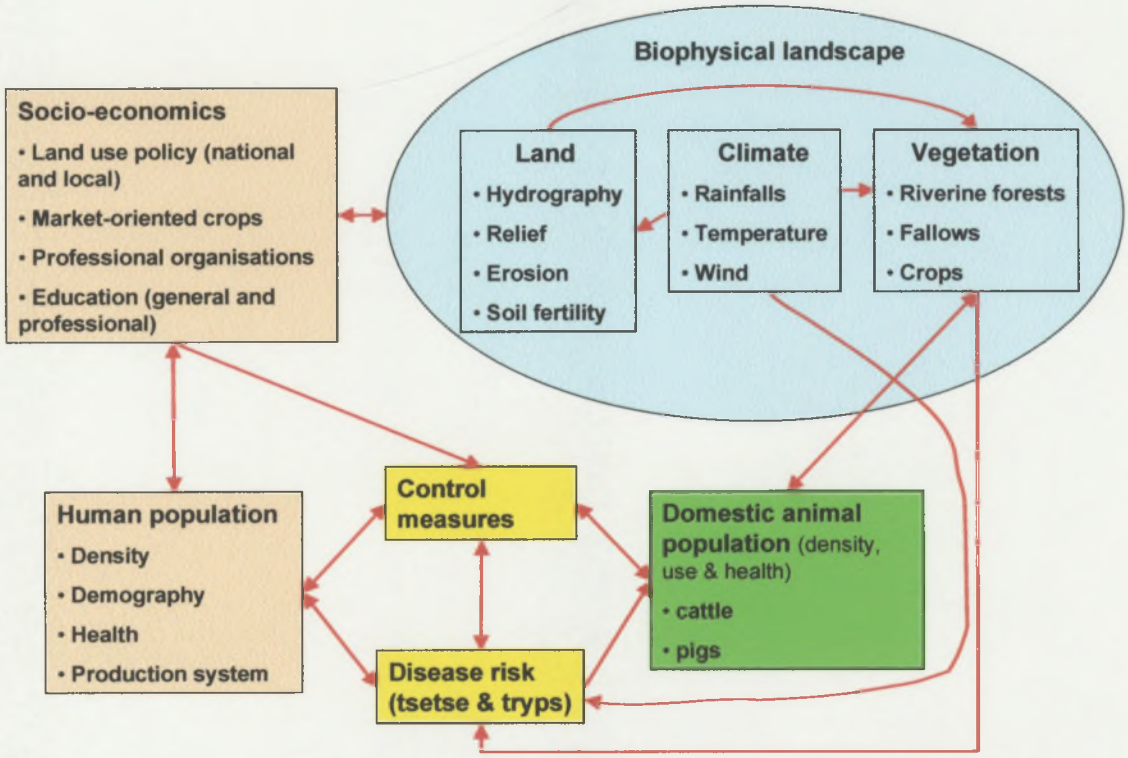


Fig. 4. Data domains and their relationships to monitor disease risk, control measures and environmental changes

These different domains will be characterized by different sets of indicators [tsetse populations and disease prevalence (sleeping sickness and Nagana) for disease risks. It should be noted, however, that the notion of risk goes beyond flies'density and trypanosomosis prevalence. For example, if tsetse flies are correctly controlled with appropriate measures, and disease prevalence is low, the risk remains high if environmental conditions remain the same. An interruption in preventive measures is likely to be followed with a relapse of the epidemiological situation.]
These different indicators are developed in the following paragraphs.

vii. Selection of pilot areas

The landscape entry point privileged in EMMC approach, leads to select pilot areas in the main different agro-eco-systems of FITCA's country programmes, in

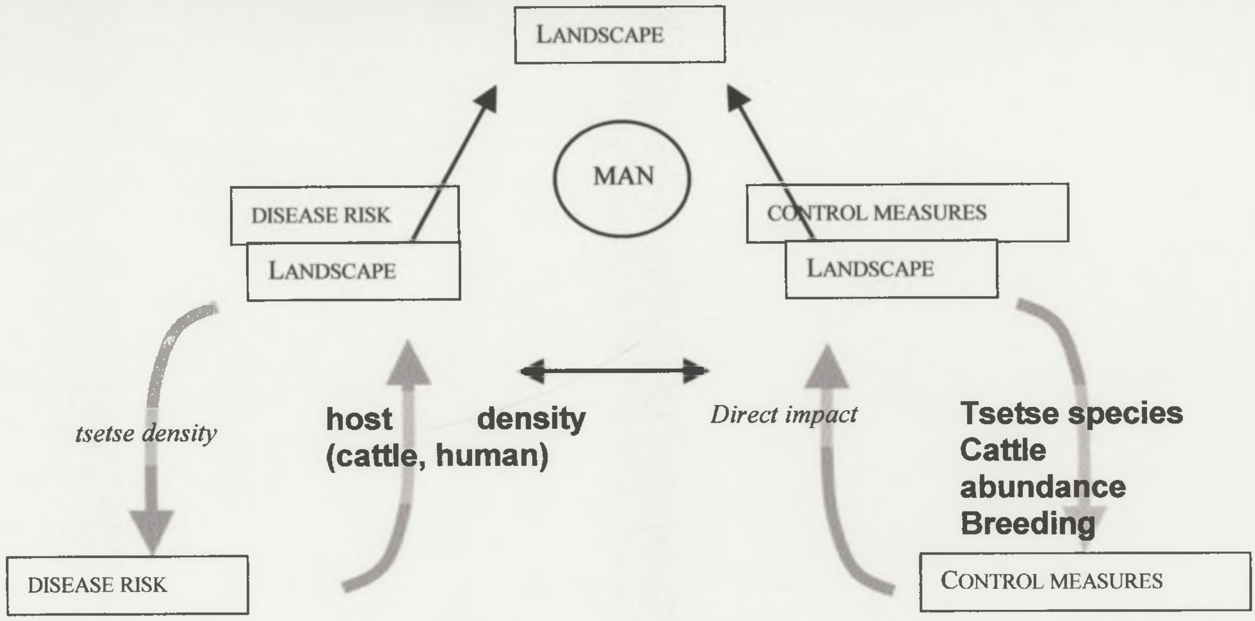
term of environment (agro zones, land use, type of vegetation, relief, hydrographical net...)
In epidemiological term (abundance of the different species of tsetse flies, cattle density, prevalence of Nagana, occurrence of sleeping seekness...)
The selection of these zones inside the control areas of FITCA was carry out in close collaboration with FITCA's national teams
Ecological studies in FITCA EMMC aims at documenting the ecological settings at some selected sites within the FITCA project areas in each of the countries (Kenya Uganda & Ethiopia). There will assess the baseline information on ecological status and processes that will affect land use / farming activities within the tsetse controlled areas. There will develop an environmental monitoring system to monitor changes with a view to maintain sustainability of land use practices. The selected study components comprise of vegetation, soils, biodiversity and water. In each of these study components there are sets of indicators that will be studies and certain elements of the indicators to be monitored for changes associated with land use change.

For the last few months activities in EMMC have involved visits to sites in the FITCA regions to identify ecological monitoring sites. In all countries, FITCA regions are very large. In Uganda for example FITCA is operating in 13 districts in a total area of about 26,000 km^2, in Kenya FITCA is in five districts with a total land surface of 7,500 km^2 and in Ethiopia FITCA efforts are to concentrate in three major valleys; Didessa, Gambella and Ghibe. In Didessa alone FITCA area is 5,500 km^2 Gambella and Ghibe may have a similar or more when put together.

The purpose of the visits was to familiarize with the study areas and to gather information that will enable selection of specific ecological monitoring sites. Identification was by assessing ecological sensitive sites listing potential impacts likely to occur as a result of tsetse control.

In some of the visits CIRAD experts accompanied EMMC team during their short-term consultancies. We have benefited from draft reports produced by the short-term consultants and numerous discussions EMMC team had with them in Nairobi and while in the field.

a. Associations between landscape, disease risks and control measures

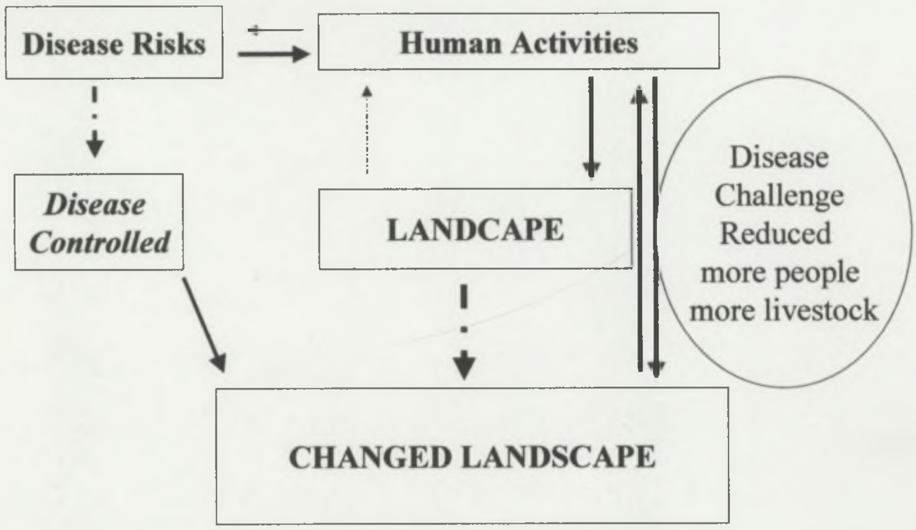


i. Hypothesis

Tsetse density	Tsetse abundance is linked with the vegetation / water / density of available hosts.	Direct impact	Toxicology
Host density	Tryp is a main causes of death for cattle Tryp is a cause of departure for people	Tsetse species	The intensity of control and the methods will be different according to the species
		Cattle abundance	Baited techniques could be used if the density of cattle is high
		Breeding capacity	Zero-grazing units could be used in productive area

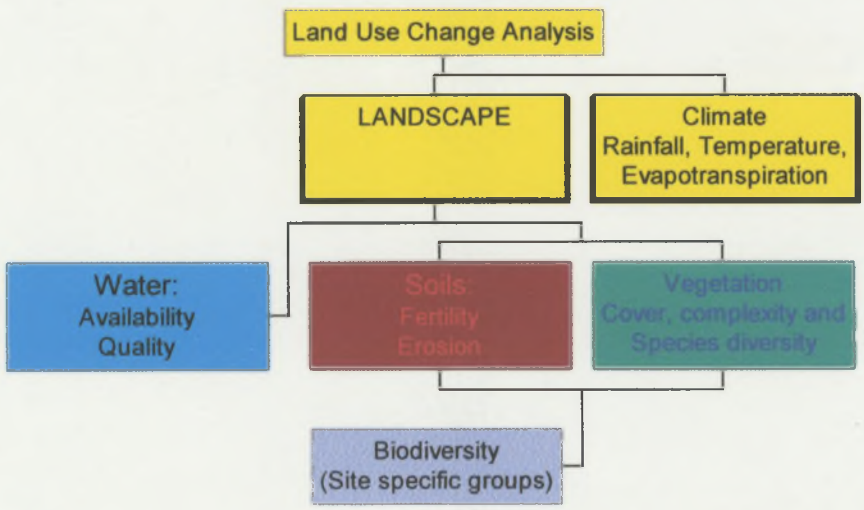
Fig. 1 below presents a framework under which disease control leads to changes in landscape and Fig.2 gives an outline of landscape components that would be affected by changes in land use because of tsetse control.

