Environmental Impacts Assessment

(EIA - Study Report)

On

Sequential Aerosol Technique Applications

(SAT Application)

In

Meru Conservation Area

Proposed By

Ministry Of Livestock Development

Through

Kenya Tsetse and Trypanosomiasis Eradication Council

Study by

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Executive Summary

In Kenya tsetse and trypanosomiasis occur in 38 out of 47 counties. To contain trypanosomiasis Kenya losses close to 70 million through importation of trypanocidal drugs, despite this high cost the country loses close 5% of our cattle due to mortality attributed to this disease. About 23% of arable land is not sustainably utilized because of tsetse and trypanosomiasis .Close to 5 million Kenyans in the Lake Victoria basin are at risk of Human sleeping sickness.

Under the economic pillar in the Kenya vision 2030, the eradication of tsetse and trypanosomiasis in the MCA will achieve the objectives of the flagship projects namely the establishment of disease free zones and the envisaged opening up of the parks for increase in the number of tourist

Aerial spraying as a technology is not new in this country it has been used in Lambwe valley In 1968, 1981 and 1985 for control of sleeping sickness .Further aerial spraying has been used in control of *Quelea qeulea* bird in Mwea Irrigation Scheme, wheat pests in Narok, Naro Moru, pests in tea plantations , and for desert locust in Inter Governmental Authority on Development(IGAD) countries

Sequential Aerosol Technique is a superior technology with computerized aerial application of insecticide using a fixed wing air craft fitted with GPS navigation system that delivers insecticides pulverized by atomizers into ultra low volume aerosols**.** After SAT application about 4.5 million people will be able to incorporate livestock keeping in their production systems , large tracks of the land will be opened up for crop and livestock production. Studies have shown that the temporary negative impact on biodiversity will be mitigated through an elaborate EMP.

Kenya Government through the ministry responsible for livestock development and through the Ministry's institution mandated to control and eradicate trypanosomiasis in the country is planning to apply SAT in Meru Conservation area as a pilot project for Kenya. MCA which comprises of Meru National Park, Kora National Park, Mwingi National Reserve and Bisanadi National Reserve and some of the areas surrounding these reserves is considered ideal for this application based on tsetse distribution, the terrain and the ecological consideration. Government had received funds from ADB to carry out this application and wishes do so as soon as possible and then latter after evaluation of the effectiveness of this pilot project will roll out to other tsetse infested areas of the country.

Following thou rough research by a team of consultants this report has been prepared for the purposes of identifying environmental and social impacts likely to occur as a result of the proposed application and suggest ways in which the impacts can be avoided or mitigated. The report is also to be submitted to the National Environmental Management Authority (NEMA) for purposes of fulfilling the requirements of EMCA 1999 for approval of Environmental Impacts Assessment Study.

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INTRODUCTION

The tsetse-transmitted trypanosomiasis in man and domestic animals poses a serious threat to the lives and livelihoods of rural communities in Africa and constitutes the greatest single constraint to livestock production. According to the World Health Organization (WHO), more than 40,000 cases of human sleeping sickness are registered every year. It is estimated that tsetse flies are distributed over 11 million km^2 of Africa which is about 37% of the continent. Presently out of the 178 million heads of cattle in Africa, 44.7 million are at risk.

In Kenya tsetse and trypanosomiasis occur in 38 of the country's 47 counties which is approximately 138,000 km^2. The number of cattle, goats, sheep, and camels at risk of trypanosomiasis in areas surrounding MCA alone is estimated to be over 8 million. Wildlife in most of our national parks and reserves are also at risk while 5 million people are at risk of infection by sleeping sickness.

Economic loses attributed to tsetse and trypanosomiasis infestation occurs due to the following:

- Cost of treatment of people and Livestock
- Mortality of infected domestic and wild animals
- Loss of human lives.
- Unproductive sick people
- Abortion by both people and livestock
- Loss of Milk
- Loss of draught power and inability to plough at all in certain areas.
- Inability to graze in certain areas.
- The inability to market livestock, or lower prices obtained for trypanosomiasis infected animals.
- Lose of income and foreign exchange from tourism due to inaccessibility to our tsetse infested national parks
- Loss of foreign exchange through loss of opportunities to export livestock and livestock products.
- Economic losses on poor crop productivity due to reduced or unavailable animal draught power, lack of animal manure and the potential for energy from biogas.

Tsetse and trypanosomiasis control began in the colonial times and various attempts from the ground spraying of organo- chlorines and organophoshates, trypanocidals and use of targets and traps have been tried in the last century but the disease still ravages the African continent.

This necessitated the Heads of States in 2000 in Lome Togo to make the decision (Decision AHG/156 (XXXVI) of the 36th African Union Assembly of Heads of State and Government to eradicate tsetse and trypanosomiasis in Africa.

Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) was established at the Agricultural Commission of the African Union in Addis Ababa in 2001 to coordinate the

eradication in Africa. Kenya was among the first six countries selected to implement this decision. In Kenya, the decision is being implemented through Pan African Tsetse Trypanosomiasis Eradication Campaign (PATTEC-Kenya) established within the department of Veterinary Services of the Ministry of Livestock Development. PATTEC – Kenya has now been institutionalized as Kenya Tsetse and Trypanosomiasis Eradication Council (KENTTEC) within the ministry of Livestock Development.

The National Livestock Policy 2008 has identified tsetse and trypanosomiasis eradication as a priority for improving livestock productivity. Therefore the intended aerial spraying for MCA is a strategy towards achieving this specific policy objective.

The distribution of tsetse flies in Kenya occurs in ecologically defined areas referred as tsetse belts. There are 7 belts tsetse fly belts as summarized below.

1. **Lake Victoria basin fly belt: (Extending to Uganda and Tanzania).**
   This covers Suba, Rachuonyo, Kisumu, Nyando Siaya, Bondo, Busia, Teso, Bungoma and Mount Elgon districts.

2. **Narok - Kajiado fly belt: (Extending to Tanzania).**
   This covers Migori, Kuria, Gucha, Bomet, Kajiado, Narok and Transmara.

3. **Lake Bogoria - Baringo - Kerio Valley - Koibatek - Turkwell fly belt:**
   This covers, West Pokot, Turkana (extending to Uganda), Keiyo, Nakuru (Solai) and Marakwet districts

4. **The Central Kenya fly belt:**
   This covers upper Tana River drainage system, Kangundo, Yatta, Masinga, Makueni, Mwingi, Thika, Embu, Mbeere, Meru south, Meru East, Nyambene, Lower Thika and Maragua districts

5. **Isiolo- Samburu fly belt:**
   This covers Isiolo, Samburu and Laikipia districts

6. **Coastal fly belt: (Extending to Somalia and Tanzania).**
   This covers Taita Taveta, Kwale, Kilifi, Malindi, Lamu, Mombasa, Ijara and Garissa.

7. **Isolated fly belts:**
   Moyale, Wajir, Turkana, Marsabit and Mandera (Daua river system)

In addition to improving livestock productivity, freeing the Meru Conservation Area (MCA) of tsetse and trypanosomiasis is crucial in the achievement of Kenya Vision 2030 flagship projects that include establishment of Disease Free Zones and opening more parks to visitors. Tsetse and trypanosomiasis eradication in MCA will also contribute to the realization of Millennium Development Goals especially Eradication of Extreme Poverty, Hunger and Diseases. Similarly, freeing areas adjacent to MCA of tsetse and trypanosomiasis will help to reduce conflicts over grazing resources among the herders, promote healthy domestic and wild animals to increase

productivity, and open MCA for tourists who would otherwise avoid visiting tsetse infested areas for fear of insect bites and contracting trypanosomes.

Background and justification

Aerial spraying as a technology is not new in this country. In 1968 following a sleeping sickness epidemic in the Lake Victoria Basin, WHO/UNDP conducted aerial spraying in Lambwe Valley to control tsetse flies. In 1981 another outbreak of sleeping sickness necessitated aerial spraying in the same area that was sponsored by Lake Basin Development Authority (LBDA). A repeat of the exercise was done in 1985 and it was also sponsored by LBDA.

Aerial spraying has been used in *Quelea qeulea* bird control in Mwea Irrigation Scheme. Similarly, wheat farmers in Narok , Naro Moru have been using aerial spraying annually to control wheat pests and diseases. The tea industry use aerial spraying for the control of pests and fertilizer application. Inter-Governmental Authority on Development (IGAD) countries under Desert Locust Control Organization (DLCO) have been using aerial spraying as a method of choice for locust control over the years in much more fragile ecosystems than where tsetse flies are found.

Sequential Aerosol Technique (SAT) is a refined aerial spraying that use an ultra low volume (ULV) spray drift technique that applies minute amounts of insecticide from aerosol generators fixed to low flying aircraft. An active ingredient of the size of an aspirin tablet will be uniformly applied to a field of the size of a football field. The spray will consist of an 0.35% active ingredient (a.i.) formulation of deltamethrin diluted in an unspecified solvent and emitted to give a dose rate of 300mg a.i. per hectare in droplets of 25-35µ v.m.d.

The Botswana Government using SAT was able to eradicate tsetse flies in an area covering 10,000 km^2 over the Okavango Delta that is a Ramsar site. Since the application of SAT in 2004, several monitoring operations have been made and have confirmed no single group of organisms has been adversely affected.

Currently the countries of Angola, Zambia and Namibia are carrying out Aerial Spraying employing of SAT in a block covering 6000 km^2 out of the projected 30,000km^2 along the River Zambezi Basin that forms their common border.

Ghana and Burkina Faso have used SAT on a 7,000 km^2 block stretching along banks of Black Volta River in an effort to eradicate *Glossina tachnoides*.

Meru Conservation Area (MCA) which covers about 5,000 km^2 is within the range that is considered feasible and economical to use SAT as a preferred eradication method given the experiences of other countries that have successfully implemented eradication programme using the technology. A risk assessment study for the application of SAT in MCA was commissioned by PATTEC and a report was made (Cybister 2009) that considered all environmental characteristics in MCA including the conservation areas, surrounding land uses and socio-economic practices. The study reports no significant risk that would prevent application of SAT in MCA.

SAT usage in the MCA is justified in terms of the cost implication, convenience, applicability in an Area-wide eradication campaign as compared to other tsetse eradication methods that include target technology, trapping , insecticide application on animals and Sterile Insect Technique(SIT). More over application of these alternative methods are not feasible in a national park or national reserve due to presence of wildlife that have been found to damage the targets and traps.

A large proportion of the tsetse infested area in the MCA is in the conservation area , which is not accessible to members of the public , through SAT application, all areas will be accessed and work will be accomplished quickly. This will helps to militate against vandalism of targets by scrap metal dealers, wild animals and poachers.

The aerial spraying in the control of agricultural pest in tea plantations, wheat farm, and locust control have been done within the provisions and guidelines developed by the National Environment Management Authority (NEMA). SAT will similarly adhere strictly to the provisions and guidelines of EMCA 1999.

The proposed approach is consistent with the way SAT was applied in other countries namely Ghana, Botswana, Angola, Zambia and Burkina Faso. In terms of the in- expansiveness of the areas, ecological condition, and tsetse fly infestation MCA is very similar and we expect to achieve the same success as already realized in these applications..

SAT as a technology is not only cost effective and efficient in the use of resources to achieve the objectives of tsetse eradication but also superior in science and technology. In many respects, the method presents a well researched innovation and improvement of traditional aerial spraying.

Objectives of the EIA

In compliance with EMCA 1999, and other international regulations, PATTEC this activity is to conduct an environmental and social impact assessment study prior to implementation of SAT in MCA. The study will prepare a report how the proposed activities will affect the environment and and advice on the mitigation measures that may be required to avoid and minimize any adverse effects. The study will develop a comprehensive Environmental and Social Management Plan (ESMP) covering all potential environmental and social impacts the project is likely to generate in all the phases of implementation.

Terms of reference

Proposed Study

This project is to conduct environmental impacts assessment for the proposed SAT applications by PATTEC in order to guide on methods of how to avoid or minimize impacts associated with SAT applications and to provide the statutory requirement document for EIA approval by the National Environment Management Authority (NEMA).

Most of the area earmarked for SAT application is in wildlife conservation with no other economic activities i.e., aside from tourism, there are no other activities allowed in the MCA but encroachment for graze, browse and water occurs in both parks and the Bisanadi and Mwingi reserves, especially during drought.

Cropland to the west of the CA is high potential but supports a largely subsistence-based agriculture. Twelve km to the west of MNP is Maua, with a population of >10,000 that enjoys enormous cash income from the cultivation of miraa or khat (*Catha edulis*). Widely cultivated in the Nyambene Hills, miraa is the primary source of income and the product is widely exported, notably to Somaila, Yemen and the UK. Its value reflects quality and earns – between KSh 100-600 kg^{-1}. Miraa suffers a wide range of pests and diseases that damage newly growing shoots, stems and leaves. The use of crop protection measures was once limited to botanicals (e.g. *B.t)* but synthetic pesticides are being increasingly employed.

Programme Concept and Rationale

The programme for the implementation of the PATTEC initiative is being executed in phases, each phase involving as many projects at a time as the available finances can support. The finances to support the implementation of projects will be derived from the affected countries, the African Development Bank Group and other partners. The programme is based on the principle of the area-wide approach in Integrated Pest Management and organized as a systematic process of suppression of tsetse flies with aim to eventually eradicate the tsetse flies from specific areas at a time. Surveillance, diagnosis and treatment of sleeping sickness in humans and nagana in livestock in each project area are also being undertaken.

The programme will integrate all available technically feasible, cost effective and environmentally acceptable tsetse intervention methods, including tsetse trapping systems, application of insecticides (through traps, targets, ground spraying or Sequential Aerial Technique) with the Sterile Insect Technique. The strategy employed in the implementation of the programme is to systematically create tsetse-and-trypanosomiasis-free zones, beginning with identified areas in selected countries and expanding the areas of intervention in roll-the-carpet fashion through a sustained action in subsequent phases.

The overall goal of the programme is to contribute to halving poverty by 2015 and promoting economic growth to the target 8% necessary to reduce poverty and enhance food security in Africa. The primary objective of the programme is to eradicate the tsetse flies from the 37

affected countries in sub-Saharan Africa and so remove the constraint on agricultural production and human productivity.

Objectives of Environmental Impact Assessment Study

Description of the Assignment

The Government of Kenya through the ministry of Livestock Development and the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) intend to spray insecticide over the Meru Conservation Area (MCA) and the surrounding areas to eradicate tsetse and trypanosomiasis and give better opportunities for people to participate in national economic growth, improving food security, and providing for better human well being by improved livestock health and hence productivity. The spraying will be done using low dosage Deltamethrin – a biodegradable parathyroid, using a fixed wing aircraft through the method commonly known as Sequential Aerial Technique (SAT).

MCA comprises of Meru National Park, Bisanadi National Reserve, Mwingi National Reserve and Kora National Park lying on the north eastern side of Nyambene hills. These wildlife protection areas have many species of fauna and flora, variable environmental habitats (including rivers, streams, wetlands, forests, open savannas etc,) and have a thriving tourism industry. The MCA is surrounded by communities that practice diverse forms of livelihood support strategies ranging from solely pastoralists, mixed crop -livestock producers, and entirely crop based farmers.

As is required by law EMCA 1999, and other international regulations, such an activity is required to undergo an environmental and social impact assessment study prior to implementation to ascertain that the planned activities do not affect the environment and people, and advice on the mitigation measures that may be required to avoid and minimize any adverse effects. The study should develop a comprehensive Environmental and Social Management Plan (ESMP) covering all potential environmental and social impacts the project is likely to generate in all the phases of implementation.

Study Methodologies

The consultants will carry out the assignment according to the following NEMA standard format for **EIA** study which include but not limited to the following:

Literature survey to establish

- How the proposed activities will affect people in MCA and the neighbouring settlements.
- The organisms at risk in different ecological habitats MCA and the surrounding areas
- The environments where Deltamethrin may accumulate to concentrations higher than expected due to topographic, land cover or other unique features within the areas where SAT will be applied.
- Baseline information relevant to identifying and quantifying impacts on all non target organisms e.g., arthropods, etc.

- Analyze the relevant e national and international regulatory statutes applicable to the proposed activities in the proposed area in order to ensure full compliance with required standards. In cases where to attain the required standards may require interventions of stakeholders, identify theses stake holders and the roles they need to play in order to avoid or reduce adverse effects based on your anticipated impacts.
- Review all relevant sector development documents applicable to the proposed project area, and show how the anticipated environmental and social impacts are likely to affect their ongoing or planned activities.
- Determine chemical bio- accumulation in the environment, living organism, their half lives in the various organisms and the effects.
- Where baseline data exists on the current wildlife populations show how they will be affected by the proposed activities, and where such data may be absent, use information of the environmental impacts from applications of SAT in other African countries as the reference, show how other organisms thought to be present may be affected.

Determination of environmental and social impacts

The consultant will determine the impacts of the proposed project activities on the following:

1. Humans: (Social Impacts Assessment)
    a. Identify vulnerable groups (gender) and show the risks that each group faces and the group related roles that put them at risk
    b. Identify activities that would increase human risks by way of exposure to chemical concentration areas
    c. Identify human food sources / or harvesting practices that increase chances for human exposure to deltamethrin Identify
    d. Find measures to avoid or reduce any impacts to people and advice appropriately
    e. Assess the human cultural and social activities that will be affected by the project in among the communities in or surrounding MCA.
2. Biodiversity of non-target organisms. These include but not limited to:
    a. Insects (with special attention to pollinators, bees and other commercial insects in the project area)
    b. Aquatic organisms
    c. Birds
    d. Invertebrates
    e. Wildlife
    f. Other biodiversity components both in the protected and non-protected areas that are likely to be affected by implementation of this project
3. Other human and livestock disease vectors (other than tsetse flies) that may be affected by the proposed activities.
4. Water resources and aquatic organisms
5. Agriculture especially the irrigation activities
6. Soils and soil organisms

7. Impacts on wildlife after tsetse is eradicated from MNP, Bisanadi, Kora and Mwingi National parks and the surrounding areas.

Environmental and Social Monitoring Plan (ESMP)

The consultant will develop an elaborate environmental and social monitoring and management plan covering all areas of the anticipated impacts with information of measures on how to avoid or reduce each specific adverse impact. The developed ESMP should clearly identify and categorize all potential impacts, ways to mitigate/ manage the impacts, ways to monitor, key performance indicators for good practice, specify who should be responsible for monitoring, at what interval the monitoring and management of each impact done. The monitoring plan should provide estimates of the costs for carrying out management of each impact.

Team of Experts

The study will be conducted by a team of experts led by a team leader (the lead consultant). The team will comprise of the following:

Dr. Joseph Maitima PhD – Lead Consultant

Dr. Maitima the lead consultant is an ecologist and will be responsible for overall study, including activities by individual experts, conducting public consultations, compilation of impacts, development of the ESMP, preparation of the reports, submission of all deliverables to NEMA and the proponent.

Other members of the team will include the following:

a. Mr. Vincent Owuor: Consultant GIS, and environmental planning / management; Lead EIA expert
b. Phoebe Mukiria*:* Consultant Entomologist
c. Mr. Titus, S. Imboma. Consultant Ornithologist
d. Dr. John Githaiga: Consultant water resources and aquatic biologist
e. Dr. Robert Chira Consultant Wild life biologist
f. Dr. Charles Warui. Consultant Invertebrate Zoology
g. Dr. Githaiga Wagate Consultant Toxicologist
h. Mr. Martin Kimathi – Technical staff on social economics and public participation
i. Dr. Patrick Kariuki - Environment Impacts Assessment and GIS analysis
j. Richard Ouma Tumba – Technical staff on data base development

Besides working as individual consultants in the areas on one's specialization the consultants will refer to each other including the lead consultant and the Ecodym office secretariat in order to share common resources, information and references to ensure high quality reports are prepared and to ensure a standard format is adapted by all the consultants.

Lead Agencies Statutory Provisions

The EIA assessment will review legal working documents of all statutory agencies whose operations will have a relationship with the proposed activities. This will be for the purpose of identifying the areas where the proponent may need to cooperate with the agency in order to avoid or reduce the impacts. These state agencies include but not limited to:

1. Kenya Wildlife Services (KWS)
2. Kenya Forestry Service (KFS)
3. Water Resources Management Authority (WRMA)
4. Pests Control Products Board
5. Kenya Aviation Authority
6. Chemical and Poisons Board
7. Local governments Authority
8. National Museums of Kenya
9. Tourism Development Authority

Other Government operations that will be involved in the assessment are:

1. Ministry of Public Health
2. Ministry of Agriculture
3. Ministry of Livestock
4. Ministry of Education

Local organizations whose activities may be affected include:

1. Farmer organizations (societies and cooperatives)
2. Women and Youth development groups
3. Others identified in the field.

Project Phases and Activities

The proposed interventions will be carried out in three project phases: (1) reparations phase; (2) operations phase; and (3) decommissioning phase. Activities in each of these three phases will be identified and impacts associated with them will be analyzed in terms of the environmental and social impacts. Appropriate mitigation measures for each of the impact will be discussed and used to inform development of the environmental and social impacts monitoring plan (EMP).

Preparations phase.

The preparations phase will involve identification and preparations of a base camp to be used by the spraying personnel. The phase will also include building of structures to be used by people and for storage of machineries and chemicals to be used. It will involve movement of equipment and chemicals to the site. Hiring of personnel for the camp and setting the utilities. It is assumed that the operations will utilize one of the existing air strips within MNP.

Activities in the preparatory phase

Delineation of the spray blocks, creation of barriers

Already the area for spraying has been delineated and a map has been produced see Figure 1. The area traverses all the 5 counties as described in section 3 above. Digital coordinates of the spray area have been prepared so that the flight area is well demarcated. Because we will not be spraying the whole area due to the vastness of the area, and the fact that no flies were found outside MNP and Bisanadi despite the possibility of there being flies, there will be need to erect barriers to protect re-invasion of flies from Tsavo National Park to the east through Kora National Park. A one kilometer barrier will cut across Mwingi National Reserve and Kora National park at an area that has already been identified to the east of Adamson's falls.

Sensitization of interested and affected local communities and stake holders

Sensitization will be done to inform the local residents, local county council, political leaders, provincial administration, faith based organizations, CBOs and NGOs operating in the area. The sensitization will be carried out by experts from MoL, NMK, UoN, KWS, MoW, Fisheries, MoA, NEMA, Gender and Social Services, experts of aerial spraying, PCPB, NCST, and consultants. This will be on the importance and reasons for SAT application, the insecticide to be used, the time of spraying, the precautions to be taken during the spraying. The main reason for the sensitization exercise will be to promote public education and awareness. In the base camp the project will ensure adequate signage including fire assembly points, brochures and posters to inform the workers, community, farmers, herders on safe movements.

Identify a site and set up an operational camp

Arrangements will be made with KWS, NEMA, and the local county councils especially in the national reserves to identify an appropriate place to set up a camp and runway. The contracted spray company will set up a base camp in consultation with NEMA to ensure compliance with EMCA, 1999 and the recommendations of the EIA project report. Critical issues here will be the storage facilities for the chemicals, jet fuel, gasoline, empty containers, and protective gears. Location and design of work rooms e.g., facilities for chemical handling and mixing, disposal for liquid and solid wastes in conformity with PCPB guidelines on disposal of pesticides and containers

- *Literature analysis to develop impact indicators (baseline surveys, publications, databases)*

  Using already published reports and publications we will identify chemical exposure units likely to be affected and how the impact will be manifested. Based on information from literature on impacts of such applications elsewhere (e.g, Okavango, Katima Mulilo triangle, Zambezi river basin), we will develop indicators on impacts of various exposure units and ways for measuring changes. Literature shows that SAT applications in Okavango Delta had impacts on some invertebrates but none of the species were made extinct and recovery rate of the populations affected was very rapid. Continued monitoring has established no records of existence of tsetse flies (Glossina spp).

- *Establishing of monitoring sites and plans for monitoring impact indicators*

  Various stakeholders will establish monitoring sites within the conservation areas and outside to monitor changes in composition and structure of all the biodiversity components, water resources, soils, socio-economics. This monitoring will use impact indicators described above to measure and document the impacts according to lifespan or life histories of various components.

- *Identification of land uses and social economic activities in the affected areas*

  A substantial amount of work has been done on land use and landcover in MCA. However, some of the studies are a few years old and some changes may have occurred overtime due to changes in land use, climate change and technological advances. There is therefore a need for this project to conduct a quick survey to update records on land use and other socio-economic activities in the area. Within MNP, Bisanadi National Reserve KWS has been restocking wildlife in MNP over the last few years. In the areas adjacent to the conservation areas grazing pressure has increased mainly due to invasion by livestock from other areas. Of late there has been an increase on the encroachment of livestock herders to the protected conservation areas in search of pastures. This has led to a corresponding increase in human wildlife conflicts.

Operations phase

Operations will include handling of chemicals, spraying over MCA, flying aircraft at the designated times, human occupation of the camp, movements of people and vehicles within the MCA among others that will be identified by the study and disposal of solid and liquid wastes.

The SAT is an ultra low volume (ULV) spray drift technique that applies minute amounts of insecticide from aerosol generators fixed to low flying aircraft. The aerosols will be applied from dusk to dawn in gentle winds and take advantage of the temperature inversion to keep the droplets in the tree canopy and under storey vegetation. Spraying will be repeated 4 times over a dry season at intervals of about 10 days between sprays. [The sequence of insecticide applications for SAT is timed so that a female tsetse emerging after one treatment has insufficient time to deposit a larva before the next treatment].

During these spray intervals monitoring groups (biodiversity, water, public health, soil etc) will conduct field surveys to assess and measure impacts between the spray cycles. This monitoring will also involve assessing the efficacy of spraying on the target (Tsetse flies).

Each block will be treated using three Turbo Thrush aircraft flying along parallel transects 270 m apart. The spray will consist of 0.35% active ingredient (a.i.) formulation of deltamethrin diluted in an unspecified solvent and emitted to give a dose rate of 300mg of a.i. per hectare in droplets of 25-35µ v.m.d.

Aircraft will navigate using a GPS based system and generate aerosols using two boom-mounted Micronair AU 4000 rotary atomisers fitted with variable restrictor units, rpm indicators and electric brakes. The atomizers will be wind driven, fitted with CBP 289 95mm blades and

20guage cage mesh. Shut-off valves will be installed to prevent spillage in the event of damage to the atomisers.

The chemical

Deltamethrin is a synthetic pyrethroid, insoluble in water, stable to heat and degraded mainly by photolysis and biological activity. The molecule breaks down, by ester cleavage, oxidation and conjugation, into a large number of compounds (25), all of which are less toxic than the parent compound.

In water, concentrations have a half-life of a few hours, as residues rapidly adsorb to plants, suspended solids and sediment. On sediment, residues have a half-life of c. 2 weeks. The half-live on suspended solids and plant life is no more than a few days.

On land, deltamethrin is strongly bound to soil particles and is resistant to leaching. Residues persist in the top few centimetres of the soil and have a half-life of several days to several weeks. Residues on plants may have a half-life of about 1-3 weeks.

In living organisms, deltamethrin is rapidly degraded by hydolysis and oxidation. There is no systemic activity in plants. However the molecule is lipophilic and residues may persist in fatty tissues. The half-life of residues in the rat, for example, is 1-5 days, depending on the tissue sampled.

Toxicity

Deltamethrin is a broad-spectrum contact and stomach insecticide. It acts upon the central nervous system (CNS) and may cause hyperactivity, convulsions, cardiac and respiratory failure, and death. In addition, it also affects the peripheral nervous system before any apparent effect on the CNS. This results in 'knock-down' in insects, hyperactivity in fish, and skin paraesthesia in humans. The effect may occur soon after exposure and may persist, but unless the CNS is also affected recovery occurs within a few hours. In Man, paraesthesia may include tingling and burning sensations, eye pain and irritation, swelling of the face, headache and dizziness (Zaim *et al*., 2000). Although paraesthesia can be unpleasant, there are no long-term consequences (WHO 1991).

The toxicity of deltamethrin is related to temperature and falls as mean temperature rises.