Fig. 1 Trypanosomosis Control Links to Landscape Change



In figure 2, below note that the major study components are soils, vegetation and biodiversity. In some sites, water will also be studied as a component. Climate affects land use and in order to understand the interactions between climate and land use we will gather climate data on each site from appropriate agencies in each country.

Fig.2 Landscape Components



3.3 Main characteristics of the pilot areas

The following are descriptions of selected EMMC sites in each country. The sites can be seen in the section 3.6 in this report.

A. Kenya

Thema	Zone 1	Zone 2	Zone 3
Agro-climatic	Warm tropic Subhumid Length of growing Period:	Warm tropic Subhumid Length of growing period:	Warm tropic Subhumid Length of growing Period:
Landuse	Farmland/ bush/ woodland	Farmland/ fallow/ woodlots	Farmland/ bush /grasslands
1999 Population density (km^2)	> 200	> 200	> 200
Percentage of crop	<50%	85%	50%
Percent of woodland/ forest	> 2%	< 2%	> 2%
Percent fallow	26%	12%	29%
Livestock density 1996 (anl/km^2)	84	124	233
Livestock density 2000/2001 (anl/km^2)	14	121	187

In Kenya three sites have been selected

i. ***Angurai:*** Angurai is settled area with people living in the area and practicing farming of various annual subsistence crops. The area has no commercial crop but recently tobacco has been introduced. The area has numerous bushes of *Lantana camara* that grow as fallow in the abandoned farmlands, roadsides and bushes along streams and river Malaba. These are known tsetse habitats and are expected to reduce due increased cultivation and grazing. There are many absentee farmers who own land in the area and most of it is now fallow. It is expected that these investors will come back to keep livestock once tsetse problem is reduced. Livestock that used to be a major income earner and played a key role in the traditional economy is no longer kept by people and will definitely increase in numbers after tsetse problem is reduced. In some parts livestock herds are already starting to build up following public confidence on FITCA project. Soil erosion is a potential problem in the area especially along the Malaba river where the ground is sloppy and has loose sandy soil most of which is currently held together by plant roots. With more cultivation and grazing in these areas will certainly result into more erosion through surface runoff. Critical ecological issues include the following:

a. Vegetation and land cover changes
b. Soil erosion
c. Increase livestock numbers
d. Animal traction
e. Biodiversity

ii. ***Busia Township:*** Busia Township is more settled that Angurai. This area is highly cultivated but there are numerous fallows some of which are up to 3 to 5 years old. FITCA is promoting zero grazing in this area by introducing treated nets around cattle pens in zero grazing units. Environmental concerns in these areas include direct impacts on non-target insects like flies and others that are exposed to the nets. The indirect impacts associated with zero grazing units are:

a. Conversion of fallow into Napier grass and other fodder plants. This will be a change from less managed to more managed ecosystems with certain impacts on biodiversity, land cover, and soils.
b. Soils
c. Changes in land use

iii. ***Budalangi:*** Bundalangi is a low-lying area on the shores of Lake Victoria. Tsetse infestation is high and has put a considerable pressure on land use systems. There is much bush and a few scattered trees. Human settlement is high only along the lakeshore. The further you go away from the lake the less the settlements and the less are the livestock numbers. Ecological issues of importance include:

a. Farming on shoreline and swampy areas.
b. Changes in grazing areas; woody resources; grasslands
c. Soils
d. Water; water quality, surface water; drainage-floods
e. Human settlements

B. Uganda

Thema	Zone 1	Zone 2	Zone 3	Zone 4
Agro-climatic	Warm tropic, subhumid Length of growing period :240-270	Warm tropic, subhumid Length of growing period :240-270	Warm tropic, subhumid Length of growing period :240-270	Warm tropic, subhumid Length of growing period :240-270
landuse	farmland	Farmland / grassland	Farmland / grassland	farmland
Population density (/km²)	>200	50-200	>200	>200
percentage of crop	> 85 %	50 %	> 85 %	> 85 %
percentage of woodland/forest	< 2%	< 2%	< 2%	< 2%
percentage of wetland	2 %	7 %	0 %	0 %
Livestock density 1995 (anl/km²)	20-50	< 5	> 50	20-50
Livestock density 2000 (anl/km²)	20-50	20-50	> 50	20-50

In Uganda, four sites have already been selected. Selection of sites in Uganda has been complicated by the diversity of background issues considered in selection. First FITCA efforts in Uganda are mainly targeting reduction of human trypanosomosis rather than livestock. The impacts of controlling human sleeping sickness on land use may not be as immediate or observable on short-term basis as in the case of livestock. One would expect in migrations in tsetse controlled areas but in all the areas people are already living there and how much sleeping sickness is a constraint to human occupation is not well understood. The other issue that was considered in selecting sites in Uganda is the epidemiological patterns of livestock trypanosomosis. Movement of animals between agricultural communities and the pastoral communities in northern Uganda has big part to play in the epidemiology of the disease. It was considered necessary to select a site in one of the disease routes disease control is a challenge and land use/ land cover influences the prevalence of the disease. Uganda sites selected are as follows:

i. ***Angurai:*** This site is on the border with Kenya and adjacent to the Angurai in Kenya. The site has contrasting features with the Angurai Kenya in that there are not or very few tsetse flies in the Uganda Angurai while the Kenya Angurai has the highest fly catch known in Kenya. Bis no or negligible incidences of the disease. The area is well cultivated with no natural or near natural vegetation. There are no perennial fallows like in the Kenyan Angurai. Perennial bushes are found only on road reserves and farm hedges: Ecological issues considered in this are as follows:

   a. Comparative site with Kenya Angurai. The two Angurai areas have similar geographical features including people, culture, and land use practices. River Malaba that forms the Kenya Uganda border only separates them. It will be interesting to study the different land use/land cover patterns in the two areas.

ii. ***Namasaghali:*** Namasaghali is a large piece of land currently covered by a dense forest of savannah woodland. At the edges of this forest, there are numerous human disturbances (burning, harvesting of plant resources, charcoal burning) and some cultivation. Some of the ecological parameters found to be useful are as follows:

   a. Savannah woodland
   b. Biodiversity
   c. Water resources
   d. Human settlement

iii. ***Namwendwa:*** Namwendwa is highly settled and widely cultivated. Many areas have fallows with a mixture of *Lantana camara* that host tsetse flies. The area has one of the highest incidences of human trypanosomosis in Uganda. FITCA project in Uganda is planning to put a lot of effort to control the disease in Namwendwa. Specific ecological issues in this are include the following:

   a. Conversion of perennial fallows into farmlands
   b. Conversion of fallows into grazing lands
   c. Changes in plant species composition
   d. Increase in animal traction
   e. Human population
   f. Biodiversity

iv. ***Serere:*** Serere is another area like Namwendwa that has high incidences of human sleeping sickness. The area is already settled but farming is very limited. Some of numerous bushes are regularly burnt. The area borders several swamps that are part of Lake Kyoga hydrologic system. Ecological issues of importance in Serere are as follows:

   a. Increase in human population
   b. Increase in livestock numbers (resulting from human migrations)
   c. Increase in animal traction
   d. Reduction in vegetation cover
   e. Water quality (in swamps and rivers)
   f. Biodiversity

C. Ethiopia

In Ethiopia we have visited two sites one of which (Didessa Valley) is an accepted FITCA site and the other (Ghibe Valley) is under consideration to be a FITCA area. Ghibe has two basins the upper Ghibe that is close to Didessa Valley and the Lower Ghibe that is further east down the Ghibe river. Discussions are underway to have the Upper Ghibe as a FITCA site. Dr. Robin Reid (Reid et. al. 1997; Reid and Swallow, 1998; and Wilson et. al. 1997) did an extensive ecological work in Ghibe Valley by. This work will provide a good source of information in developing an ecological baseline for Ghibe Valley. EMMC will also work in Gambella but we have not yet visited the site.

i. ***Didessa valley:*** Didessa Valley has tsetse control area of about 5,500 km^2. Tsetse control has already begun in the human settled area near the valley. Following tsetse control Ethiopia government is planning a settlement plan in which people will be moved into the area to settle with a view to have land use practices maintain low tsetse populations. Ecological issues in Didessa include:

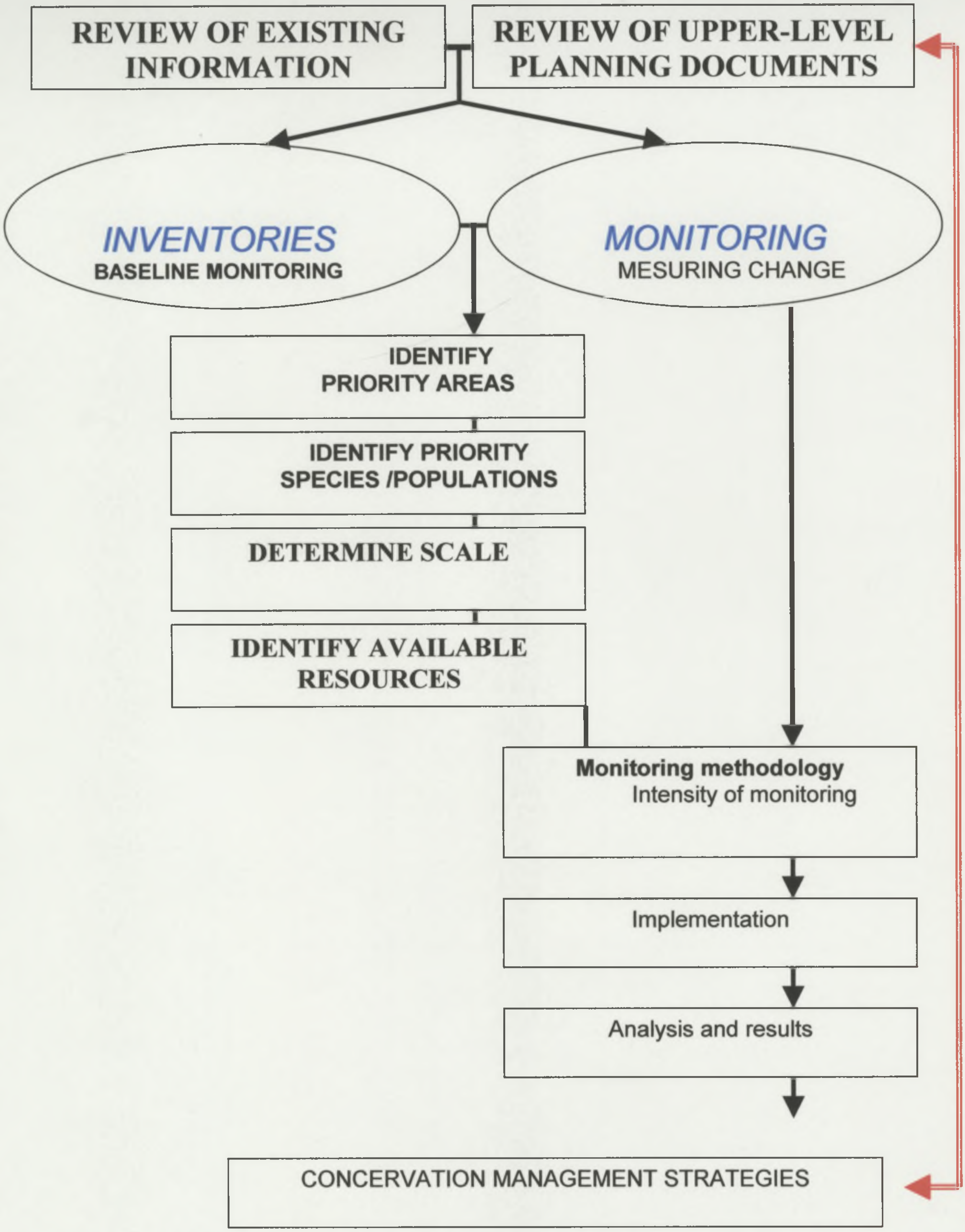
a. Changes in vegetation structure and species diversity
b. Soil characteristics
c. Water resources
d. Biodiversity
e. Land cover

ii. ***Ghibe Valley:*** Ghibe valley has an ecological gradient that has different land use types. The escarpment of the valley is under cultivation while the valley floor is largely use for grazing. The valley sloppy area is very extensive and is mainly a wildlife area. Ecological issues in Ghibe include:

a. Plant species composition
b. Land cover
c. Biodiversity
d. Water resources
e. Soil characteristics