Topical applications under laboratory conditions show tsetse *Glossina morsitans* are about 30x more susceptible to deltamethrin than house flies *Musca domestica*, and about 600x more susceptible than honey bees *Apis mellifera*, although the ambient temperature of these tests is unstated accidental or self-inflicted exposure in Man shows an oral dose of 2-250 mg/kg of deltamethrin is fatal (Extoxnet).

Table 1 below shows a sample of data recorded by the data logger of the aircraft and a map (figure 1 showing a layout of flight lines during a spraying campaign.

Sortie	Aircraft	Runs	Line km sprayed	Area sprayed ha	Litres sprayed	Appl'n l/ha	x Speed kph	Flow l/min
1	OAS	12	660.5	18163	1506.4	0.0829	284.8	10.82
1	NNC	10	550.9	15149	1301.7	0.0859	246.5	9.71
1	LDI	10	555.9	15288	1311.1	0.0857	251.3	9.88

The downloaded SATLOC map below shows the accuracy of tracking (navigation) of three spray planes, and the distance maintained between tracks (270m) during one sortie. Computers shut down the insecticide flow at the end of the spray blocks as the aircraft perform the procedural turns.

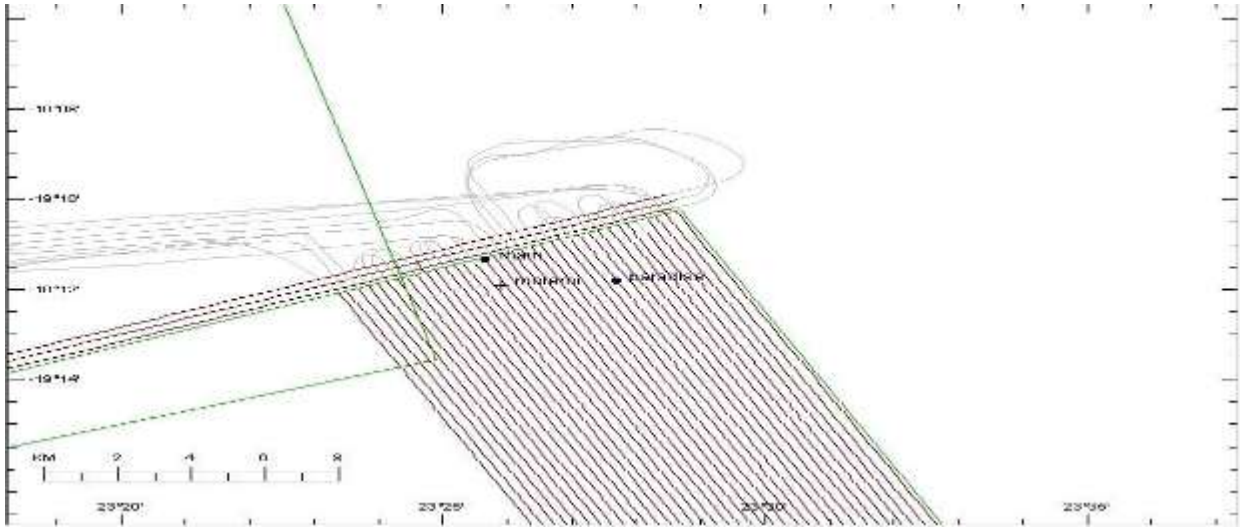

Figure 1 A GIS generated map of flight lines during spraying

Decommissioning

The project will design acceptable decommissioning plan as will specified by the EIA project report. These will be in respect to disposal of used /unused containers, other solid wastes; liquid / chemical wastes and operational equipments.

Not all structures may be demolished as the contractor will hand over structures that will be used during post spraying monitoring. The contactors will take the responsibility to ensure that the structures, the compound are safe for human use.

This will involve removal of the structure, movement of equipment from the site, disposal of solid and liquid wastes including chemicals. The decommissioning will make sure that the airstrip is left the way it was found or better for use as an airstrip for tourists and other flight services.

Impacts Analyses

A comprehensive list of impacts associated with all activities of the project will be analyzed to show the nature of the impacts on all the components of the natural environment and humans. The extent of the impacts will be analyzed in terms of geographical coverage, magnitude of the impact specifying the seriousness of it to the affected organisms, environment and humans.

A number of impacts analysis methods are available including the most commonly used Leopold matrix that puts a weighting value of the impact using several criteria of considerations.

Environmental Impacts Matrix

An environmental impact identification matrix will be developed covering the main anticipated impacts (positive, negative, major, minor, long and short term and any cumulative, synergistic or secondary impacts) of the project. The matrix will list impact types under broad headings with more detailed project specific impact categories. The impacts will be divided into: Preparation; Operation and Decommissioning Phases of the project.

Environmental Profile of the Project Site and the Surroundings

Characteristics of Meru Conservation Area (MCA)

The Meru Conservation Area (MCA) is located in the eastern side of Mt. Kenya and is traversed by the equator. It is the largest conservation area in Kenya after Tsavo East and West National Parks, with an area of 5278 km^2 comprising of Meru National Park, Kora National Park, Bisanadi National Reserve, Mwingi National Reserve, Rahole National Reserve, and a remnant of the Ngaya forest. The Kenya Wildlife Services (KWS) is responsible for the management of Meru National Park and Kora National Park while Isiolo county council manages the Bisanadi National Reserve, Kitui county council manages Mwingi National Reserve and Garisa county council manages Rahole National Reserve and Kenya Forestry Service (KFS) manages the Ngaya forest.

In the context of the application of SAT, MCA includes human settlements adjacent to the parks and reserves found in Tharaka, Tseikuru, Danyere, Garbatula, (Kina), and Igembe.

The MCA traverses 5 counties namely Isiolo, Meru; Kitui; and Tharaka Nithi and Garisa. However, SAT application will not extend beyond Kora national Park to the residential areas of Garisa as currently no tsetse flies are in this area. The area is covered by seven constituencies: Isiolo South, Igembe North, Igembe South, Tharaka, Tigania East, Mwingi North and Dujis (but this may not be a SAT application area). The actual areas for SAT application will be delineated after an update on tsetse distribution boundaries before spraying commences.

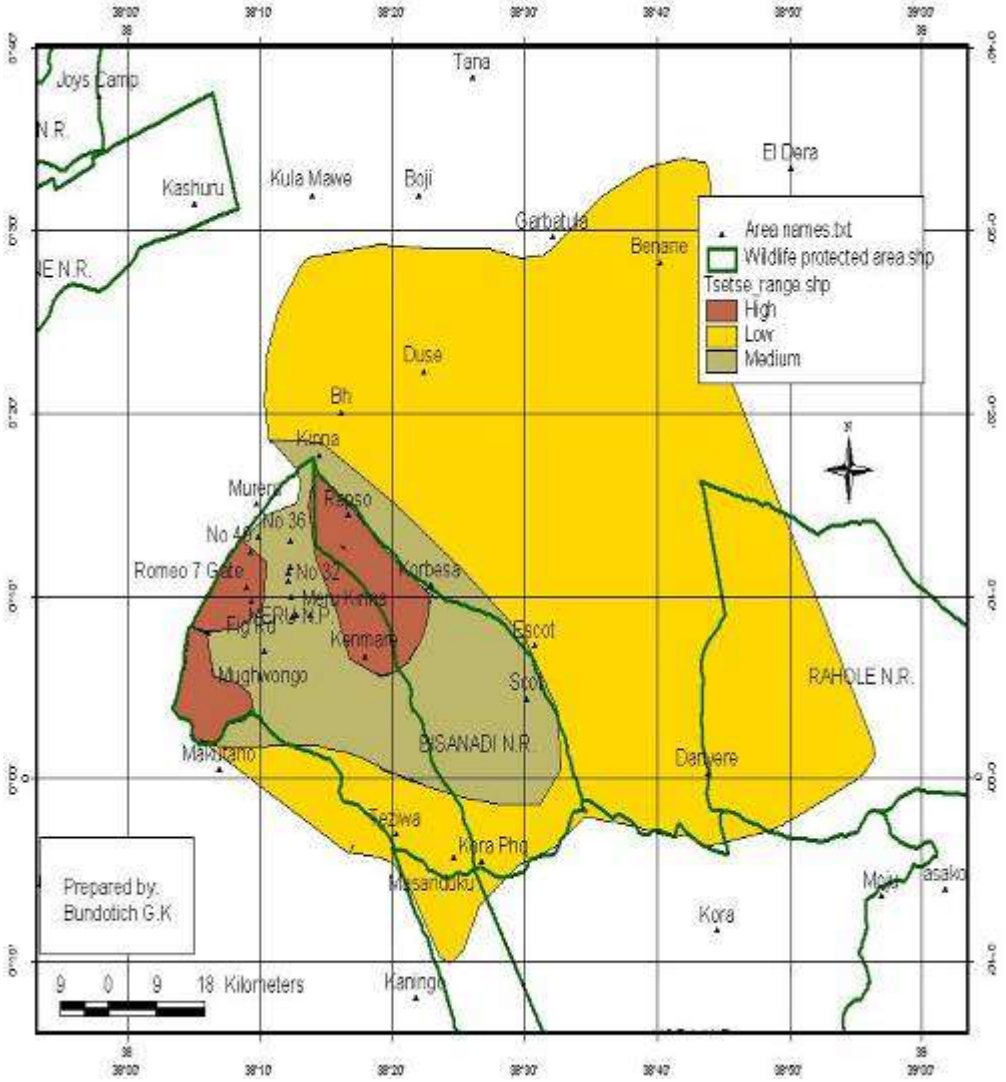

Figure 2 Map of the MCA Showing tsetse distribution

The Study Area

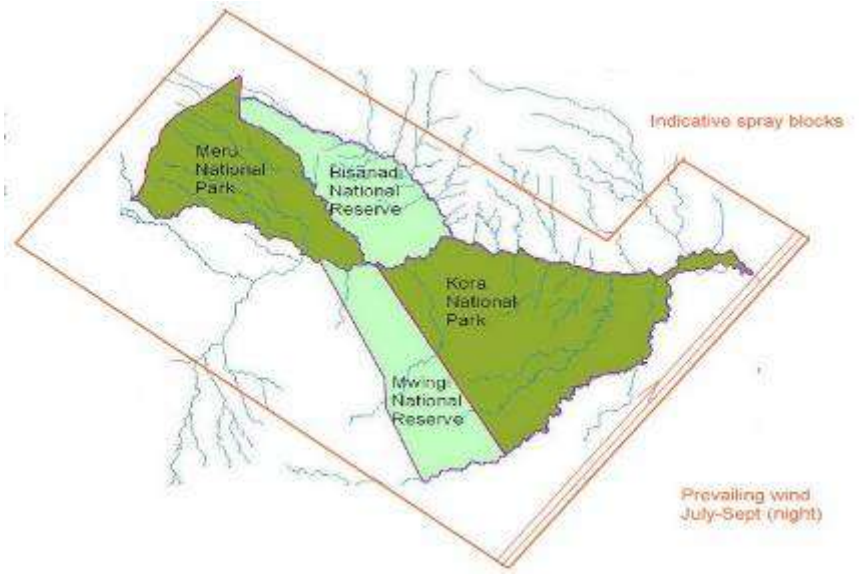

Figure 3 The MCA Study Area

Landscape

The MCA slopes from the base of the Nyambeni hills in the west in an easterly direction. Meru National Park (MNP) with an elevation of 1036 m a.s.l in the north west to 304 m a.s.l in the south east. Kora's altitudinal range is between 200 m a.s.l at the Tana River and 560 m a.s.l in the extreme south. Several isolated hills rise up to 875 m a.s.l (Murera) and 835 m a.s.l (Kina) and there are several inselbergs (notably Leopard Rock and Mughwango). MCA is crossed by numerous permanent streams which drain from the Nyambeni hills and flow south eastwards into the Tana River; the main river basin that drains into Indian Ocean. Land cover, changes from the montane evergreen forests around Nyambene hills through dense woodlands to open savannah ecosystems and semi arid lands near-bare grounds.

Climate

MCA straddles the equator: Meru to the North and Kora to the south. The area is arid/semi-arid (Agro-Ecological Zone VI) and experiences bimodal rainfall: from October-December and March to May/June. Average rainfall is between 350 and 1000 mm p.a. At higher altitudes in the North West, MNP receives 600-800 mm, and in the south east 300-350 mm. Kora's elevation is less but the gradient is similar and rainfall is around 500 mm in the west and 250 mm in the east.

Rainfall seldom exceeds evaporation: dry season temperatures in Meru and Kora NPs (July to September) rise to 24-32°C in the day from 15-18°C at night, depending upon the elevation. At Meru NP airstrip, between August and October, average wind speed and wind direction are 1.4-2.7m sec^{-1} and S to SE from dusk to dawn. SAT is a night-time operation.

Vegetation

In the western part of MCA the landscapes are much higher elevated and the basic vegetation type is *Acacia/Commiphora* bush. The area is covered by bush, thornbush and wooded grassland of varying densities with *Combretum spp*. prevailing in the north and *Commiphora* spp in the south. In the extreme north there is a small remnant of the Ngaya forest. Vegetation on the ridges is *Combretum* wooded grassland, dominated by *C. apiculatum*. This gives way to *Acacia* wooded grassland to the east with *A.* senegal and *tortilis* on the rocky ridges. To the west *Combretum* merges into *Terminalia* wooded grasslands. On the plains, *Sehima nervosa, Chloris gayana, C.roxburghiana* and species of *Pennisetum* are the dominant grasses. Riverine forests are characterized by doum and raffia palms (*Hyphaene coriacea* and *Raphia spp), Phoenix reclinata, Ficus sycomorus, Newtonia hildenbrandtii, Acacia elatior* and *A. robusta. Populus ilicifolia* are found along the Tana river in the south east. There are numerous riverine swamps, some permanent, with *Cyperus* and *Echlinochloa* and *Pennisetum* species of grass. Element of inselberg and rocky outcrop flora are different.