3.4 Study plan

EMMC ecological study plan has been discussed with CIRAD experts during the recently concluded short-term consultancies.
The rest of this report presents summaries of discussions with short-term consultants that will serve as a guide to developing an environmental monitoring system for FITCA.
Fig.3. Simple design of environmental monitoring programme proposed for FITCA project areas.



METHODOLOGICAL FRAMEWORK FOR ENVIRONMENTAL MONITORING

i. Choice of indirect relevant indicators

It is clearly understood that the present component does not concern the study of the direct environmental impacts resulting of either the tsetse fly control or the chemical applications preventing or treating against trypanosomosis, but only their indirect consequences on ecosystems in the long term. The aim is to make sure that the ecosystems subjected to change following the progress of the project remains viable and that the production systems in development are sustainable.

In the field of environment, quantified, clear and easily accessible indicators must support monitoring of natural or cultivated ecosystem. Among many possible indicators of change, we have to select only those linked with the human and animal trypanosomosis and the tsetse control.

Consequences of ecosystem changes are discernible at different scales:

- at the village or district level, i.e. with a geographical approach, one can observe the land use and land cover evolution, as well as the ground cover and the state of surface. It is obvious that the environmental consequences must be interpreted in a long-term perspective. The remote sensing is the most useful tool for this approach.
- At the field level, attention must be given on the key environmental components or resources as soil, water (particularly in water bodies), vegetation and animal diversity. Tools of measurement are used on the field; measurements must be reproducible and comparable.
- In relation with rural production systems and rural population, the useful criteria are obtained by surveys and statistic data collection.

ii. Proposed indicators and their justification

a. Main indirect indicators for an environmental monitoring

i. Human population

Unusual changes of population could find explanation as a result of the tsetse control. They will be in the same time the cause of changes in land use and production systems. Population data and population density are important indicators of human pressure on environment. Data on population number have to be interpreted taking into account the several other possible causes of variation as settlement programmes and incentives, migrations, etc. The data are collected by national census and completed by FITCA through socio-economic surveys.

ii. Climate

◆ Rainfall and temperature

The most common climatic data as mean monthly temperature and rainfall are needed to analyse some of the following indicators as the river flood, the crop yield, the botanical composition of herbaceous layer. These data can be obtained in the national meteorological services.

iii. Land use/land cover

The consequences of tsetse fly invasion were mostly desertion of land by farmers, decrease of population density, lack of workers, lack of draught animals. Since the beginning of the XXth century, the epidemic of sleeping sickness occurring in this part of Eastern Africa and then the large interventions undertaken (including large scale land clearing and massive use of remnant insecticides) have thoroughly modified the distribution of population and the land use.

The current programmes of tsetse control remain in the line of these first actions, using new technologies much more benign for environment, but already facing technical difficulties limiting their effect. Nevertheless one expects a prompt positive impact on control of the farmers' involvement in the tsetse fighting techniques (FITCA objective). Due to the population pressure for land resulting of the natural population growth, changes in land use will continue to progress.

The first indicators of change concern the land use and principally:

- ◆ the ratio "cultivated area / total area"
- ◆ the ratio " area covered with natural vegetation / total area ; natural vegetation includes forest, savannah, riverine forest and old fallow.

These indicators must be established using remote sensing techniques. Precision of measurement is limited by the perception capacity of the tools used. Analysis has to include diachronic comparisons on the same areas. These indicators are not useful *per se* to evaluate the environmental consequences but have to be combined with other complementary indicators (for instance, analysis of landscape and principles of landscape ecology as mentioned in the "remote sensing" component).

Other indicators concerning the land use:

- the ratio "perennial crop areas / annual crop area
- the mean size of the ploughed fields
- the length, the structure, the botanical composition of hedgerow
- the size, the structure, the botanical composition of areas covered with natural woody vegetation included in the cultivated areas.
- The area, the structure and the botanical composition of fallow in relation with their age.

The three last indicators are directly related with the possible presence of glossines, the vegetation constituting possible habitat for certain species. Evolution of areas with bushy or woody vegetation can be interpreted with the density of flies. Production system changes can directly modify hedgerow and fallow density and distribution.

The methods to establish these indicators combine remote sensing techniques with high-resolution product analysis (for ex. aerial photographs) and field measurements. At this very detailed scale, the monitoring is applied only on sample areas, and observations are repeated on the same place after a sufficient time interval. For the botanical composition, the survey will be practised on a permanent observation line.

iv. Water and soil

Water and land resources directly influences agricultural productivity and livestock rearing. They constitute basic elements of the production system and their viability. Consequences are not limited to the cultivated areas but have also indirect effects on the neighbouring ecosystems. Monitoring of these resources has a significant importance in environmental point of view. The proposed indicators are explained below:

◆ Date, frequency and level of river flood: the rainfall collected in a basin flow out differently according to the state of the soil surface, the vegetal cover, disposition of fields, hedgerow, anti-erosive mechanisms, etc. All change encouraging runoff will increase the risk and occurrence of flood as well as the portion of water infiltrating in soil and reconstituting the deep-water reserves is reduced. The project cannot install the specific tools and organise the data collection; it only can be aware of the existing monitoring systems and the national institutions or research centre in charge of it. A significant increase of floods can express a worrying reduction of water absorption by soils and/or an increase of sediments in the riverbed reducing the river flow.

◆ Erosion and transport of sediments in river: runoff carry soil material, part of it up to the river. The sediment is deposited away, in the bed of river or in the lakes fed by these rivers. Lake Victoria, for instance, is shallow and the silting up is a common preoccupation of the bordering countries. The project cannot undertake measurements of the solid particles carried by flooding rivers but can use the existing data collected by specialised institutions. A significant increase of sediments in water must be analysed in comparison with the land use and land cover changes. If necessary, the project could propose the farmers to apply anti-erosive practices.

◆ Erosion and bare soil: land clearing or bad agricultural techniques can initiate superficial degradation of soil and later extension of eroded areas. Rehabilitation of degraded land is difficult and expensive. The best indicators to express erosion are the numbers of eroded places and the total area eroded in a specific zone. Remote sensing can monitor eroded areas. This technique informs on the zones to be monitored at field level and the dynamic is perceived by diachronic analysis. Anti-erosive techniques and tree plantations can by applied to reduce erosion.

◆ Soil fertility: evolution of agricultural practices and production systems modify the soil fertility status. This fertility is an important factor of sustainability of land resource. Agricultural production systems are directly influenced by the consequences of tsetse control: labour, animal draught, cropping extensification, length of fallow, use of fallow, rotational system including forage crops, fertilisation with animal manure, etc. Unfortunately the follow up of soil fertility is very difficult (soil sampling and analysis). Use of indirect evaluation is more relevant: measurement of crop yield (expressed by area unit and compared on the same place over a sufficient period), yield of annual crop at district level according to the statistics (if sufficiently accurate), report of the farmers, presence of indicator plant or weed...

◆ Water or soil pollution: use and storage of pesticides as the insecticides for tsetse control can produce localised pollution if unsafe. Direct impacts are not part of this project, but one must consider the long-term pollution hazard, particularly in water for domestic use. Water analysis could be ordered if case of doubt.

Note: during the mission, some farmers expressed their basic need of safe water for human consumption in the villages. They often have only access to the river, with unsafe water. Water availability is an important factor of well being and hygiene improvement. Programmes against tsetse fly are positively perceived by population but cannot mask this other need of water access and availability.

V. Biodiversity

The biodiversity is deeply modified by rural activities and land cover/land use changes after tsetse control. Operations represent a potential risk for sensitive areas. Environmental changes caused by clearings, ploughing, introduction of animal and plant species, hunting, fires lead to the extension of some species as well as the reduction or disparition of others. Associated predator populations are also affected.

◆ Vegetal diversity (woody and herbaceous plants)

Studies on vegetation and flora should focus on the natural savannah and forest areas (including riparian forests) (Ethiopia, Didessa Valley), patches on natural vegetation which remain within the cultivated areas (thickets), on the rocky hills and in the riparian forests (Kenya, Uganda). The floristic composition of the live hedges and the role of network they play for wildlife (movements, refuges), especially for birds, rodents and insects, should be studied in this landscape under a high human pressure. In the Lambwe Valley in Kenya, Maitima, Stones & Tumba (1998) showed that the avian fauna is richer in the human settlements than in the adjacent Ruma National Park. The cause is that human activities tend to increase food resources for the birds by increasing the diversity of plant shrub species.

Vegetation surveys will include the collection of the following data:

- ⇨ Species diversity
- ⇨ Species richness
- ⇨ Density
- ⇨ Vegetation structure {diameter (basal area), height, cover at species level}
- ⇨ Spatial patterns of plant communities
- ⇨ Condition (vigour, mortality, number of damaged trees, etc.)
- ⇨ Regeneration
- ⇨ Status of species

A preliminary survey as a « T0 » must be done as soon as possible, especially in Ethiopia where large areas of natural vegetation still exist. The data could be obtained using methods similar those used by ILRI (transects and plots) in the upper reaches of the Ghibe Valley in south-western Ethiopia (Reid *et al.* 1997). They will permit a comparison of the vegetative characters in different land cover/land use types as well as between different production systems (cultivation techniques, farm sizes). Such a comparison could be also done between wooded grasslands, grasslands (including fallow) and riparian forests.

The tsetse control, using different methods (insecticide impregnated targets, application on pour-on insecticide to cattle, odour baited traps) will lead to a decline of the tsetse flies populations. Thickets are refuges for flies but harbour vegetal and animal diversity. One can expect that it will not be necessary to maintain bush clearing if the tsetse control is efficient.

** Uses of plants*

Although natural resources uses are generally part of the socio-economic studies, the monitoring programme must also focus on the uses of natural resources as food for human and animals, traditional medicine, religious purposes, timber, fuelwood, fibres, dyes, thatch, etc. A good knowledge of plant species is required for such a survey which must be conducted in a close collaboration with the local farmers (traditional knowledge). If the data obtained will show how people are using their natural resources, they will also highlight the difficulties that people meet to get the resources, due to the conversion of natural habitats to cultivation and what is today the part of the traditional culture in such a populated area.

◆ Animal diversity

As for plants, basic data must be collected to establish a medium to long term monitoring programme. It is impossible to think about an exhaustive survey of all the animal groups and only three groups could be selected: medium-large mammals, small mammals, birds, insects (butterflies).

The data needed will concern:

- ⇨ Status of species
- ⇨ Species diversity
- ⇨ Species richness
- ⇨ Density, index of abundance
- ⇨ Distribution (area occupied)
- ⇨ Migrations, movements

❖ Mammals

Monitoring of mammal populations is often difficult to implement and most of the time a costly exercise. In such an area as the FITCA Project, where the land is mostly under cultivation (except in Ethiopia), simple methods to assess selected wildlife populations must be used. In Kenya and Uganda, the low proportion of natural vegetation excludes a survey of large mammals. Medium size mammals (bushbuck, duikers) could be still present at a low density in some vegetation types (riparian forest, woody thickets for example). In the Didessa Valley in Ethiopia, large mammal populations (buffalo, waterbuck, warthog, bush pig for example) still occur in the wooded grasslands, grasslands and forests. According to the landscape (hilly region, low network of roads) and the cost of wildlife surveys, aerial surveys cannot be applied in such an area. For large mammals, line transect sampling will be the most efficient way to make direct observations of individuals and record signs (browse, dungs and tracks). Ground transects, following secondary roads or trails of predetermined direction, will be used in such an area. In both areas, small mammal populations (rodents and insectivores) can be determined by using traps placed on transects (trap lines). These surveys will provide qualitative (species identification) as well as quantitative data (abundance, index) which should be sufficient to monitor the trend within the populations. These data could be completed by interviews with local populations.

❖ ***Birds***

Birds are often been used as indicators of environmental change (Morrison, 1986; Pomeroy, 1991) and are good indicators of local ecological conditions. They are relatively easy to identify (visually or through audible sounds), except for immatures, and numerous identification guides are available. A problem of using birds as indicators is that birds tend to be « cosmopolitan » in distribution, meaning that they can move easily from site to site (Gardiner, 1997). They are many methods described for monitoring land birds (Distance sampling, Timed Species-count), but point counts are the most efficient way to make counts and collect data in forest and grassland habitats (Elzinga, 2001). Data will provide the number and abundance of species in the different types of vegetation and the abundance of species can also be compared between land uses.

❖ **Butterflies**

Butterflies are colourful, readily identified, and fly by day. They are sensitive indicators of changing environmental conditions (Kremen, 1994). Due to the enthusiasm of amateur butterfly collectors, this group is one of the best known within the invertebrates. and various identification guides are also available. As for studying birds, transects in contrasting land use types could be set out to assess the relative abundance of butterflies.

One observer and one recorder can be used to record data. Species difficult to identify must be caught. Butterfly trapnets cal also be hung in the transects to collect species which are difficult to see or to catch by net. Such a study will be especially interesting in the Didessa Valley in Ethiopia. Previous studies conducted in the Ghibe Valley permitted to add new species (*Anthene, Tuxentius, Acraea* and *Bicyclus* genera) to the checklist of Ethiopia (Gardiner, 1998).

**** Uses of animals***

As for plants, uses of wild animals must be addressed. Bush meat is obtained through illegal hunting and little information is known about the consumption by local people. Rodents and insect often play an important role in the diet of children, as a source of proteins, as well as in the traditional culture. The honey production is increasing in the FITCA Project area and local farmers would like to improve their technology for a better production. This can be done in providing better equipment but also through the promotion and conservation of plant species used by the bees.
Uses of animals in the traditional medicine or for religious purposes are not well known in the FITCA project area. Socio-economic surveys should provide information in this issue.

**** Problem animal control***

Human/animal conflicts are increasingly frequent in the overpopulated areas when the land cover changes from natural vegetation and habitats to cropping areas. These conflicts should not be a problem in most of the FITCA area in Kenya and Uganda where large mammals are not more represented. They could occur in heavy cultivated areas, especially with monkeys when patches of natural vegetation remain or with birds, which feed on grains. In the Didessa Valley in Ethiopia, the conversion of relatively pristine areas of savannah and forest into crops will certainly lead, in the first years after people have settled, to conflicts between farmers and large mammals (especially buffaloes) and monkeys.

It would be interesting to assess how the land conversion, after tsetse control, affects the uses of natural resources, plants and animals species, by the farmers in terms of quality, quantity, time spent and distance used to get the products. Such changes in the day life of the populations will affect their traditional culture with the risk of a big loss in traditional knowledge.

3.5 Creation and harmonization of FITCA database

As FITCA-EMMC is a regional component and as it has to deal with national FITCA programmes, at a very early stage raised up the need for an harmonized and comprehensive database system at the regional level.
National FITCA components are undertaking tsetse fly control initiatives for different goals in line with both national and local priorities. FITCA (Kenya) is involved in tsetse and trypanosomosis control to improve livestock production systems and alleviate poverty of the local communities living in the selected areas. FITCA (Uganda) undertakes tsetse and sleeping sickness control initiatives to raise health status and general production systems of their communities. Unlike Kenya and Uganda, FITCA (Ethiopia) is working on tsetse, trypanosomosis and sleeping sickness control programs to open new areas for resettlement and also to improve national economic income. Tanzanian component, which adds number of countries in the regional project to four, has not yet started. These initiatives would generate common data layers on human population, livestock, tsetse, crop and landscape, among other data layers in line with objectives of national component. EMMC would therefore, federate entities of environmental significance from these FITCA national databases. It is important to note that in landscape domain, other data sets like land use, vegetation and soil are completely missing from national components' initiatives. It is therefore, the duty of EMMC to identify existing techniques to acquire these data sets in details.

From a database management point of view, four national databases are completely autonomous, however, EMMC would veto for elements of similarities in some baseline data structures like in human population, livestock, tsetse, crops, plants among others. This would enhance regional and cross boundary information analysis and comparisons.

Conceptually, the structure of EMMC database is a federated database, which draws and updates relevant data from FITCA national components (figure 1). EMMC keeps each national data in selected entities for individual national component environmental change monitoring and management information system. Further, EMMC would combine selected elements of environmental change from federated national database entities to carry out regional and cross boundary analysis.

i. EMMC data base

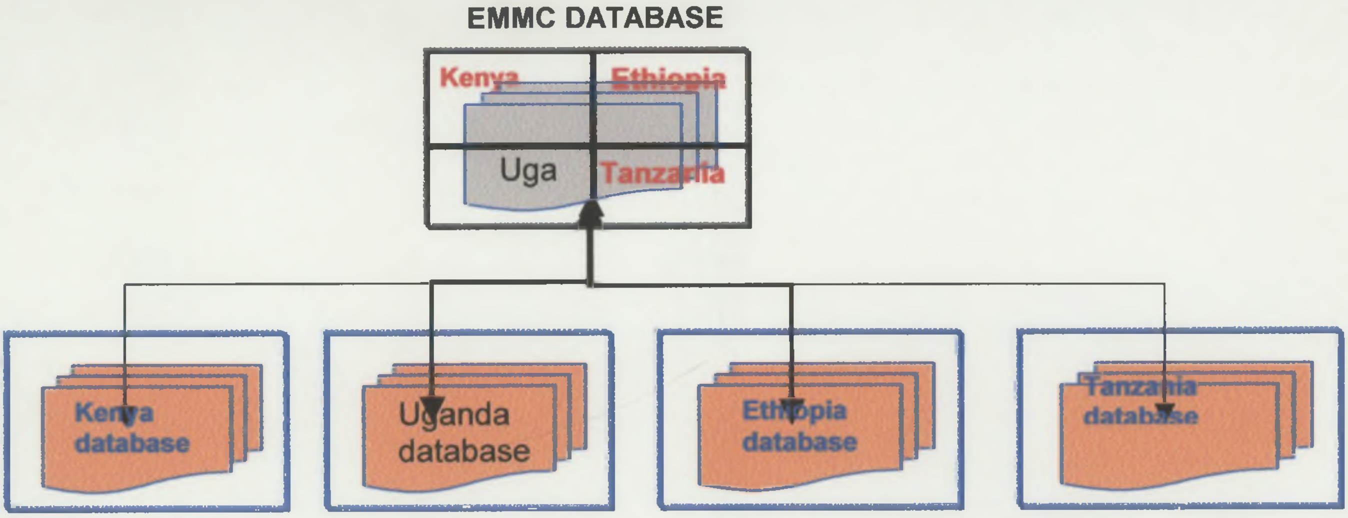


Figure 1: Conceptual link between EMMC database and National FITCA components databases

*ii. **Status of databases in the National FITCA components***

During STC in February and March 2002, the consultants and EMMC personnel undertook data inventory in the three FITCA national component project countries, besides investigating sites prone to environmental change after tsetse control initiatives. Table 1 shows status of data acquisition from the Kenya, Uganda and Ethiopia national FITCA initiatives

Table 1: Shows the status of data acquisition from FITCA national components.

A. Data	Kenya	Uganda	Ethiopia
Human population	1999	1991 (a new one is needed)	1994 (a new one is needed
Household Surveys (socio-economic survey)	2000	Going on	Partly done and planned in some areas
Tsetse, Trypanosomosis and Sleeping sickness	2000 and still going on	Started and will continue (2002)	Partly started in some areas
B. Crop	2000	Going on	Planned
C. Livestock	2000	Going on	Planned
D. Land use \cover	FAO, a detailed and new one is needed	NBS (1996), a detailed and new is needed	Ministry of Agriculture, detailed and a new one is needed
E. Vegetation	Unknown	Unknown	Planned
F. Soil	Unknown	Unknown	Planned

In FITCA (Kenya), a lot of baseline data has been collected and entered into a computer. However, these data are kept in a spreadsheet (Microsoft Excel), which is not a database management package, and therefore does not meet database requirements (Gilles Fournie (STC-2002). FITCA (Kenya) also attempted to import some of the spreadsheet data into Microsoft Access to make a first-hand databases. This approach introduced several database redundancies, which violate database integrity rules. Database team interviewed FITCA (Kenya) database personnel and also reviewed their data, objectives and activities, and made the following recommendations:

- Break down the current data in Excel form into tables to build a new database in a right database management system.
- Review and correct some of the traps records to reflect their actual spatial locations in a uniform projection system.
- Develop a simple user-interface linked to the database to enhance data entry and retrieval for information analysis.
- Select a relational database management package for database development because its flexibility and capability, and easy to use in management of the data already acquired.