The rest of the MCA comprising of Mwingi, Kora, Rahole, and Bisanadi conservation areas are much drier and dominated by dry savannah type of vegetation. In the riparian areas, for example, Bisanadi more wooded vegetation is found along the water courses. The dominant vegetation types of these areas are basically similar but the composition differs from place to place. In the wetter north west of MNP, some permanent swamp areas and riparian corridors support swamp and gallery forests

MCA faces a number of environmental and social economic constraints linked to its peculiar location at the foot of Nyambene hills and at the border line between several kinds of ecosystems and socio-economic environment. To elaborate on this uniqueness the following sections discuss the nature and composition of various important environmental aspects of MCA.

Land use and socio-economics

Apart from the NE end of Kora NP, the MCA falls into agro-ecological zone VI, which is arid/semi arid and marginal for agriculture. There are three principal forms of land use in the MCA: agriculture, agropastoralism and pure pastoralism. The disease free zones are planned to be located in the pure pastoralism area. In the wetter western and southern buffer zone of the MCA, 35% of households practice subsistence agriculture. In the southern, western and northern buffer zones, 55% practice agro-pastoralism while pure pastoralism dominates in the northern pastoral lands. There are no recognized agricultural activities in the parks although cattle regularly encroach all the unfenced parks (the rhino sanctuary in north west MNP is fenced) when pastures are poor in the buffer zones. Riparian cultivation is noticeable along the Mwingi NR side along Tana River.

To the west of the MCA, the land use is subsistence agriculture. To the west of the MCA is high potential area but supports a largely subsistence-based agriculture. Twelve km to the west of MNP is Maua, with a population of over 10,000 that enjoys enormous cash income from the cultivation and export of miraa or khat (*Catha edulis*).To the north, east and south east, the land is used for grazing and there are also large pockets of forest. Around the pastoral town of Kina, just north of the MNP boundary, the Borana and Somalis practice agro-pastoralism and pure pastoralism. Within the conservation areas the sole socio-economic activity is tourism.

Population Distribution

The population distribution in MCA is extremely contrasting. There is a very high population density on the Nyambeni hills with between 200 to 400 people per km^2, while in the lowland plateau human population about 10 people per km^2. This contrast is mainly due to geographical features and climatic factors, but presence of tsetse in the lowlands limits utilization of the area for livestock which is the only suitable land use. A feasibility study done for the development of MCA identifies population as a threat to long term survival due to very high densities in the North West and west areas of MCA (Republic of Kenya 2001). If the rest of MCA was habitable the problem of population pressure can reduce. Freeing MCA of tsetse and trypanosomiasis will people to move to lowlands and thus decongest the highlands.

Soils

The wetter north western sector is hilly, with rich volcanic soils. As the land flattens towards the east, grey alluvial volcanic soils appear. The wooded western grasslands of the park are underlain by volcanic rocks while the east is an open grassland plain of red lateritic soils. Soil texture is variable: sandy, sandy loams and clays such as the black cotton soils that are found in the south.

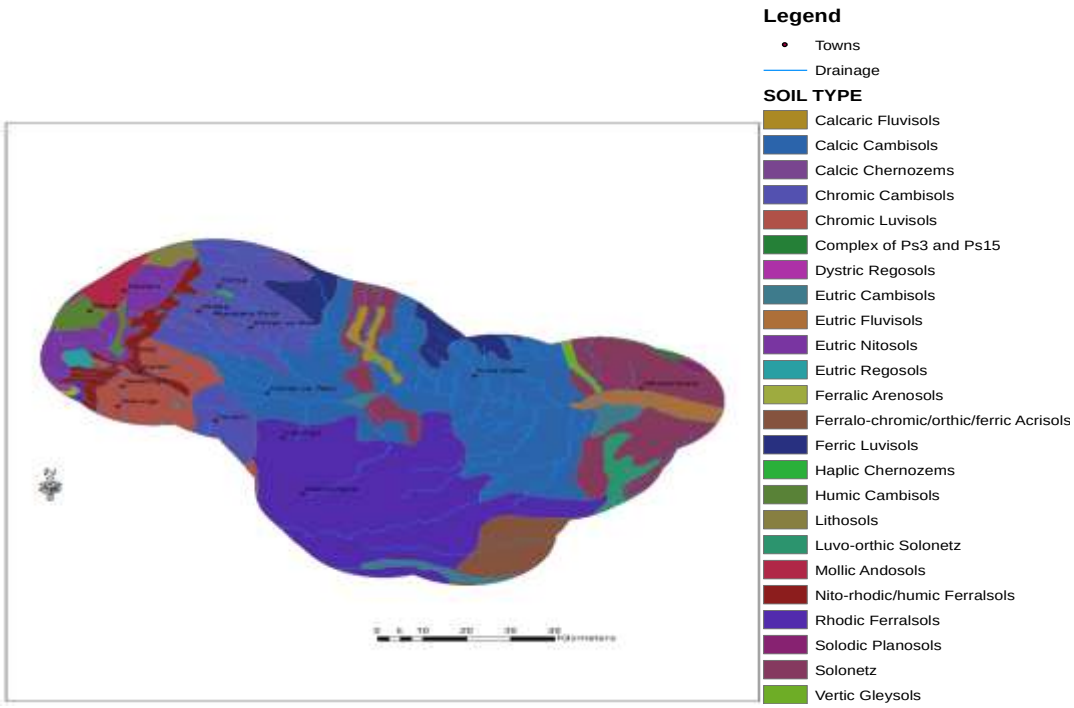

Figure 4 ***Soils in MCA***

Biodiversity

Species inventories of MNP include Grevy zebra, elephant, buffalo, bush pig, common waterbuck, lion, leopard, cheetah, reticulated giraffe, hippo, impala, lesser kudu, eland, Grant's gazelle, gerenuk, bohor reedbuck, hartebeest and monkeys plus 40 species of reptiles, 11 species of amphibians and 14 species of bat and many of arthropods. There are many small and medium sized mammals. The invertebrate fauna is not well described in MNP but Kora was the subject of an ecological inventory in the early 1980s.

More than 300 species of birds have been recorded, five of which are regionally threatened. MNP is one of 60 important bird areas (IBAs) in Kenya. There are no records for fish species in the streams but a survey of the Tana River species in Kora NR revealed 21 species of fish as part of the ecological inventory. The molluscan survey returned one freshwater bivalve, three gastropod species and 28 species of terrestrial molluscs.

Black and white rhinos have been re-introduced into the park. The black rhino is also listed as Critically Endangered in the International Union of Conservation and Nature (IUCN) Red List of Threatened Species.

According to IUCN (2004) an endangered species of freshwater crab (unidentified) occurs in MNP. Other decapods (crayfish) may be present in streams (no verifiable records).

Hydrology

Several streams and rivers cut through the MCA which is also bounded by several rivers: the Ura, Rojeweru, Kathita; Bisanadi; Mutudu and the Tana. In Meru NP, the streams that drain from the base of the Nyambeni Hills are permanent, although their discharge is being reduced by climate extremes and abstraction for irrigation outside the park. Streams entering the park are well oxygenated but carry significant concentrations of suspended solids (causing slightly brown coloration) and possibly agrochemicals from upstream agricultural activities.
The Murera, Kathita, Kanjoo, Bwatharongi and Rojewero rivers flow to the Tana, the main river that flows within the MCA and eventually draining into the Indian Ocean. This river and the many tributaries that feed into it are a source of water for both wildlife and livestock in the MCA.

Climate Change

Kenya is experiencing adverse effects of climate change. Variations in weather patterns and global warming have caused prolonged and frequent droughts, floods, and the resurgence of disease pests. The knock-on effects of these events include crop damage, loss of livestock, and environmental degradation. It is also probable that the ecological responses of fauna and flora, including livestock, crop and human disease pests, are changing their distribution, populations and behavior. In arid and semi-arid areas (AEZ VI) where ecosystems may be more vulnerable to climatic extremes, pastoralists may struggle to find grazing and water, and new challenges from livestock parasites and disease vectors may arise.

Relevant legal and institutional framework EIA Meru conservation area

Overview

The project entails conducting an aerial spray over the Meru Conservation Area (MCA) in a bid to control tsetse flies in the targeted area. The scope of the project covers: Meru National Park; Kora National Park; Bisanadi National Reserve and the Mwingi National Reserve.
In view of the above, a number of statutory regulatory frameworks must be considered in the performance of the project. These measures ought to be fully complied with so as avoid criminal liability alongside other potential illegalities. This study outlines these aspects and gives suggestions as to how the project is to be complied with. The major statutes of concern include: The Environmental Management Co-ordination Act (1999); The Wildlife (Conservation and Management) Act; The Civil Aviation Act; The Forests Act amongst others.

Environmental Management and Co-ordination Act, 1999

Section 3 (1) of the Act, provides that every person in Kenya is entitled to a clean and healthy environment and is obligated to safeguard and enhance the environment. It must be noted that Section 148 of the Act, gives an overriding interest on the Act with regards to any conflicting provisions of the Act (EMCA). To achieve this section 7 of the Act establishes the National Environmental Management Authority (NEMA) which acts as the statutory body responsible for the implementation of the Act.

The Act sets outs projects, which must be subjected to an Environmental Impact Assessment (EIA), process prior to the performance of the works/project. These projects are set out in the Second Schedule of the Act as read with section 58 (1), (4). Key to note is that s.5 of the Second Schedule expressly requires that an EIA study be carried out for any project involving aerial spraying.

The environmental (Impact Assessment and Audit) Regulations, 2003

The regulations are entrenched under section 147 of EMCA. The regulations provide the framework of conducting EIAs and EAs in Kenya

This EIA project report is conducted in conformity with these regulations and EMCA, 1999

Discretionary approvals required

The Act requires projects to acquire approval prior to their commencement. NEMA approves and issues an environmental license after the EIA or a project report depending on the extent to which the project satisfies it. This is in compliance with EMCA Part VI s.58 (1) and (2) which expressly provides:

Notwithstanding any approval, permit or license granted under this Act or any other Law in force in Kenya, any person, being a proponent of a project, shall, before financing, commencing, proceeding with, carrying out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the second schedule to this Act, submit a project to the authority in the prescribed form, giving the prescribed information and which shall be accompanied by the prescribed fee.

The proponent of the project shall undertake or cause to be undertaken at his own expense an environmental impact assessment study and prepare a report thereof where the authority, being satisfied, after studying the report submitted under Subsection (1), that the intended project may or is likely to or will have a significant impact on the environment, so directs.

Environmental Management and Co-ordination (Water Quality) Regulations, 2006

These regulations are premised upon the regulation of pollution of water resources and apply to a wide spectrum, principally; Domestic, Industrial, Agricultural and other Uses incidental to Aquatic life, Fisheries, Wildlife and/or Recreational purposes.

Noting that the scope of the project is set to cover; wildlife conservation areas, agricultural areas, fish rearing areas alongside homesteads. The proponents are required to comply with the stipulations of the legislation. key amongst these provisions include: Section 11 which provides *"No person shall discharge or apply any poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants or permit any person to dump or discharge such matter into the aquatic environment unless such discharge, poison, toxic, noxious or obstructing matter, radioactive waste or pollutant complies with the standards set out in the Third Schedule of these Regulations."*

Section 24 which provides *"No person shall discharge or apply any poison, toxic, noxious or obstructing matter, radioactive wastes, or other pollutants or permit any person to dump or discharge any such matter into water meant for fisheries, wildlife, recreational purposes or any other uses unless such discharge, poison, toxic, noxious or obstructing matter, radioactive waste or pollutant complies with the standards set out in the Third Schedule to these Regulations."*

The Third Schedule of the regulations provides for the minimum allowed standards of effluent discharge to the water resources. Any amount of discharge that exceeds the set out levels is illegal and constitutes an offence that carries with it a fine not exceeding five hundred thousand shillings alongside any other order a court of law deems fit as per section 27 of the regulations.

The proponent shall undertake to ensure that the rules and regulations are complied with.

Environmental Management and Co-ordination (Noise and Excessive Vibration Pollution -control) regulations, 2009

These regulations seek to control the emission of undesirable noise and vibrations that may have an adverse effect on human health and/ or the environment. The regulations set out general prohibitions under section 3 which provides inter alia *(1) Except as otherwise provided in these Regulations, no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. (2). In determining whether noise is loud, unreasonable, unnecessary or unusual, the following factors may be considered- (a) time of the day; (b) proximity to residential area; (c) whether the noise is recurrent, intermittent or constant; (d) the level and intensity of the noise; (e) whether the noise has been enhanced in level or range by any type of electronic or mechanical means; and,(f) whether the noise can be controlled without much effort or expense to the person making the noise.* Subsection 3 of the Regulations makes it an offence for anyone to contravene the provisions of the Regulations.

Section 4 of the rules concern vibrations and state as follows:

(1) Except as otherwise provided in these Regulations, no person shall-

(a) make or cause to be made excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment; or (b) cause to be made excessive vibrations which exceed 0.5 centimetres per second beyond any source property boundary or 30 metres from any moving source.

The proponent shall ensure that they will adhere to the rules as set out in the regulations.

Wildlife (conservation and management) Act, cap.376

The Act was enacted in a bid to consolidate and amend the laws concerned with the protection, conservation of wildlife in Kenya. The Act establishes a body referred to as the Kenya Wildlife Service that is mandated to properly manage National Parks and National Reserves for the greater benefit of all persons in the country.

The proponents are required to adhere to the provisions of the Act as the project entails aerial spraying over the MCA (Meru Conservation Area). To adequately carryout their project the proponents must comply with provisions of section 12 by seeking authorization from the Minister (Cabinet Secretary) in charge of Wildlife to be able to use aerodromes within National Parks and/or fly any aircraft below 1500feet from the ground. Failure to comply with authorizations from he minister, the contravener would be liable to a fine not exceeding Ten Thousand Shillings and/or a prison sentence of 12 months.

The proponents must familiarize themselves with section 13 of the Act which provides for the general offences under the Act and more specifically to subsection (3) (g) makes it an offence to deliberately disturb or cause stampedes of any animal. Nonetheless section 14 provides the proponents with a lifeline whereby they would be excluded from the offences if exempted from the provisions by the rules; by a written permission of an officer of the service and those rules and/or conditions are fully complied with.

The proponents are required to comply with the provisions of section 16, the National Park Regulations, more specifically subsection (1) (e) which expressly provides for "*the regulation of landing of aircraft in, and of traffic in or over, a National Park, the carriage of goods and passengers in a National Park, the points by which a person may enter, and the routes to be followed in or through, a National Park"*

With respect to the regulations of National Reserves, section 18(3) of the Act provides that the regulations of National Parks are to apply to National Reserves as they are subject to exclusions by any such conditions or restrictions resulting from an agreement between the Minister (Cabinet Secretary) and the relevant Local Authority.

Section 35 (3) of the Act, prohibits the use any aircraft, motor vehicle or mechanically propelled vessel in such a manner as to drive, stampede or unduly disturb any protected animal or game animal for any purpose whatsoever. Nonetheless the section goes further to provide exceptions where the prohibition would not apply. Of relevance is the subsection (1) which allows for the

driving away of game from an aerodrome or airfield for safe landing of an aircraft and (3) which exempts a person from liability of the section in the event of performing a prescribed purpose.

Wildlife (Conservation and Management - National Parks) Regulations

These provisions were enacted in accordance with section 16 of Cap.376 and apply solely to National Parks. The regulations basically entail; the Entry of national parks, Closure of national parks, Prohibited acts and Nuisance regulations amongst others.

With respect to entry to National Parks, entry is limited to payment of the prescribed fees or possession of a special car pass, which exempts the permitted occupants from payment of fees.

He regulations under section 5(1) (c) prohibits being within the park between 7.15pm and 6 a.m unless with the express authorization from the director of KWS or officer of service duly authorized. The proponents are therefore required to apply for the exemption and any such exemptions incidental to accessing the National Park at the prohibited hours as the Aerial Spray is premised to take place in the night and might involve the utilization of aerodromes within the National Parks for landing and/or take-offs.

The regulations under section 6 (c) of the prohibits production of unnecessary noise or act likely to disturb or annoy any other person. Nonetheless such nuisance is permissible with authorization from the Director or a duly authorized officer. This authorization would be critical to the proponents to prevent possible liability as the flying of aircrafts within the conservation areas may result in nuisance complaints.

Civil Aviation Act, cap 394

The Act was premised on making provisions for the control, regulation and orderly development of civil aviation in Kenya. The Act establishes the Civil Aviation Authority which is tasked with the responsibilities of planning, developing, managing, regulating and operating a safe, economical, and efficient civil aviation system in Kenya.

The Act sets out rules and regulations such as: Licensing of Air services; Air navigation regulations, registration and marking of aircrafts; Certification of airworthiness and equipment amongst others. Of additional concern to the proponents would be the provisions of section 13 provides for nuisance regulations caused by aircraft and aerodromes and the liability for damage alongside section 14 which makes it an offence for dangerous flying.

The proponents shall undertake to acquire all necessary approvals from the Civil aviation Authority as well as ensure that their operations do not violate the provisions of the Act.

Forests Act, Act no. 7 of 2005

The Act was enacted for the establishment, development and sustainable management, including conservation and rational utilization of forest resources for the socio-economic development of the country. The Act establishes the Kenya Forestry Services which is mandated to enforce the provisions of the Act. The Act sets out prohibitions that constitute offences if violated.

The proponent shall acquire all the necessary approvals if any, as required by the Act necessary for the operations of the project.

Local Government Act (cap 265)

Local authorities under section 155 (e) read alongside with section 146 (d) of the Act have been empowered with the power to establish and manage game parks. By virtue of section 18 (6) of the Wildlife (Conservation and Management) Act Cap 376, game reserves are to be referred henceforth as National Reserves. Key to note is that the local authorities are still entitled to continue their administration of the National Reserves, unless otherwise directed by competent authority.

The project area is inclusive of the Bisanadi National Reserve which lies under the Isiolo County Council and the Mwingi National Reserve under the Mwingi North County Council. Of note however would be the consideration of transition of Local Government institutions to County Governments in line with the new constitution. The Counties of concern here are those of Kitui in the case of Mwingi National Reserve and Isiolo County in the case of Bisanadi National Reserve.

The proponents shall seek all necessary approvals and comply with the relevant Local Authorities and/or County Governments (as the case may be).

County Governments Act 2012

This act gives effect to Chapter Eleven of the Constitution, which provides the county governments the powers to function and take responsibilities for the delivery of services within their designated counties including management of environment and natural resources among other responsibilities. The functions provided for in Article 186 of the constitution and as assigned in the Fourth Schedule of the Constitution. These include management of water resources, biodiversity, forests, and National Reserves among others.

The respective counties i.e., Meru, Tharaka Nithi, Isiolo, and Kitui and the project proponent will ensure that the relevant offices are well informed on the proposed activities and are ready to take part in public awareness and in handling the information on environmental impacts.

Pests Control and Products Act (cap. 346)

The purpose of the Act is to regulate the importation, exportation, manufacture, distribution and use of products used for the control of pests and of the organic function of plants and animals and for connected purposes. Section 3 (1) of the Act stipulates *"No person shall manufacture, package, store, display, distribute, use or advertise any pest control product except in accordance with conditions prescribed by regulations made under this Act."*

The Act under section 5 sets up the Pest Products Board to enforce the provisions of the Act.

The proponent therefore must comply with the standards and regulations set out in the Act alongside acquiring all the necessary permits.

Kenya Airports Authority Act (cap 385)

The statute establishes the Kenya Airports Authority Act alongside stipulating the powers and functions of the Authority. To effectively carry out its mandate, the Authority is empowered to impose charges for use of its facilities i.e. aerodrome and aerodrome facilities amongst others alongside enacting offences and penalties to persons who contravene the rules and regulations of the Act (Part VI of the Act).

The proponent is required to honour all charges liable to the Kenya Airports Authority alongside adherence to the rules and regulations stipulated in the Act.

Penal Code (cap 63)

The penal code outlines the general offences applicable in the republic of Kenya. In addition to the offence of poaching which is outlined in the Wildlife (Conservation and Management) Act, the proponents are required to adhere to the provisions of the penal code to steer clear from criminal liability. Of noteworthy would be chapter XVII which provides for the Nuisances and offences against Health and Convenience. Section 175 of the Act creates the offence of common nuisance alongside sections 191 and 192 which makes it a misdemeanor to foul water and air respectively.

Expert analysis and professional judgment

This study has involved specialists to analyze the effects of applying the pyrethroid deltamethrin MCA. We have involved a specialist on toxicology who is conversant with pesticide control regulations in Kenya to give is professional view on the use deltamethrin as proposed for this project and also assess impact mitigation measures required in Kenya. We have also involved specialists in fields affected by the proposed project. These include; a socio-economist, to analyze the how the proposed spraying will affects socio-economic activities in the area; an entomologist with experience in tsetse control activities to assess how insect non-target (non tsetse) will be affected by the proposed activities. We have also worked with specialists in Wildlife, Ornithology, and Invertebrate and Aquatic biology to assess how application of deltamethrin in the way proposed for this project will affect the organisms in their respective fields.

To do this we have relied heavily on available literature on studies done in the area to give us ideas on the checklists of organisms in the park. In most cases we were able to obtain checklist in one or all the four conservation area and the surroundings, but in some other cases, the obtained information was scanty. In all cases we have consulted heavily on the results of SAT application in Botswana where adequate baseline surveys and monitoring procedures were applied over Okavango Delta. We have also consulted experiences gained recently by Ghana through similar application over the basin of River Volta. These experiences have been used in a space for time concept (Maitima 2003, 2007) to fill in the gaps that lack of adequate before intervention baseline data may have left.

Space for time analysis has been effectively used to study impacts of land use change on biodiversity where comparisons on biodiversity composition of two place one where an intervention has occurred and one where no intervention has occurred. In this study we have used experiences from Botswana and Ghana to guide on the possible effects in MCA.

Assessment of SAT Applications on Public Health

Deltamethrin is an insecticide belonging to the pyrethroid family. Pyrethroids are synthetic chemicals modeled after the pyrethrin components of pyrethrum but unlike other pyrethroids, deltamethrin consists of one pure compound.

It is generally assumed that pyrethroids affect neuroactivity by delaying the closing of sodium channels.

This affects action potentials and often results in repetitive activity (type I) or blockage of nerve conduction (type II). Deltamethrin, contains a cyano group, predominantly produces type II effects.

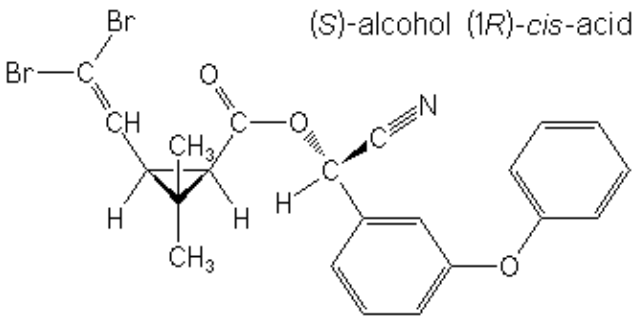

Figure 5 ***Adapted from http://www.alanwood.net/pesticides/deltamethrin.html accessed 26th October 2012***

Deltamethrin is used outdoors on lawns, ornamental gardens, golf courses, and indoors as a spot or crack and crevice treatment. In its purest form, deltamethrin is colorless or white to light beige crystals that have no odor. Deltamethrin was first described in 1974 and entered the marketplace in 1978. Delmethrin based products are used to control numerous insect pests of field crops, potted plants, and ornamentals. Formulations of deltamethrin include emulsifiable concentrates, wettable powders, ultra-low volume (ULV) and flowable formulations and granules. It is the primary metabolite of another pyrethroid, tralomethrin and environmental fate studies indicate that tralomethrin undergoes rapid and essentially complete debromination to form deltamethrin.

Deltamethrin is based structurally on natural pyrethrins, which rapidly paralyze the insect nervous system giving a quick knockdown effect. Deltamethrin has a rapidly disabling effect on feeding insects and for this reason there is hope that it may be useful to control the vectors of "non-persistent" viruses (viruses that can be passed on by the vector within a few minutes of starting to feed on the plant. Deltamethrin's mode of action is thought to be mainly central in action, or at least originate in higher nerve centers of the brain. Death of insects seems to be due

to irreversible damage to the nervous system occurring when poisoning lasts more than a few hours . Deltamethrin poisoning occurs through cuticular penetration or oral uptake. The susceptibility of insects is dependent on a variety of factors and can vary, as with many insecticides, according to the environmental conditions.

Deltamethrin has very good residual activity for outdoor uses (field crops, cattle dip, tsetse) and for indoor uses (mosquitoes, house files, fleas, cockroaches, stored product insects). Deltamethrin has very broad spectrum control. It is considered the most powerful of the synthetic pyrethroids. It is up to three orders more active than some pyrethroids.

In Kenya, the Pest Control Products Board (Statutory Organization of the Kenya Government) has registered over 30 products containing deltamethrin as the active ingredient these are for use in agriculture, livestock, public health and manufacturing (PCPB 2012).

The active ingredient of deltamethrin is found in a variety of commercial insecticide products. Trade names for products containing deltamethrin include Butoflin, Butoss, Butox, Cislin, Crackdown, Cresus, Decis, Decis-Prime, K-Othrin, and K-Otek.

Effects of deltamethrin on public health

Many factors affect the concentration and persistence of an insecticide in the environment and the nominal application rate is a poor guide to exposure. For example, navigation errors, poor calibration of spray gear, leaking equipment and emergency dumping of insecticide can lead to overdosing that can result in severe side-effects.

Spray swaths are normally aligned at right angles to the prevailing wind. Under a temperature inversion and in the absence of wind, spray settles by gravity beneath the aircraft. However calm conditions are rare and typically spray concentrations diminish exponentially with distance downwind from the emission point, the larger droplets settling within the spray swath and the smaller ones travelling for 40 km or more. As wind speed increases, more insecticide should impact inertially on the vegetation and less settle on the ground or water, but when turbulence develops spray will lost to the upper air.

The spray concentration and duration of exposure may also vary depending on whether the spray aircraft works progressively up or down wind. In the former case the maximum concentration of spray should be lower, but exposure longer, than in the latter case. Spraying usually takes place progressively downwind. However the implications of this for efficacy and side-effects have not been studied.

Exposure of people is an inevitable consequence of SAT in areas where population density is medium to high. In theory, up to 5 acute exposures could be experienced by householders who are outside the home at dusk and dawn. The deltamethrin will be applied in extremely low concentrations during the SAT operations. Deltamethrin residues dissipate rapidly resulting in generally low and short-lived exposure of non-target organisms. No biomagnification occurs in the food chain and residues are metabolized rapidly. As a result there is no significant risk of chronic exposure to animals or of effects such as endocrine disruption. However risks do exist.

These are associated with acute exposure, the incremental effects of sequential applications, and secondary effects due to acute exposure in prey, parasites, predators or browsers.

Toxicological review of deltamethrin (Technical grade Purity 98.5%)

The review of toxicological databases identifies that deltamethrin as with the pyrethroids is less toxic to mammals compared to insects due to mammals' higher body temperature, larger body size, and decreased sensitivity of the ion channel sites (Ray D. E and Fry J. R (2006). Effects of Deltamethrin have been reviewed extensively by various international bodies including United Nations-World Health Organization/Food and Agriculture Organization, US-Environmental Protection Agency (US-EPA), European Food Safety Authority (EFSA), Canadian Pest Management Authority etc.

Acute toxicity: Laboratory studies have demonstrated that Deltamethrin Technical has high toxicity via oral and inhalation routes (LD_{50} 87mg/Kg; LC_{50} 0.6mg/L (4 hour exposure) with low dermal toxicity (LD_{50} >2,000mg/Kg). The toxic signs after oral and inhalation exposure were consistent with neurotoxicity, systemic toxicity and poor grooming. It was not irritating to the skin or eyes nor was it a skin sensitizer.

When deltamethrin gets in the soil, it has a tendency to bind tightly to soil particles. It has a half-life ranging from 5.7- 209 days. Half-life is the measure of time it takes for half of the applied amount to break down. The half-life can change based on soil chemistry, temperature, water content and the amount of organic matter in the soil. Deltamethrin does not break down as quickly in soil with a high clay or organic matter content. Deltamethrin is broken down by microbes, light, and water. Its two major breakdown products move more easily in the soil than deltamethrin itself.