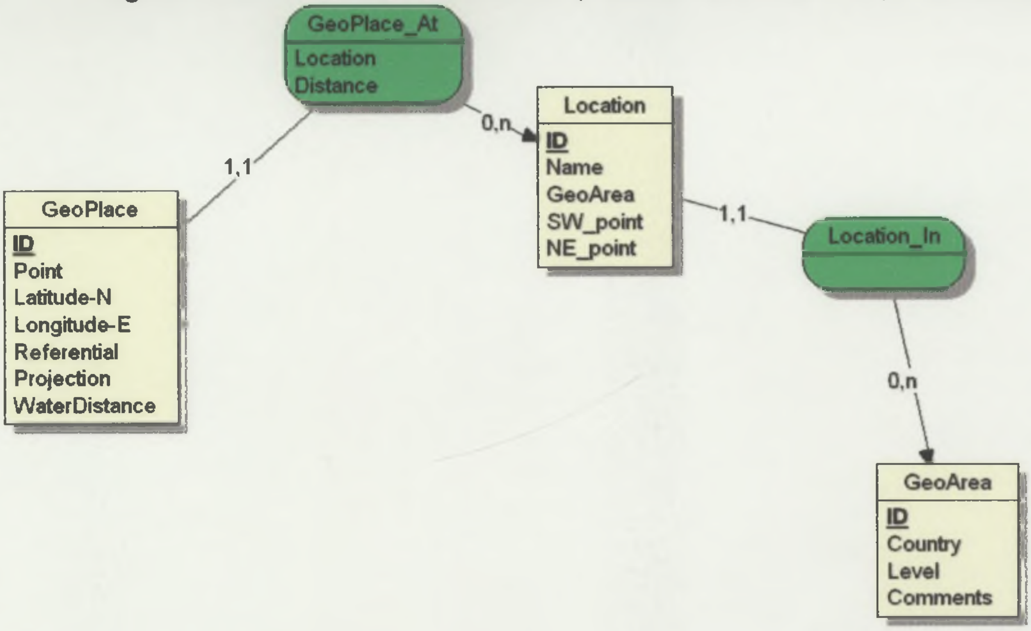
In FITCA (Uganda), the team was presented with a questionnaire of 23 pages containing 122 questions for the on-going household survey. The questionnaire looked very complex to break down into database entities, however, the Uganda project leaders promised to employ a database manager, who will help them breaking down the questionnaire into tables to build a database. No recommendations were made, however, the team suggested a follow up of database development progress by EMMC personnel.

Ethiopia, who is still undertaking administrative arrangement for project, had nothing to present to database consultants, except verbal picture of the project area. Like in Uganda, the development of database of Ethiopia requires a follow-up.

iii. EMMC Database models

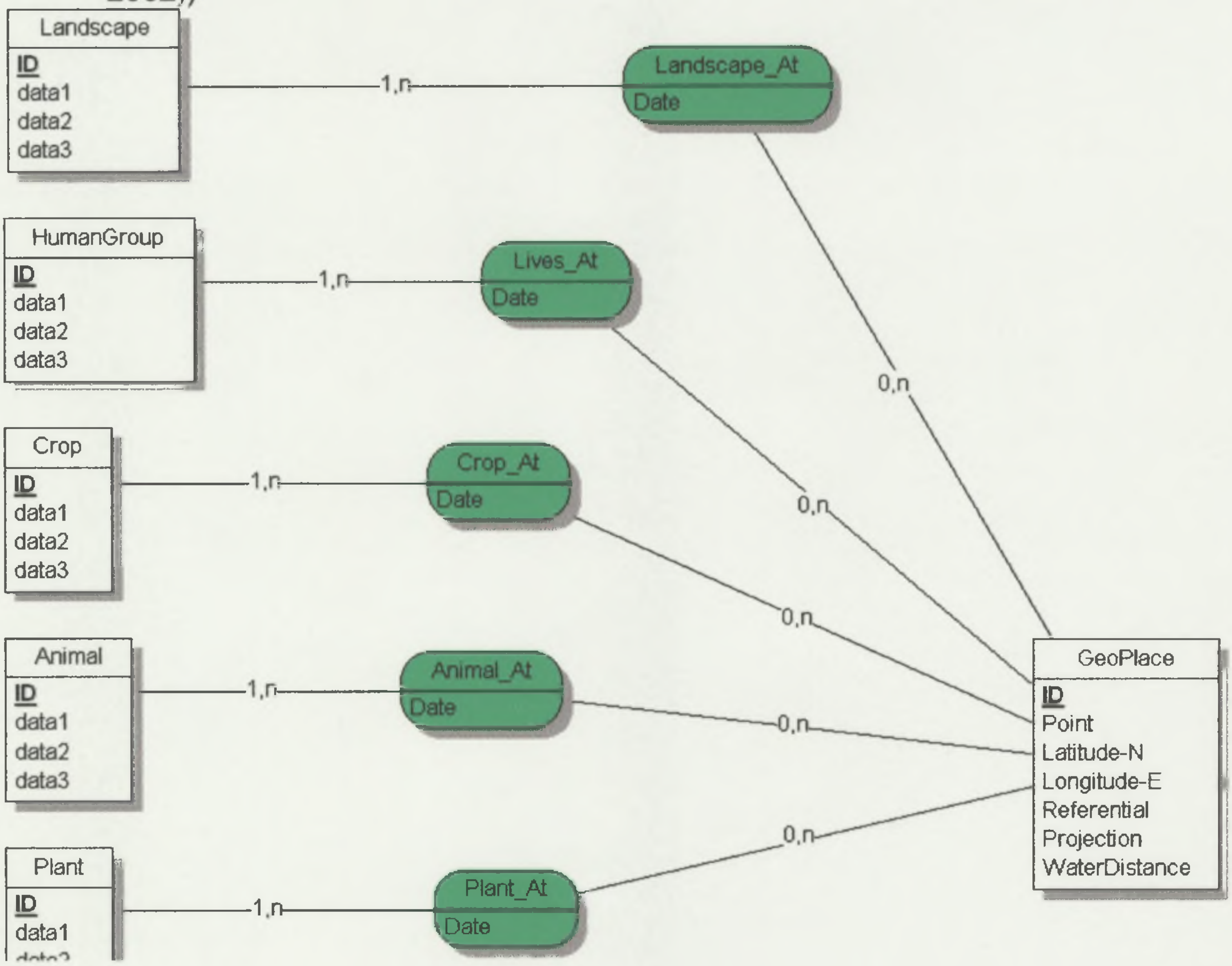
From discussion with scientific team of STC, a list of preliminary data for environmental change monitoring system and their relationship to each other were drawn from national FITCA components' projects documents, data and planned activities' statements. A relational data model was then, developed by a database consultant for either the elements in environmental change or anticipated activities for monitoring the changes; for example location, landscape, traps, trapping and spraying. Figure 2 shows a data model for location, which would provide a linkage between spatial and non-spatial data collected through field surveys using questionnaires, market survey, etc. Figure 3 shows a model of landscape and linkage with location, and figures 4 and 5 present data models for traps and, trapping and spraying respectively. In each data model, the database consultant attempted to provides main attributes to be captured in the EMMC database.

Figure 2: Data model of Location (Source: Gill Fournie (STC, 2002))



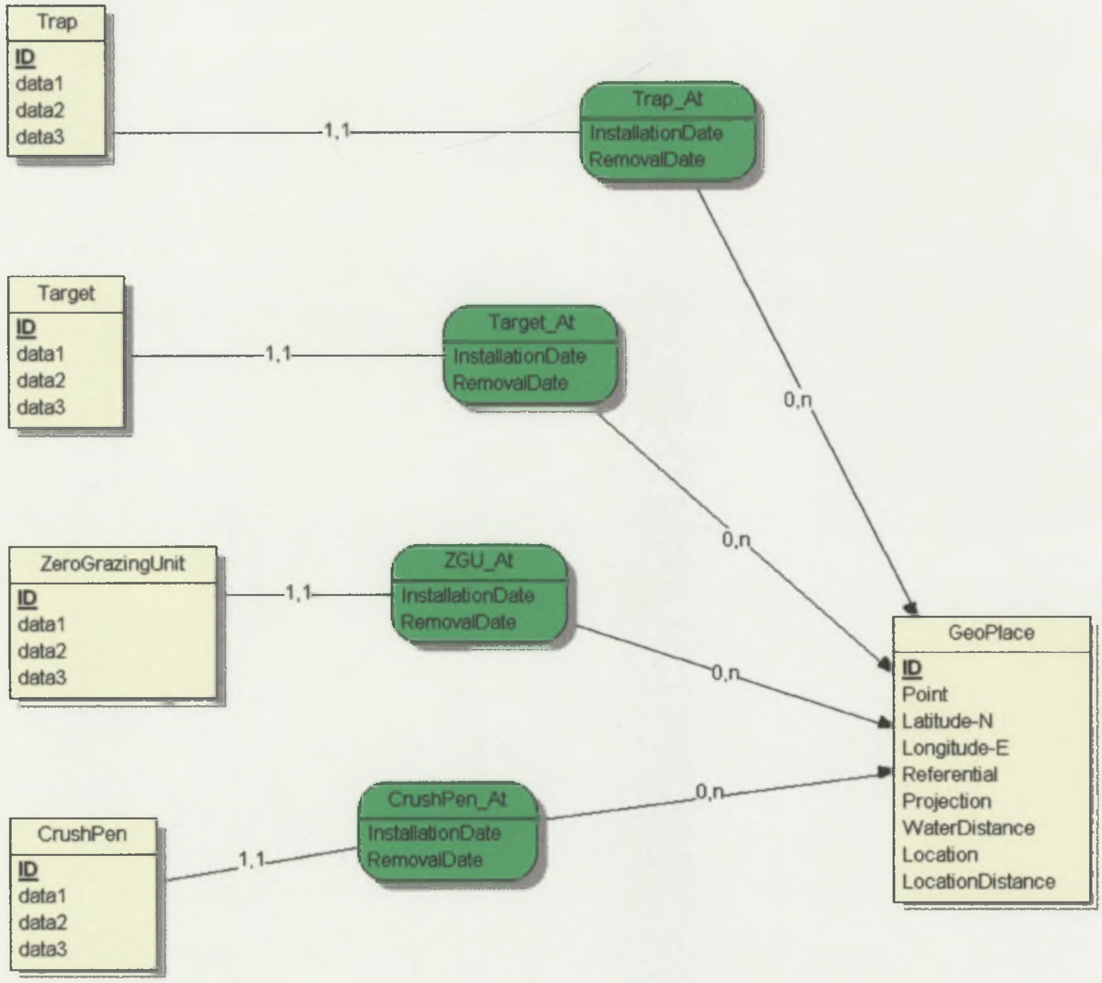
This data model structure provides mapping of data within administrative systems, upon which control initiatives are undertaken. The model captures spatial topological arrangement that exist in actual nature for example a water point 1 in sub-location in a district A in Kenya (for example).

Figure 3: Data model for Landscape analysis (Source: Gill Fournie (STC, 2002))



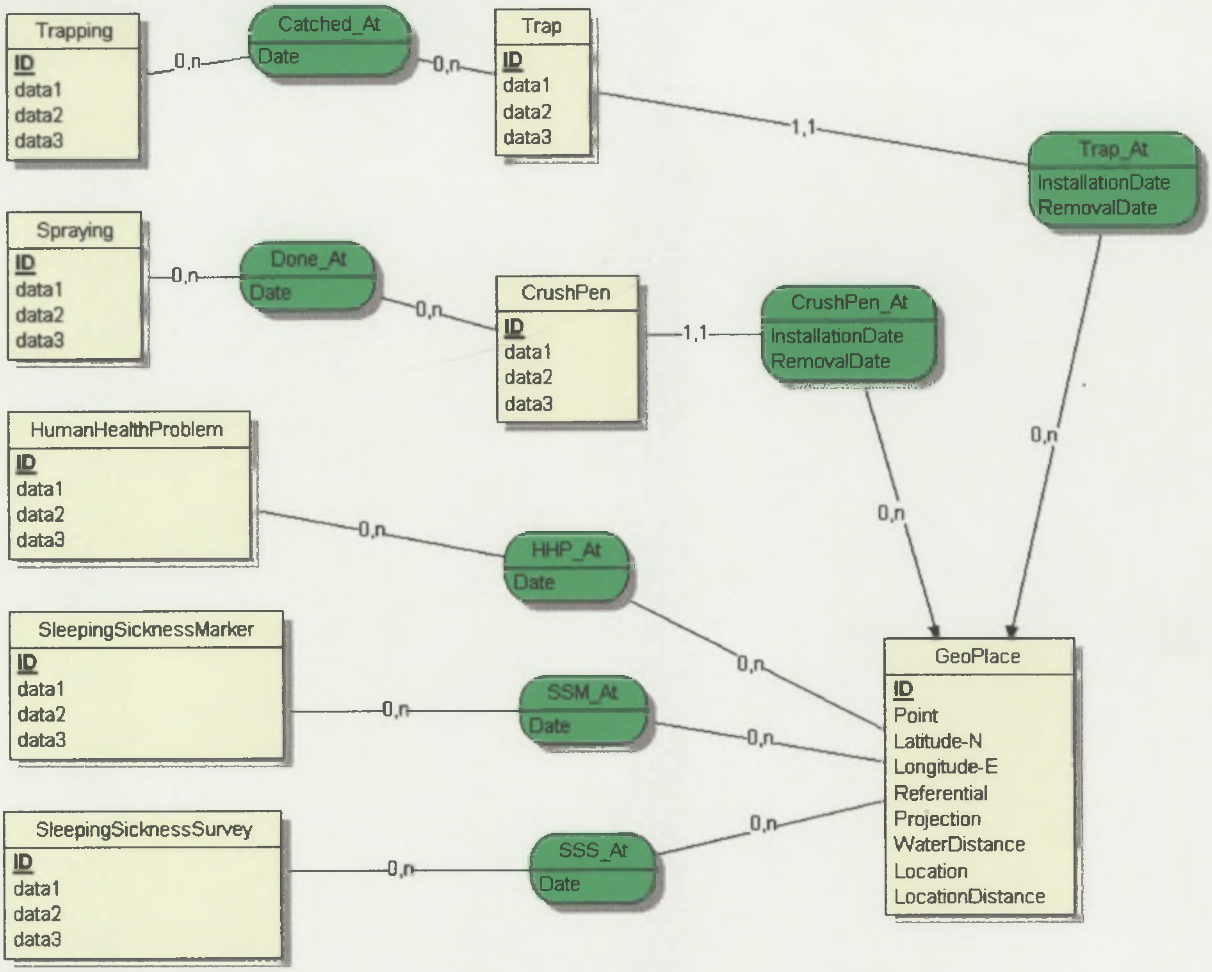
This model captures major landscape parameters together with temporal components, which allow environmental changes analysis to be observed from a database. The *geoplace* provides a link to the mapping activities (see figure 2). Note that some of the data items have been already collected in FITCA (Kenya) component, and they should be collected again for change analysis.

Figure 4: Data model for Traps and Targets (Source: Gill Fournie (STC, 2002))



This data model reflects database structure from FITCA (Kenya). It contains zero grazing and crush pan entities, which uniquely define specific activities undertaken in Kenya initiatives. It can be modified to fit into other activities in Uganda and Ethiopia either by replacing crush pan and zero grazing parts of the model with other activities or collapsing them completely from the mode structure before a database is developed.

Figure 5: Data model for crush Pen & spraying (Source: Gill Fournie (STC, 2002))

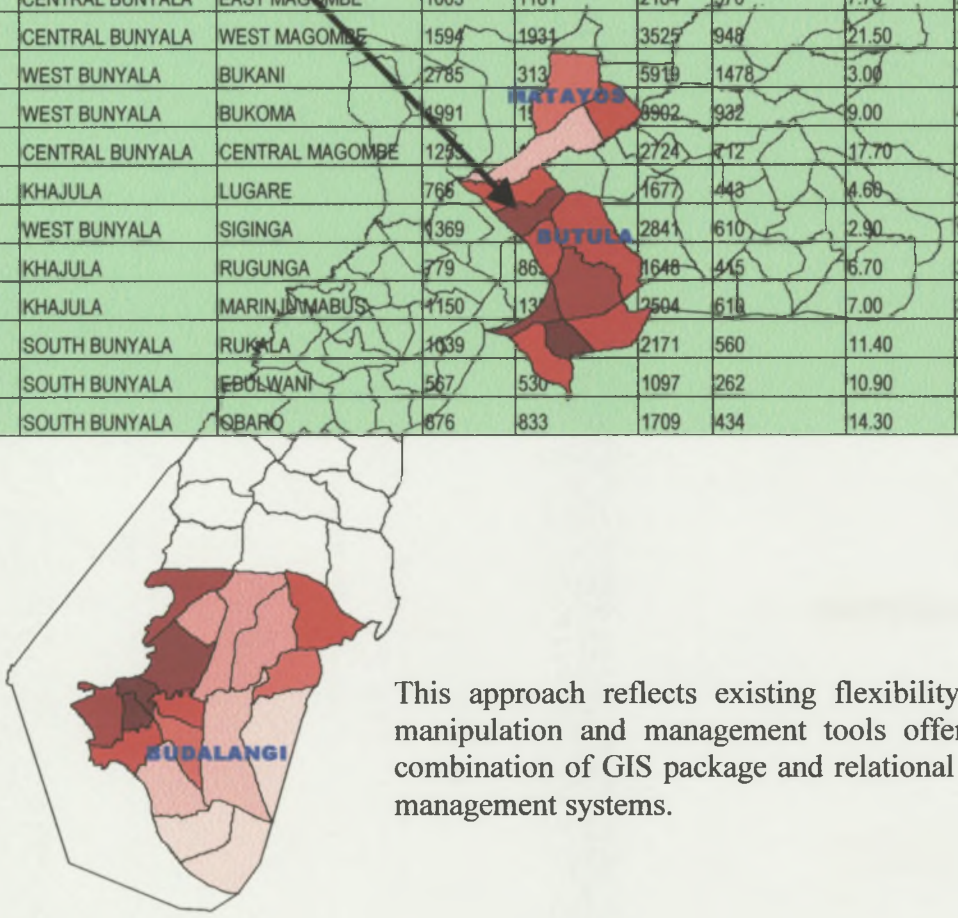


This data model integrates sleeping sickness survey with trapping and spraying as control activities, which is linked to traps and crush pan data model (figure 4). It would fit Uganda and Ethiopia initiatives with a little modification based on approach of tsetse control mechanism put in place.

The implementation of the EMMC database would require a relational database management system linked to GIS packages through Open Database Connectivity (ODBC). Microsoft Access, a relational database management system together with ARC-INFO and Arc-View, GIS packages are already available in People Livestock and Environment (PLE) program. This makes EMMC database implementation cheap and easily accommodated with other projects in PLE. Figure 6 shows a link between landscape elements (human population density) and location (a site in Kenya). This is a prototype of what EMMC database attributes can be retrieved and presented in a map form.

Figure 6: Link between Human population density and administrative boundary (using data models of location and landscape (figures 2 & 3)

DIVISION	LOCATION	SUB-LOCATION	MALE	FEMALE	TOTAL	HOUSEHOLD	AREAKM2	P_DENSITY
MATAYOS	BUSIBWABO	NASIRA	1539	1780	3319	688	12.90	257.29
MATAYOS	LWANYA	BUSENDE	1124	1242	2366	511	7.50	315.47
MATAYOS	LWANYA	IGERO	1158	1364	2522	532	5.60	450.36
MATAYOS	LWANYA	LULIBA	878	1005	1883	403	5.10	369.22
BUTULA	BUMALA	BUSIRE	1048	1257	2305	602	3.60	640.28
BUTULA	BUMALA	BUKHAKHALA	1187	1397	2584	634	7.10	363.94
MATAYOS	BUSIBWABO	ALUNGOLI	1064	1137	2201	438	7.00	314.43
MATAYOS	BUSIBWABO	NAKHAKINA	1109	1283	2392	490	12.60	189.84
BUTULA	BUJUMBA	IKONZO	2961	3425	6386	1413	16.40	389.39
BUTULA	BUJUMBA	BUJUMBA	2430	2865	5295	1172	12.60	420.24
BUTULA	BUJUMBA	BURINDA	1450	1797	3247	847	8.60	377.56
BUTULA	BUMALA	BULAMA "A"	1340	1648	2988	721	4.40	679.09
BUDALANGI	NORTH BUNYALA	SISENYE	1764	1909	3673	725	9.20	399.24
BUDALANGI	EAST BUNYALA	BUDALANGI	1690	1780	3470	842	15.00	231.33
BUDALANGI	EAST BUNYALA	RUAMBWA	1952	2285	4237	979	12.60	336.27
BUDALANGI	EAST BUNYALA	MUDEMBI	1547	1684	3231	694	14.50	222.83
BUDALANGI	NORTH BUNYALA	MUNDERE	662	709	1371	303	6.30	217.62
BUDALANGI	NORTH BUNYALA	BULEMIA	2549	2924	5473	1250	12.20	448.61
BUDALANGI	CENTRAL BUNYALA	EAST MAGOMBE	1003	1181	2184	576	7.70	283.64
BUDALANGI	CENTRAL BUNYALA	WEST MAGOMBE	1594	1931	3525	948	21.50	163.95
BUDALANGI	WEST BUNYALA	BUKANI	2785	313[illegible]	5919	1478	3.00	1973.00
BUDALANGI	WEST BUNYALA	BUKOMA	1991	[illegible]	3902	932	9.00	433.56
BUDALANGI	CENTRAL BUNYALA	CENTRAL MAGOMBE	1255	[illegible]	2724	712	17.70	153.90
BUDALANGI	KHAJULA	LUGARE	765	[illegible]	1677	443	4.60	364.57
BUDALANGI	WEST BUNYALA	SIGINGA	1369	[illegible]	2841	610	2.90	979.66
BUDALANGI	KHAJULA	RUGUNGA	779	86[illegible]	1648	415	6.70	245.97
BUDALANGI	KHAJULA	MARINJ[illegible]MABUS	1150	13[illegible]	2504	610	7.00	357.71
BUDALANGI	SOUTH BUNYALA	RUKALA	1039	[illegible]	2171	560	11.40	190.44
BUDALANGI	SOUTH BUNYALA	EBULWANI	567	530	1097	262	10.90	100.64
BUDALANGI	SOUTH BUNYALA	OBARO	876	833	1709	434	14.30	119.51



This approach reflects existing flexibility of data manipulation and management tools offered by a combination of GIS package and relational database management systems.