Deltamethrin is not likely to evaporate into the air or dissolve easily into water.

Deltamethrin has a half-life of 5.9-17 days on plant surfaces. It is unlikely to be taken up by plants, since it binds to soil particles so tightly.

Chronic toxicity & Oncogenicity/carcinogenicity: no evidence of cancerous growth was reported in mice and rats exposed to deltamethrin technical in feed for two (2) years. In both species the nervous system was the target organ. The U.S. EPA classified deltamethrin as "not likely to be a human carcinogen" by all routes of exposure.

Genotoxicty and mutagenicity: US-EPA, 2004 did not consider deltamethrin to be a mutagen based on negative results. However studies on formulation of which deltamethrin was the active ingredient showed positive results.

Reproductive and Developmental toxicity: possible reproductive toxicant resulting in rats to decreased weights of the testes, seminal vesicles and the prostate. Significance decreases were also noted in sperm cell concentrations and percentage of live cell and sperm motility. There was also reduction of plasma testosterone concentration and depressed pregnancy rate.

Mammalian metabolism: Deltamethrin is readily absorbed when administered orally. In humans oral absorption is estimated to be 50% (California Department of Pesticide Regulation, 2000). It mostly excreted through the urine in man (>50%) and feces (<30%) with most excretion occurring 96hours after exposure (64-77%).

Review of sequential aerosol technique in control of tsetse flies

In order to address the increase in tsetse transmitted Trypanosomiasis, the Heads of State and Government of the African Union collectively launched the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) in 2001 with to guide the process of eradicating tsetse flies and Trypanosomiasis. The phase I had four components: i) Tsetse suppression and eradication; ii) Capacity building; iii) Sustainable land management; iv) Coordination and management. The project design was for the eradication rather than control due to high recurrent costs associated with the control

Over the years use of SAT has been employed to eradicate tsetse flies. The use of SAT in Kenya was reviewed extensively in 2009. The Meru Conservancy Area extends from Meru North District in the north to Machakos District in the south through eight didtricts namely; Meru North, Meru South, Meru Centreak, Tharaka, Mbeere, Thika, Maragwa, Meingi and Machakos. The MCA at the southern end of the Mt Kenya Belt is a reservoir of tsetse flies and trypanosomes. The MCA covers about 5278km^2 comprising of Meru & Kora National Parks, Bisanadi and Mwingi National Reserves (Fig. 2) and remnants of Ngaya forest

Risk Assessment:

Sequential aerosol technique (SAT) employs ultralow volume spray drift technique that applies minute amounts of insecticide from aerosol generators fixed to low flying aircraft or helicopters. The spraying is repeated 4-5 times over the dry season at intervals of 10-15days depending on ambient temperatures. *Deltamethrin will be used at* ***250-300mg a.i*** *Deltamethrin****/ha/cycle.*** *The solvents for ULV are oil based and* ***formulated product typically contains 5g deltamethrin/L to be applied at flow rates of about 6.5-7.5L/km^2 (65-75ml/ha).*** *The efficiency, effectiveness and safety of spraying has been increased by using aircraft equipped with satellite navigation and computerized dosing systems. No ground marker system is required as all aircraft are fitted with SATLOC Airstar 98 guidance equipment. This GPS based system is accurate to 1m and the pilots are guided by a head-up light bar. Boom mounted rotary atomizers (Micronair AU 4000) with 20 gauge cage mesh spin at >10000 rpm to produce droplets in the range of 20-35µm VMD. The system automatically adjusts the insecticide flow rate to the aircraft's speed and cuts off the flow if the aircraft stray outside their designated spray block. It also incorporates a data logger from which all flight and spraying statistics can be downloaded.*

There are 3 principle land use system in the MCA: agriculture, agro-pastoratism and pure pastoralism. The wetter western and southern buffer zone (1000mm rainfall per year) 35% of household practice subsistence agriculture. In the southern, western and northern buffer zones 55% practice agro-pastoralism with pastoralism predominant in the northern pastoral lands (LUCID, 2004).

Effects of deltamethrin on man and animals

LUCID, 2004 reported significance increase in human population density in areas bordering the MCA between 1979 and 1999 especially in higher agricultural potential. Human population density in southern buffer zone increased from 2-50 people/km^2 to 5-125 people/km^2; and an average 126-500people/km^2 to >500people/km^2 in western buffer zone.

The biodiversity of Meru National Park include Grevy zebra, elephant, buffalo, bush pig, common waterbuck, lion, leopard, cheetah, reticulated giraffe, hippo, impala, lesser kudu, eland, Grant's gazelle, genenuk, bohor reedbuck, hartebeest and monkeys plus 40 species of reptiles, 11 species of amphibians and 14 species of bat.

a) Man

There is little risk of skin paraesthesia following exposure to spray drift. Exposure of local residents should be less than that experienced by international air travelers when the aircraft cabin is sprayed with the similar pyrethroid, permethrin. Skin paraesthesia is, in any event, of no clinical significance.

There is no significant risk attached to residue levels found on a range of foodstuffs

b) Animals:

There is no significant toxicological risk to mammals given the low recorded exposure levels (SEMG, 1987) and low mammalian toxicity of deltamethrin.

Secondary effects may arise in insectivorous mammals due to 'knockdown' of their prey. Food availability may decline for aerial feeders (e.g. bats) but increase for ground feeders (e.g. shrews). Reduced availability of food due to insect 'knockdown' should not effect the survival of bats significantly as the period of deprivation should be short and they may be able to move temporarily to less affected areas. However a general reduction in insect abundance over the spray season could affect breeding success. This risk has not previously been investigated.

Impacts of low dose deltamethrin and cumulative effects of deltamethrin in food chain

Concentrations of spray do not appear to vary with either habitat or degree of shelter. However the formulation may affect partitioning in water and the degree of exposure to aquatic organisms. In still water, oil based Ultra-Low Volume (ULV) formulations should remain on the surface film before becoming adsorbed to other floating material, plants and sediment at the water's edge.

The effect of sequential aerial application of low volume deltamethrin on terrestrial insects

Control of tsetse using insecticides started in the 1940s with the highly effective but indiscriminate aerial application of high dosages of residual insecticides following the discovery

of organochlorines. Upto 1 kg ha^{-1} of insecticide was applied to ensure persistence and was widely practiced in southern and eastern Africa till the late '70s and in western and central Africa till the mid-'80's. The deleterious effects of the insecticides on non-target fauna included heavy mortality of reptiles, small mammals, fish, birds, insects and amphibians (Du Toit 1964).

The development of ground spraying was necessitated by the need to reduce the indiscriminate nature of aerial sprays and started in the mid '60s. The technique reduced the amount of insecticide applied to 200-250g/ha^{-1} and the vegetation coverage to about 20% (Grant, 2001). Though quite effective, the logistical requirements of the technique were a challenge to many African governments and only externally funded veterinary departments could sustain such operations for any length of time. That notwithstanding, the technique was the method of choice to suppress the fly in east and central Africa till the advent of bait technology in the mid '90s. Concerns about bioaccumulation of the persistent insecticides and its effect on the food chain also started cropping up at this time.

In the 1970s, sequential aerosol drift technique (SAT) evolved as an alternative to the indiscriminate high dose aerial application of residual insecticides applied either with helicopters or fixed wing aircraft. The technique employs reduced volumes and lower concentrations of non-residual insecticides, the most commonly used being deltamethrin, a synthetic pyrethroid. To make up for the loss of residual action, treatments are repeated at intervals timed to kill newly emerged flies before they can deposit a larva in the soil. However, as tsetse pupae of various ages are in the soil and are not affected by the insecticide, the application has to be repeated with four consecutive applications and one safety application being sufficient (Nagel, 1995). Sprayed at night from low altitude, the aerosols are held in and above the tree canopy by the temperature inversion and are dispersed as the inversion breaks up in the morning.

Upto to the end of the '90's, SAT operations relied on navigation by compass and ground-based markers whereas insecticide release was controlled manually by the pilot where accidental over and under dosing was occasionally reported. Recent improvements in navigation and dosing systems have improved the efficiency, effectiveness and safety of spraying such that the amount of insecticide on the environment has been stabilized and extreme impacts on non-target organisms have been noticeably reduced. (Kgori et al 2006). The improved SAT was employed in the Okavango Delta (HOORC, 2001 and 2002), in the Kwando/Linyanti river system (Botswana/Namibia) in 2006 and SE Zambia in 2009. Studies of the effects of deltamethrin treatments comparable to those proposed in the present operation have been carried following SAT operations described above in Botswana (HOORC, 2002 & 2004), Namibia (DAHP/ HOORC, 2007 & 2008) and Zambia (Lyczkowski, 2006) and this study will be based on these reports.

As the target of sequential aerial spraying is on resting flies, canopy dwelling and flying insects are the ones most affected by the technique (Perkin and Lamberg, 2002). Also as some insecticide will drift to the ground, crawlers and other ground dwelling insects are also likely to be affected. The effects of the insecticide are immediate and long-term. Immediate effects are determined by measuring 'knock down' from tree canopies and pitfall traps before and after SAT whereas recovery studies are used to determine the long-term effects.

A major immediate effect of deltamethrin aerial spraying is a temporary paralysis of many insects that live in the tree canopies (HOORC 2002, 2004 and 2008). This causes them to fall from the trees to the ground where the majority may recover but are at risk from opportunistic predators and exposure. In the Botswana SAT campaigns, beetles, flies, ants, Hemiptera and wasps were the most abundant pre spray taxa, collectively accounting for 93% of the total sampled as determined by fogging trees prior to the SAT application Spray of 0.2 - 0.25 g ha^{-1} increased the rate of fall-out of canopy insects and the bulk of the individuals (about 93%) in the knockdown samples were from four insect groups namely, mayflies (Ephemeroptera), beetles (Coleoptera), bugs (Hemiptera) and flies (Diptera), (HOORC, 2002). To estimate recovery from a single application, the knocked down specimens were collected and observed for 12 hours. Mayflies, grasshoppers and booklice (Psocoptera) had the lowest rate of recovery whereas other insect orders recorded 12 hour mortality directly proportional to their initial abundance (HOORC, 2002). Beetles and Lepidopterans had 65 and 53% mortality respectively.

At the end of the 5^{th} spray cycle, the beetles had declined by 84%, bugs by 56% and ants by 46%. Recovery monitoring after 3 and 12 months gave the same indications in that beetles, flies, ants, Hemiptera and wasps still accounted for the major insect types found on trees but this time accounting for 80& of the total insect population. (HOORC, 2004). The drop in the numbers was due to fewer catches of beetles at 16% compared to pre spray catch of 34% in 2002.

Information from the National Museums of Kenya indicates that at least twelve species of dung beetles occur in the Meru and Kora National parks. The beetles perform a vital role in the nutrient cycle of pastures, particularly in humification of cattle dung. In Australia where no native dung beetle community exists, it is estimated that the un-degraded dung of five cattle removes from production one acre of land per year (Skidmore, 1991). The scarabids have been shown to be susceptible to deltamethrin at 0.01ppm per litre of dung (Chihiya et al, 2006) and dung of cattle treated with alphacypermethrin has been shown to contain upto 0.02-0.15ppm of insecticide for even upto 12 days after treatment, (Vale et al, 1988). Ecotoxicological studies after the 2002 and 2006 spraying did not look at deltamethrin deposits in dung, so the relationship of the two studies to SAT applications is not clear. The first study entailed spiking cow dung with doses of deltamethrin and the second used dung of cattle treated with alphacypermethrin pour-on. The dosage at 0.26 g ha^{-1} applied in SAT is only a fraction of what is applied as pour on in cattle. Also the head to tail application of the pour-on leads to a deposition of a reservoir of the insecticide in the anal region which ensures that the dung is contaminated as it exits the anus of the herbivore, thus leading to enriching of the dung with the insecticide, a situation that is not possible with SAT applications. That notwithstanding, it is desirable that as the baseline data is being gathered , the amount of deltamethrin that accumulates on animal dung be determined so as not to compromise the dung beetle populations.

Flying insects monitored in Botswana/Namibia after the 2006 spraying showed that Diptera (flies and mosquitoes), Hymenoptera (wasps and ants), Hemiptera (plant bugs), Orthoptera (grasshoppers and crickets), Homoptera (cycads and leaf hoppers), Neuroptera (lacewings or anti-lions), Isoptera (termites) and Lepidoptera (moths) suffered high mortalities. Dipterans, wasps and ants had reached the prespray levels whereas beetles had recovered to 60% after 12 months (HOORC, 2007). No grasshoppers, lacewings or moths caught after twelve months, but

the number of individuals caught in the prespray samples was too few to make any meaningful inference.

Effects on bees

Though previous studies have shown that low-dosage deltamethrin delays the return time of *Apis mellifera* (Vandame et al. 1995) and reduces the foraging activity (Decourtye et al. 2004) the risks of bees encountering deltamethrin are reduced as a result of the night application of the insecticide when they are hidden in their nests, the rapid breakdown of droplets on plant surfaces and the repellent effects of the insecticide (Kenya ERA). The risk posed by exposure to aerosols that have not landed by dawn and contact from water surfaces, trees, shrubs and crops in flower is considerably reduced by the fact that *Apis mellifera* is 800 times less sensitive to deltamethrin than tsetse (contact 24h LD50 of 0.05µg bee^{-1} for the honey bee compared to 0.06ng fly^{-1} for *G morsitans* at 25°C*).* The deltamethrin hazard ratio for *Apis mellifera* is 0.6, which is very low considering that a ratio of over 2,500 is considered dangerous to bees.

The effects of deltamethrin on ground dwelling insects

Results obtained in the 2001 and replicated in 2006 spraying in Botswana indicated that the relative abundance of insects caught in pitfall traps did not change as a result of the spray (Perkins & Ramberg, 2002; Bonyongo & Mazvimavi, 2007). Overall, there was no difference in the numbers caught in the pitfall traps before and after the spray event suggesting that the spray event did not change the activity of ground dwelling insects. However, there was some difference in insect composition after the spray depending on the habitat type. This was due to change in abundance of beetles, ants and springtails, either due to the spray although it could easily have been attributable to the increasing temperatures (Perkins & Ramberg, 2002;).

Ant abundance can be highly variable due to activity rates, habitat and proximity of nests to the sampled area. In Botswana following 5 cycles of deltamethrin at 0.26g/ha per cycle spray in 2001, there was no significant differences in ants species richness in before and after spray samples taken in the different habitats. However there was a slight but significant decline in the dry riparian habitat, but this was not enough to affect the overall species richness. The species diversity was also unaffected by the spray. The before and after trend in mean abundance was only declined in dry riparian habitat, but was unaffected in other habitats. In some habitats there were more ant species sampled after than before the spray and it was speculated that many of these may have been either opportunists foraging on invertebrate knockdown or this was a result of weather or temporal-related effect (HOORC, 2002).

In 2006, mosquitoes suffered the highest reduction of 80% followed by ants with 74%, the wasps had 65% reduction, while flies reduced by 60%. The rest of the groups listed declined below 50%. Conversely, ants were the least abundant while maximum reductions were found in beetles at 84% followed by mosquitoes with 71% reduction in 2002 as shown in the table below:-

Table 2 Effects of deltamethrin on terrestrial arthropods dwelling in woodland types after spray cycle 2 in 2002 and 2006.

Common name	Taxa order	% Reduction – 2002	% Reduction – 2006
Ants	Hymenoptera	11	74
Flies	Diptera	41	60
Mosquitoes	Diptera	71	80
Beetles	Coleoptera	84	43
Wasps	Hymenoptera	23	65
Leaf hoppers & bugs	Hemiptera	46	45

Recovery monitoring after 12 months showed that there is great variation between years in the composition of invertebrates (Dangerfield & McCulloch, 2003). Canopy beetles had recovered to only 60% in certain habitats but to 100% in others. There was no change in fly or ant abundance between 2002 and 2003 while Hemiptera abundance was significantly greater in 2003 than before the spray events. Though grasshoppers had disappeared after the spray in 2006, recovery monitoring one year later indicated that their recovery was dependent on availability of food and in habitats its availability had not been compromised by bush fires or drought, they had recovered to the prespray levels (Chikwenhere, 2007). However, crickets of the species *Gryllus bimaculatus* disappeared after the first spray cycle and was absent after the subsequent spraying cycles in (Chikwenhere & Shereni, 2007). The species had not recovered a year after spraying. A chrysomelid beetle disappeared after the 3rd spray cycle and was not sampled in the recovery monitoring, but it is difficult to attribute their disappearance to the insecticide as the numbers in the prespray samples were already very few.

Monitoring the effects of deltamethrin on terrestrial insects

The types and abundance of terrestrial insects naturally change throughout the year due to weather changes that affect their development cycles and the availability of their food. Therefore monitoring should be designed in such a way that changes in the types and abundance of terrestrial invertebrates caused by the spraying of deltamethrin can be isolated from those due to

other natural factors (HOORC, 2004). Also different insects colonise different habitats and incorrect surveys can give misleading information. Baseline surveys should therefore be carried out to isolate the effects of the insecticide from those of season and reproductive cycles. Such surveys will also identify the most suitable habitat types for sampling to accurately assess the environmental effects of the insecticide. This is especially important because the major vegetation type in MNP and Kora National Park is bush, thorn bush and wooded grassland interspersed with varying densities with *Acacia/Commniphora/Combretum* combination (Kenya ERA, 2009). In Botswana, woodland dominated by *Croton megalobotrys* had the highest abundance of tree dwelling arthropods, followed by mopane, with *Combretum spp* woodland having the least abundance (HOORC 2004).

As the whole of the MNP is targeted for aerial spraying, there will be no control block where comparative data will be collected to assess the effect of the insecticide as opposed to seasons and developmental cycles on the insects. The populations of terrestrial invertebrates naturally vary throughout the year due to changing environmental conditions. Baseline prespray data must therefore of necessity be collected to cover the major seasons so as to have an idea of the abundance and species diversity. Sampling should be done for canopy, ground dwelling and fling insects.

Canopy dwelling insects

As there is preference in the insects for different habitats, which in turn affects the effect of the insecticide, dominant woodland types occurring within the park have to first be identified. Stratified sampling procedure should be adopted in this study since the abundance of insects is dependent on habitat types. The following methods are used for sampling:-

(i) Pitfall trapping for active ground-dwelling terrestrial invertebrates,

(ii) Sweep netting for low height vegetation dwelling terrestrial invertebrates, and

(iii) Sheet traps for sampling tree canopy-dwelling terrestrial invertebrates after fogging of deltamethrin using hand-held foggers.

Pitfall traps for sampling epigeal invertebrates

Pitfall traps (Grant and Tringle, 2002) are used to sample ground dwelling insects. They are placed at 10 m intervals along a line transect and two transects per woodland/vegetation type are ideal. Each container is third filled with 70% ethanol and buried into a hole with the opening of the container level with the ground. Plant debris is used to prevent trap exposure and at the same time reducing possible vandalism from animals such as baboons, rodents and birds. The traps should be set 3 days prior to spraying and left in place and for another 3 days of post spray. The traps are emptied daily and the samples are emptied into labeled jars and later sorted into sampling jars filled with 70% ethanol.

Flying insects

Sweep nets made of 8-gauge wire and fine mosquito netting material are used to trap flying insect species. The opening of the net is 45 cm in diameter and 90 cm in depth. Ten transects of 50 sweeps per transect are done in the different vegetation types making at least 500 sweeps in each habitat type. The sweeper constantly moves randomly in different directions sweeping on grass to trap insects seating on grass and those flying. Observation has shown that insects' activity increase with an increase in temperature. Therefore sweeping should be done in the morning (0900 – 1100hrs) and late afternoon, (1500 – 1700hrs) when insects are most active. Emptying should be done after each transect to avoid losing some of the catches. The catches are transferred into a plastic bag containing a piece of cotton wool moistened with 40% formalin to anesthetize the catches. Sorting and counting is done and all specimens are recorded separately and preserved in 70% ethanol.

Canopy dwelling insects

Canopy fogging of selected trees using a hand-held motorized fogger is a technique that is used to assess the abundance of terrestrial insects in selected trees. Plastic sheet traps each measuring 1.5 m × 1.5 m are used to collect tree dwelling terrestrial invertebrates that are knocked down by the insecticide. The sheets are suspended from tree branches using adjustable cotton strings at a height of approximately 1 m above the ground. The sheets are used to collect insects that are knocked down or killed by fogging individual trees. Fogging should be done in the evenings when temperatures and pressure allow for the mist to rise and envelope the tree canopy and when the insects are resting and to maximize the harvesting of insects. Pre-cycle fogging should be done 3 days before aerial spraying to allow for re-colonization of the tree canopy by the insects. Sampling just before each cycle spraying event and in the following day after the spraying assumes that significant changes in abundance of individuals in any taxa are likely to be caused by the spraying. Monitoring after each spray cycle is done to assist in analysis of trends in numbers of any taxa is compared to show the tolerance and susceptibility of the target taxa.

Pre-cycle fogging is done to get an estimation of the number of insects in the canopy before each aerial spray. Collection of data should be done early the following morning after fogging to avoid unforeseen incidents such as destruction of the sheets by animals such as baboons and elephants. The harvest is emptied into a labelled plastic bag and sorted the same day according to orders and families.

Fogging should be repeated on the evening after the spray. Immediate fogging is crucial to avoid introducing errors to the post-spray results as a result of re-colonization of the tree canopy due to migration and development of immature stages after aerial spray. The same trees fogged for the pre-spray data are also fogged for the post spray data. The same procedure for harvesting of pre-spray data is employed.

Data analysis

Before and after catches are compared by subjecting data on insects' abundance to t-tests. As MNP has bush, thorn bush and wooded grassland, one- way and two-way analysis of variance (ANOVA) is used to test whether sampling times and habitat types have an effect on insect abundance.

Aquatic Invertebrates and Vertebrates in Meru Conservation Area

Meru conservation complex is composed of the Meru national park, Kora National Reserve, Bisanandi National Reserve, Rahole National Reserve and Mwingi National Reserve. It is in the Somali-Maasai ecological region of endemism, covering an area of 1.5million square kilometers, much of which is in northeastern Kenya.

The complex holds a wide range of water bodies, for instance the thirteen rivers that bisect the Meru National Park and the numerous streams that draw their water from the mountain and Nyambene Ranges. A number of oases can also be found in parts of the conservation area within and in Bisanandi, which is described as true wilderness.

Adamson Falls, Grand Falls and Mwitamwisi River are some of the water bodies in the Kora National Reserve. In Bisanadi, there are a number of seasonal river owing to the aridity of the region. Many permanent swamps can be found in the region, with the highest number being in the Meru National Park.

The mean rainfall is 700milimeters per annum in the northeastern sector, which is wetter and hillier. Topographically, the region slopes towards the east. The streams flowing from Nyambene Hills drain into the Tana River where they discharge their waters. Some of these rivers in the region are the Ura and Rojeweru rivers.

Aquatic Invertebrates

With the complexity in the area, there is a wide range of aquatic invertebrate species. These are mainly in the super phylum Arthropoda and they are the most successful organism one earth, found in all ecological areas. They are also the oldest existing gropus and have endemic species in many areas. Some of the groups found in the Meru Complex are:

Crustaceans

(a) Crabs-

Crabs are the most prominent crustacean specie in the region. Their concentrations are highest near points where the streams enter the rivers.

Their color ranges from black to brownish and their size from seven centimeters for a young adult to as large as thirty centimeters for a fully-grown adult in its last molting stages. They prefer areas where the water is slow moving but deep. They feed on earthworms and small fish and act as population regulators for the fish in the food chain

(b) Fresh water shrimps-

Their populations are not as high as crabs. They are found in the Tana River at the regions near the Kora National Reserve. They are not large enough in size and numbers to be of economic financial importance.

Insects

(a) Water beetles

These are in high populations in streams and narrow parts of rivers in this region. They prefer habitats with vegetation growing in the water and slowing the water currents.

They are mostly shinny black in color, swimming fast on the surface of the water in groups. Their length is on average length of one centimeter.

(b) Mosquito lava

The stagnant crossbow mini lakes formed on the banks of rivers and the swamps hold a large population of mosquito lava. Their numbers are large (over three thousand per square foot of water- laterally) in areas with reeds and various grasses growing in the water. These types of habitats provide microbial food resources for the lava and refuge from predators. The most common lava species belong to the Culicoides complex of mosquitoes. They are highly adapted to forests and other ecosystems where conditions are conducive.

(c) Dragon flies

Adult dragonflies are very conspicuous in water bodies and associated habitats in the Meru conservation complex with huge populations where there are water reeds growing around swamps and slow flowing streams. The dragon fly larva are the longest living component in the dragon fly lifecycle and prefer microhabitats with few disturbances.

(d) Water striders

They are found in the rivers and most streams in this region, and can observed skipping on the surface of the water. They prefer slow flowing regions of the water.

(e) Mud beetle

These are found in the muddy regions of the swamps and their heads are heavily sclerotized to protect them as they burrow through the mud. Antennae are small and they have a mainly black color with some brownish spots that camouflage them in the mud. Their eyes are almost vestigial due to their mud burrowing lifestyle.

(f) House fly lava

These are found mainly found in the muddy regions of the swamp, where there is decaying vegetation and occasionally dead decaying animal material. The larva occur in large numbers. Most of the lava found in human populated areas are white in color but the ones found in Meru Conservation area tend to be cream in color.

(g) Non biting midges

Species of non biting midges found in this region are semi aquatic. They mostly hang under papyrus reeds and other types of reeds that grow in the water. Sometimes they are seen flying along as the water flows down stream.

(h) Crickets

These are most conspicuous during the rainy season and are most common in swampy portions with reeds and near river beds. Their chiming sounds are mostly heard at night. Unlike field crickets, these crickets are more elongate and darker in color. Their cerci are also longer and mouth parts more sclerotized. They lay their eggs in the muddy water from which nymphs emerge and hide within the reeds.

(i) May flies

These flies appear in large numbers in the rainy season along the rivers and streams. Their larvae are aquatic and observed swimming in water prior to the onset of rainy seasons. The adults have a short lifespan, dying soon after mating and laying eggs in the water.

Phylum Annelida

(a) Earth worms

The earth worms are found deep in the mud in the swamps and river banks. Their populations are huge and dug samples of mud contain some individuals. Some of the earth worms can be twenty centimeters long with thick diameters. They are fed on by mudfish and crabs.

(b) Leeches

They are not universally found in the water bodies in the region but mostly in some streams from Nyambene hills, downstream to the rivers. Portions of river Ura also have been reported to have leeches. They bite and suck blood from animals that cross water bodies in which their niche is located.

(c) Water snails

These occur at low densities mainly along the rivers banks in the Meru Conservation Complex. Their younger stages are aquatic, mainly living in water bodies. They have preference for moist habitats and are observed feeding on the leafy vegetation near rivers and streams.

(d) Slugs

Unlike the snails, the slugs lack a shell. They move in mucilaginous excretion coverings along the shores or in shallow ponds formed as the water flows along streams. They also feed on aquatic vegetation. They prefer fresh water areas avoiding salty areas as their mucilage is degraded by salts, especially chloride based salts.

Vertebrates

1. Fish

(a) Mud fish

Mudfish are common in streams in this region where they feed on earthworms. The local people capture them for food but are rarely sold in the markets as the sizes of fish caught are too small. Larger specimens occur in deep rivers such as the Tana.

(b) Cat fish

Catfish are ubiquitous common in the area and local people venture deep into the conservation area to catch them for sale. Species found in the deep parts of rivers in the conservation area are large due to low exploitation pressures and an abundance of food sources. However smaller sized specimens are encountered in oxbow lakes formed by the rivers during rainy seasons.

(c) Goby fish

This is a group of very tinny fish that can be seen swimming near the surface of less turbid parts of the rivers. Their bodies look like translucent with brownish dots. They are ecologically critical as regulate the mosquito populations through predation on their forms.

(d) Tilapia

These are common in the Tana River and Tributary Rivers such as Ura and Rujowero. They are of economic importance to the locals because they are the species widely commercialized.