3.6 Mapping of other Landscape Elements Using Remote Sensing Techniques

During STC data inventory, data on land use, vegetation and soil, which meet the EMMC level of details and date of acquisition requirements, were not available. National Biomass Study from Forest Department, Ministry of Natural Resources in Uganda has a land use\cover data produced in1996 from satellite remote sensing imagery. This data was compiled at scale of 1:50,000, combined, and generalized several land use classes to reflect national land use status in Uganda. The Land use consultant together with the EMMC team analyzed this data and dropped it, because it is too coarse to capture the details of land use activities of major environmental interest in the selected sites.

Africover project, which is funded by FAO, also have produced a land use data for Kenya and other countries within central and east of Africa. This data could is not yet available in public domain, however, the team arranged to visit the FAO in late date to view their land use and find out if it can be applicable in EMMC land use analysis for environmental changes within selected sites.

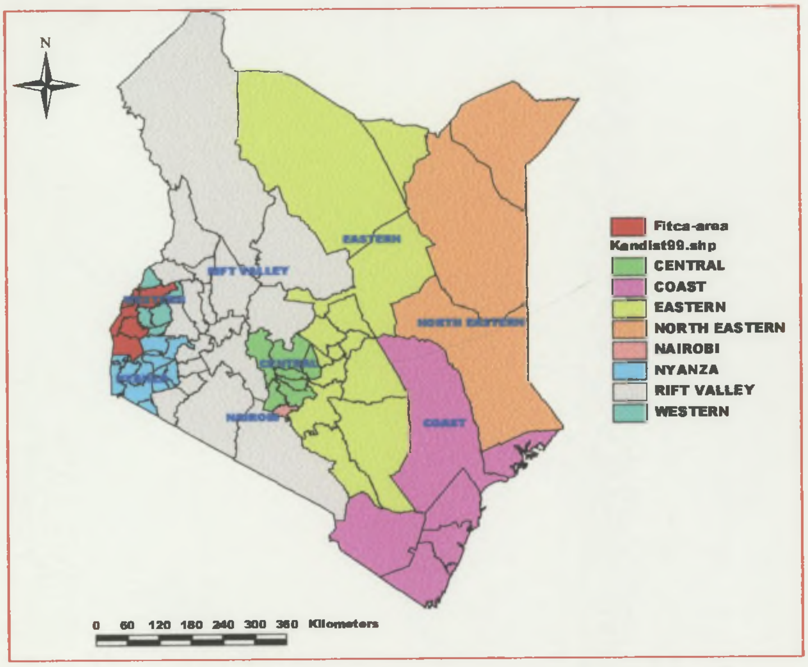
Similarly, Ethiopia land use data has been capture by Ministry of Agriculture using satellite imagery, however, the information about the details, date of production and rules of accessibility were not available, when the consultant and EMMC team were in Ethiopia. A follow up of getting these information were recommendation.

In the absence of land use, vegetation and soil, EMMC proposed the use remote sensing techniques to capture past and current land use activities within the selected sites in the project countries. The question of which satellite platform and suitable data temporal resolution to adopt is still being discussed with consultants and other stakeholders. The guiding factors for the technique adoption would depend on: -

- Size of EMMC site in each country
- Cost of the imagery\ Photography
- Landscape elements that influence environmental changes
- Length of time to monitor the landscape elements
- Level (details) of monitoring changes
- Once a platform is selected each site will be mapped and data is achieved in EMMC database in each national component.

The discussion on the choice of the platform for mapping land use and vegetation in the Kenyan and Ugandan (figures 7, 8 and 9) sites has been narrowed down between SPOT5, IKINOS, and Aerial photography at scale of either 1:10,000 or 1:20,000. Unlike the above, the Ethiopian sites would be mapped using SPOT5 imagery because of their large size and cover homogeneity characteristics observed during the fieldwork. EMMC would also undertake ground-sampling surveys for vegetation and soil mapping, besides the conventional ground trusting requirements in satellite image analysis. Use of GPS for survey orientation is considered too.

Figure 7: FITCA (Kenya) project area (districts) and EMMC sites



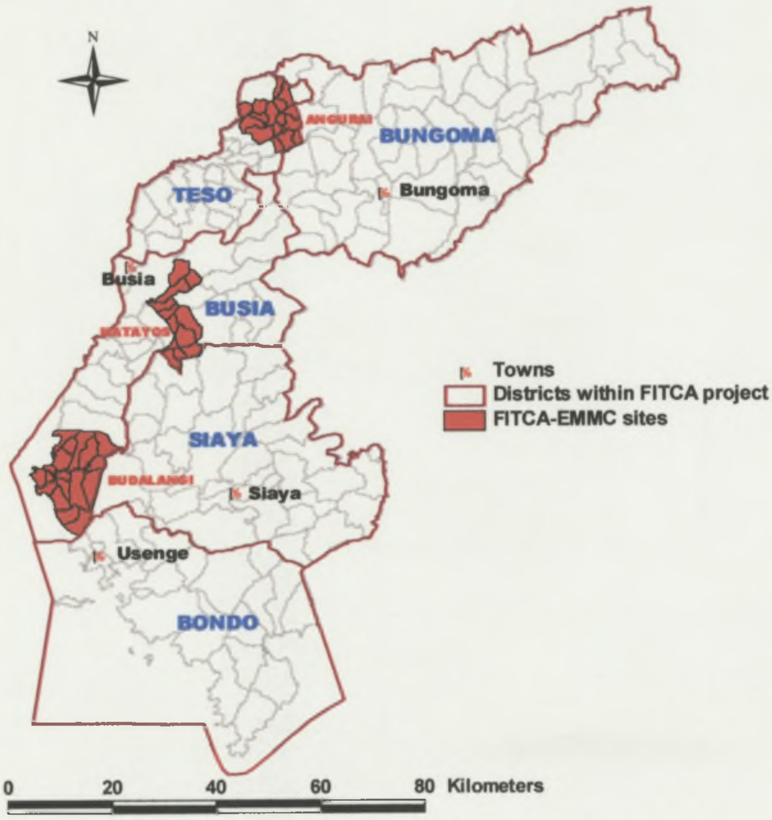
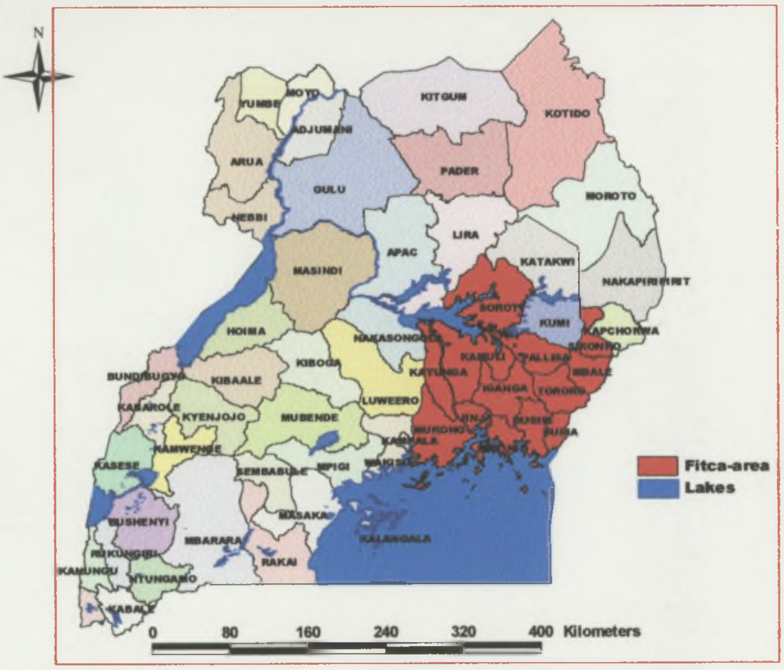


Figure 8: FITCA (Uganda) project area (districts) and EMMC sites



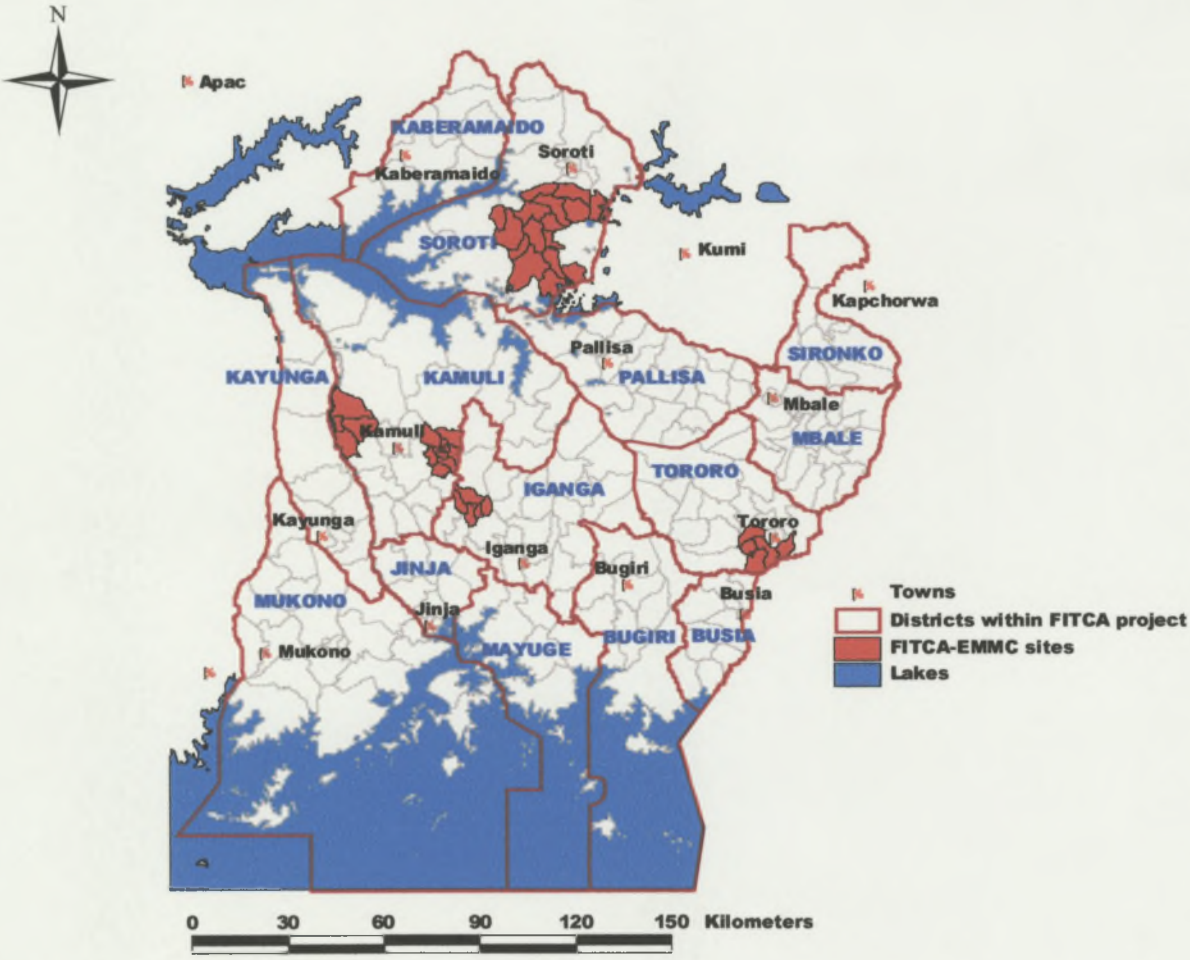


Figure 9: **Attempted aerial photography flight plan**

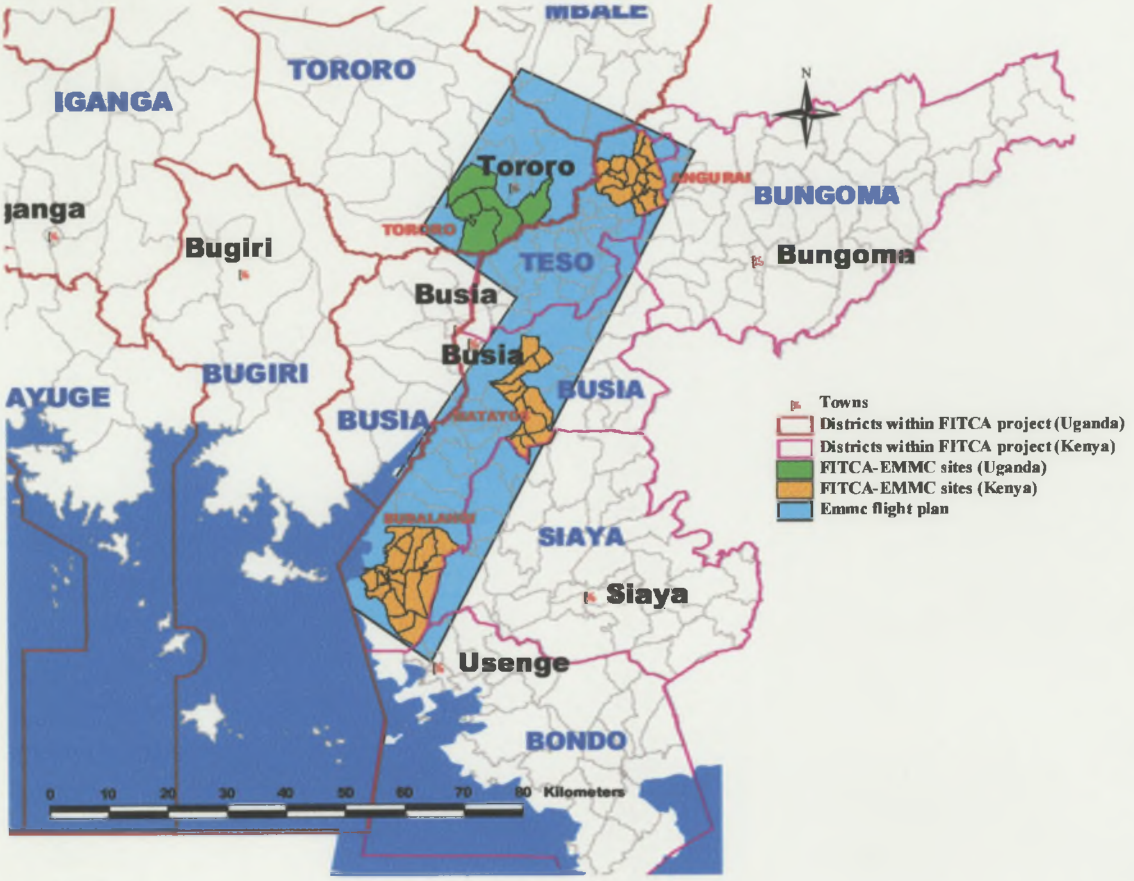
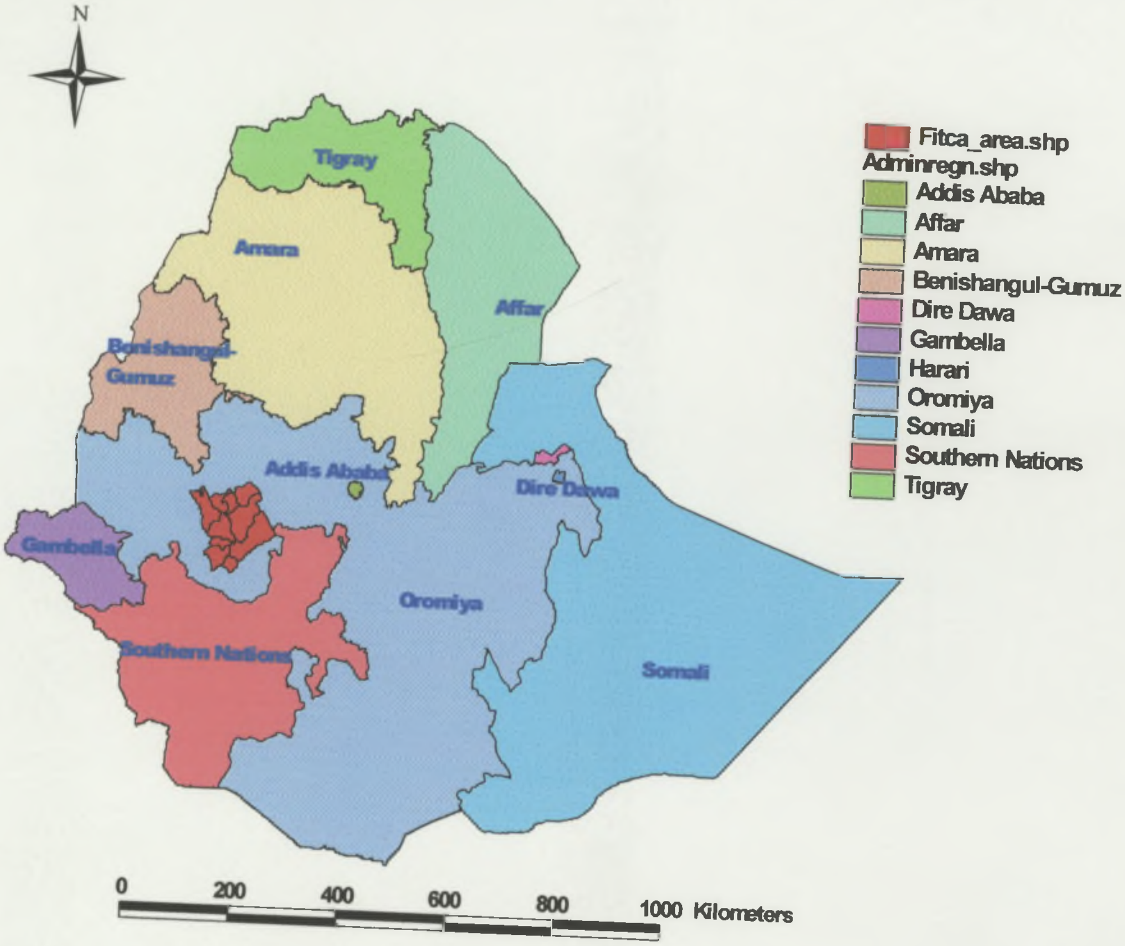


Figure 9: FITCA (Ethiopia) project area (Weredas)



3.7 Outputs

- ***Back to office reports***
  - 17-24th June 2001 Western Kenya & Uganda
  - 25th September-5th October 2001 Ethiopia
  - 21-25th November 2001 Uganda
  - 30th November-6th 2001 December

- ***Meeting reports***
  - Coordination meeting with FITCA Uganda 13-15/01/2001
  - C2I-ILRI strategic alliance meeting 19-20/04/2001
  - Meeting with KETRI 30/05/2001
  - FITCA regional 16th Ministerial meeting 4-7/07/2001
  - FITCA regional technical coordination meeting 23/08/2001

- ***Short term consultancies reports***

  A set of seven TOR for STC was drawn. The five first ones were conducted in February and March 2002. Progress reports are available and final reports expected. The sixth one will take place in May 2002. Up to now no expert is identified to carry out the last one.
  The chapter III will report main outputs of these consultancies.

  - Agro-ecological and agro-pastoral baseline survey in the FITCA Regional area
  - Community profile analysis in the FITCA Regional area
  - Regional and National FITCA database harmonization
  - Assessment of disease risk and tsetse challenge
  - Landscape and land use analysis using satellite imagery at the FITCA regional and National level
  - Community based training in safe handling, use and disposal of insecticides
  - Historical approach of tsetse control policy in the FITCA Regional area

- ***PowerPoint presentations***
  - 8 slideshows were developed to present FITCA-EMMC to different publics. They should be the frames of the future EMMC Website.

- ***International Conference communication***
  - BOURZAT (D.), REID (R.) 2001 – FITCA and environment.
    Ouagadougou, 26th ISCTRC Conference 1-5/10/2001
  - BOURZAT (D.), 2002 – Concept note : Livestock-human & animal health-environment.
    Addis Ababa, 6th Livestock and Veterinary Ministerial Conference 18-22/04/2002

CONCLUSION

The Environmental monitoring and management component of FITCA is now completely operational. Administrative burden has delayed the launching of the field works. A comprehensive review of scientific papers and publications associated with field visits with FITCA national programmes and support of STC from SEMG gave to the project team, the opportunity to identified in the different countries the pilot areas where the environmental monitoring will take place.
The landscape entry is privileged according to the suspected importance of indirect impact of tsetse control on land use and landscape.
Different tools will be used to monitor the changes.

The choice of the monitoring sites in the different countries was done according a continuum of land use situations, from the most cultivated and very high-density populated areas in Western Kenya and Uganda to the natural forest, which is under beginning of deforestation in Ethiopia. Intermediate situations are also considered (Victoria Lake shores, swampy areas in Uganda and peri-domestic habitats in Western Kenya).

The efficiency of this trans-boundary approach is highly related to the quality and accuracy of the regional database system under development. There is a need for a federative database system co-managed by the regional and nationals FITCA teams.

As most of these studies will be a forward-looking assessment because it is unlikely that there will be significant impacts on biodiversity in the first 4 years of the project, it appears crucial that Ghibe valley in Ethiopia, will be included in the project (even it is only bordering FITCA Ethiopia area)
This is the only place in the region where there are continuous environmental surveys before and during the tsetse flies' control operations. The Ghibe valley is parallel to Didessa valley and could be considered as very close environmental situation.

The environmental management with the communities needs a huge involvement of sociologists and community participatory specialists. The secondment of the formers by NAR's was delayed and it is not sure that the national institutions concerned have the human resources for these positions.
A tentative approach on this topic is undergoing with main Universities of the region.
The financial component of the initial service contract was reshaped in order to provide more management flexibility. The rigid repartition in between fixed and direct costs has speed down the first year of the EMMC. It appears clearly at the analysis of the financial level of payment.

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