The Kenya National museum has done an analysis of various species found in this region as per data obtained in June 2012. This was on a capture recapture method and is summarized below.

Table 3 Insects

REGION	SPECIFICS	ORDER	GENUS	SPECIES NUMBER
Tana river system	Ura river at Ura gate	Hemiptera	Belostomatidae	4
		Coleoptera	Dycticidae	3
		Decapoda	potumonamtidae	12
		Megaloptera	Corydaiidae	1
		Prosobranchiata	Thyaridae	31

Table 4 Fish

REGION	SPECIES	NUMBER
River Murera in Meru conservation complex	*Labeobarbus oxyrhynchus*	45
	Barbus sp. cf. kerstenii	139
	Oreonchromis spilurus spilurus	22
	Anguilla bengalensis labiata	1
	Garra cf. dembeensis	127

	Amphilius grandis	12
	Chiloglanis brevibarbis	10

REGION	**SPECIES**	**NUMBER**
River Ura in Meru conservation complex	*Labeobarbus oxyrhynchus*	20
	Labeo cylindricus	6
	Chiloglanis brevibarbis	19
	Neobola flaviatalis	8
	Garra cf. dembeensis	4
	Amphilius grandis	3

Critical habitats

- Mulika Swamps
- Muera
- Bisanadi River
- Rojoweru

Full species inventories of aquatic invertebrates have not been conducted and endemism levels at least can only be deduced through habitat uniqueness.

Possible Effects of Deltamethrin Sequential Aerosol Technique to Bird community in Meru Conservation Area.

The Meru Conservation Area (MCA) includes the entire Meru National Park, and the adjacent Bisanadi to the east, the Kitui National Reserve to the south, Kora National Park and the Rahole National Reserve. These adjacent areas have a birdlife that appears lesser rich than the main Meru and little known in terms of their conservation status (Bennun and Njoroge 1990). The Meru Conservation Area is classified as an Important Bird Area (IBA) as well as an Endemic Bird Area (Fishpool *et al* 2001). These are areas of international importance for conservation of birds at the global, regional, or sub-regional level (Bennun and Fishpool, in press). The site is categorized among the 62 Important Bird Areas in Kenya.

The area's avifauna is generally diverse, with around 280 species recorded. The threatened Hinde's Babbler *Turdoides hindei* recorded here has a very restricted range in central Kenya. It is one of the eight keystone species, found in Kenya's Endemic Bird Areas. It qualifies the site as one of the Kenya Mountains Endemic Bird Area (EBAs). The species has recently been recorded near Kindani and Nyati Camps in the south-west of Meru National Park. This is a critical species for conservation because it is categorized as a vulnerable species that is endemic to Kenya (checklist of Birds of Kenya 2009). Barblers are omnivours that feed on both insects and fruits. Any negative impact on its ecosystem will be of critical concern to their survival. MCA also has a number of regionally threatened species. They include Saddle-billed Stork *Ephippiorhynchus senegalensis* (known to breed here), Martial Eagle *Polemaetus bellicosus* (status unknown), African Finfoot *Podica senegalensis*, Pel's Fishing Owl *Scotopelia peli* and Violet Wood-hoopoe *Phoeniculus granti*.

Effects of Deltamethrine on avifauna of Meru Conservation Area:

Deltamethrin is an extract from chrysanthemums C*hrysanthemum spp*. (Extoxnet 2001). Based on the chemical structure (C22H19Br2NO2), it is a strongest synthetic pyrethroids among the group of broad spectrum insecticides. However, it is less powerful and with a shorter half life than synthetic pyrethroids, but quite effective plants extract insecticides (Perry et al. 1998). Endosulfan was the originally most favoured insecticide of choice for the 2001 – 2002 Okavango Delta spraying operation, but it was changed to deltamethrin by the Environmental Impact Statement team, partially due to concerns about fish kills. In Zimbabwe, DDT was used for tsetse fly control. It was realized to accumulate in several bird species and was correlated with population declines in certain guilds in birds (Douthwaite 1995, 1992). It was also correlated with eggshell thinning which probably led to nest failure in African goshawks *Accipiter tachiro* (Hartley and Douthwaite 1994) and African fish eagles *Haliaeetus vocifer* (Douthwaite 1992). Food chains and webs provide a network of consumer resource interaction among groups of organisms, populations or aggregate trophic nits. This may arise when the chemical used become more concentrated as it moves up the food chain, getting more concentrated in predators due to continuous accumulation than in the prey. Raptors (birds of prey) and scavengers (the Vultures), are the most affected since they are at the top of the food chain.

Toxicity of deltamethrin

Deltamethrin is less problematic than many other pesticides because it has a low toxicity to vertebrates. It breaks down quickly and adheres to the top layer of soil instead of percolating through to the water table or into streams (Elliot et al. 1978, WHO 1990, Perry et al. 1998, Extoxnet 2001). Degradation of deltamethrin occurs within days in the air or on the surface of plants, and within weeks in the soil (Extoxnet 2001). It has no effect of bioaccumulation because it is metabolized and broken down in a matter of days (WHO 1990) when absorbed by plants or animal (WHO 1990, Perry et al. 1998, Extoxnet 2001).

Pyrethroids can be toxic to both beneficial insects and pest insects. Different application rates of the synthetic pyrethroid cypermethrin have been known to reduce insect numbers to varying degrees. This can have differing effects on insectivore birds. For example at high application rates (75 g/ha) insect populations have been reported to have devastated, leading to catastrophic reductions in breeding success of birds. However, at a lower application rates (3.75 g/ha), insects can significantly reduce but not devastated, though still reducing breeding success in birds, but far less dramatically (Pascual and Peris 1992).

Reductions in insect populations can affect birds in various ways depending on the severity of the decline and the coping mechanisms of the species of interest. The effects can range from behavioral changes or reduced body weight in individual birds, to reduced fecundity and detectable drops in populations (Cooper et al. 1990, Whitmore et al. 1993, Sample et al. 1993). In some cases, insects are not limiting to bird populations, and significant reductions in insect numbers may not necessarily cause biologically significant change to birds' food supplies.

MCA is an ornithological hot spot. Fifty-seven of the Maasai Somali biome bird species out of the ninety-two species recorded in Kenya occurs here. Being also an Important Bird Area (IBA) and also Endemic Bird Area (EBA) makes it an important area for avian conservation at local, regional as well international level. It is a key site for both Palearctic (Eurasian migrants) wintering here, as well as Afrotropical migrating birds (birds that migrate within the African continent and associated Islands eg. Madagascar). The Eurasian migrants arrive here in the late September and stay till late April to early May, when they get back north in summer to breed. Most of the Palearctic migrants come from the Eastern Europe, Russia, the Middle East and Siberia.

Both the migrants and the local species occupy different ecological niche. This helps to reduce competition and utilize different resources among species. Some species prefer to forage and stay in grasslands, woodland, bushlands and wetlands. There are different feeding guilds in birds that are found in different ecosystems that may be affected differently by the deltamethrin aerial spray in the process of eradication of tsetse flies within the MCA. The most to be affected are the insectivorous which directly feed on the insects. Carnivorous and scavengers, which feed on both vertebrates and invertebrates, are also most likely to be affected. The insectivorous here comprises 41% of the total avifauna of the area, while carnivores and the scavengers comprises 22% and 3% respectively. Among the carnivorous and scavengers are raptors (eagles, falcons, kestrels, and hawks) and vultures. These are at the top of the food chain and likely to be affected due to bioaccumulation of chemicals in their body systems as well as the prey they feed on. The

three guilds are the most likely to be affected by deltametrin application. However, Pyrethroids are moderately toxic to birds, with most LD50 values greater than 1000 mg/kg. Birds will be indirectly affected by pyrethroids, because of the threat to their food supply. Waterfowl and small insectivorous birds are the most susceptible (Mueller-Beilschmidt, 1990). Deltamethrin has low toxicity to vertebrates, and therefore will have no direct negative impacts on birds within the MCA. Negative effects of deltamethrin spraying on breeding success of birds are due to indirect rather than to direct effects Such indirect effect would be caused by reductions in insect food supplies, and not particularly directly by poisoning the birds**.** Reduced prey supply for the insectivours birds will affect the breeding populations. A combination of anthropogenic and natural environmental factors such as prolonged drought or wild fires may as well contribute to the reduction in bird population and reduced nesting success in birds.

Other feeding guilds include the seedeaters identified with the MCA are seed eaters (35%), frugivours (5%), omnivours (3%) and the pscivours(fish eaters) at 2%. Most of the Palearctic migrants belong to the insetivours and carnivours.

Effect of the Deltamethrin on migratory bird species

During the wintering period, Palearctic species share the food resource with the resident species. At times this may lead to competition for the available resources. Spraying may further reduce the food resources for both resident populations and Palearctic population. Some of the migrants are threatened species in their breeding regions because of lose of habitats, and therefore the wintering regions in Africa are quite significant ecosystems for their survival. Such species are under the convention on migratory species (CMS) also known as the Bonn Convention, under which Kenya is among the 100 countries as a contracting party. In order to provide a safe foraging ground for both the resident migratory birds, it will be advisable to carry out spraying in the time when the migrants are still at the breeding grounds in the north. Even though this will still affect the local population, the effect will not be devastating and recovery is quite rapid.

Recovery Period in bird populations

Pyrethrins are inactivated and decomposed by exposure to light and air. Natural pyrethrins are highly fat soluble, but are easily degraded and thus do not accumulate in the body. It has no effect of bioaccumulation on birds because it is metabolized and broken down in a matter of days) when absorbed by plants or animal (Extoxnet 2001, Perry et al. 1998, WHO 1990,). This means there are no risks of bioaccumulation among groups of organisms within the food chain, hence no chemical accumulations in the predators (birds of prey) and the scavengers (vultures) in the MCA. They are as well unstable and rapidly degrade in contact with water, air and light. Delmethrin will be more exposed to light and air since the Meru Conservation Area is not under dense forested cover, and therefore no threats of persistence within the ecosystem. It undergoes photolysis, hydrolysis and oxidation. Under anaerobic conditions it is reduced to various carboxylic acids. Degradation of deltamethrin occurs within days in the air or on the surface of plants, and within weeks in the soil (Extoxnet 2001). Deltamethrin has been classified ‘‘immobile’’ by the US EPA (URL 2). Therefore, in the field, most of the affected organisms show rapid recovery. The spraying of deltamethrin will only have a temporal effect on insect population in the Meru conservation Area, which will affect the population of the local or

resident, mostly the breeding population. This will be followed by a quick recovery of arthropods, hence a rapid recovery in food supply for birds. Deltamethrin has prolonged effects in thick and cold vegetation or forested areas especially in temperate zones due to lack of light heat energy. MCA has open semi-arid plains with mostly red soil. It is covered with uniform combretum-wooded grasslands, Acacia commiphora bushlands, a hot dense thorny habitat. This provides a habitat for different bird species. In such kind of environment deltametrhrin will degrade very easily hence quicker recovery in affected insects and further recovery in bird populations.

Effects of Deltamethrin on wildlife in MCA

The Meru Conservation Area (MCA) lies in the Somali-Maasai Regional Centre of Endemism, an area of some 1.87 million square kilometers, extending from north-eastern Somalia to north-eastern Tanzania and including much of north-eastern Kenya, south-eastern Sudan, parts of Ethiopia and north-eastern Uganda. The MCA is a complex of protected areas along the Tana River that includes the adjacent Bisanadi and Mwingi National reserves, the Kora National Park, and Meru National Park. The complex occupies an area slightly over 5,000 square kilometers. The two parks and the two national reserves constitute an important conservation area in Kenya which is the second largest conservation area after the Tsavo East and Tsavo West and are perhaps one of the remaining true wilderness areas in Kenya and the world. Meru National Park (MNP) was gazetted in 1966 and is one of the oldest national parks in Kenya. The park is located in Meru North District, and covers 870 km^2. Kora National Park, which covers 1,787 $km^{2,}$ is by far the largest protected area in the Meru Conservation Area. The park was initially gazetted as a nature reserve in 1973. It was gazetted as a national park in 1990, following the murder of George Adamson by poachers. Key features include Adamson's falls, Grand Falls and the Kora rapids. The Mwitamvisi River marks its eastern boundary and the park also has seasonal rivers. Bisanadi National Reserve was gazetted in 1979. The reserve covers 606 km^2 and it is located just north of Meru National Park (MNP), providing an important dispersal area for many wildlife species that concentrate around the permanent swamps in Meru N.P during the dry seasons. Mwingi national Reserve (MNR) located south of MNP covers an area of 745 km^2.

Climate

The MCA enjoys a Tropical semi-arid climate and classified to fall within the eco-climatic zone V. Rainfall in MCA closely associated with changing elevation, with the north western side receiving more rainfall compared to low lying south eastern part. The annual rainfall can fluctuate considerably with the Northern area having a mean of about 700 mm per year, while the southern part less wet has a mean of about 500mm per year. The MCA enjoys bimodal rainfall with the short rains in December and long rains between March and May. The amount of rainfall could vary by a factor of 10 from year to year (Ogallo, L.J.1988). The annual rainfall can fluctuate considerably with wet years having more than double the mean annual rainfall and dry years less than half or quarter of the mean annual rainfall. The dry seasons can last anywhere between four and eight months. The moisture index fluctuates between –42 and –51, where rainfall seldom exceeds evaporation. Desiccating winds characterize the dry season with

temperatures above 33 degrees Celsius during the day and declining to an average of 20 degrees Celsius during the night.

Flora

The vegetation composition within Meru National Park can be broadly divided into three communities (Ament, 1975).

Acacia/Commiphora bushland

The Southern part of MNP is composed of *Acacia and Commiphora* bushland wish is dominant where the basement rock is exposed towards the southern region. Near the boundary of *Acacia/Commiphora* bushland *Acacia mellifera, Acacia nilotica,* and the Scrambling *Acacia brevispica* and *Acacia ataxacantha* is common. Further South-east *Acacia Senegal and Acacia rafiens* dominates (Ament, 1975). *Commiphora africana* is the most frequent species near the western side as well as *Commiphora boiviniana*. Further East *Commiphora campestris* appears and replaces *Commiphora africana.*

Combretum woodland

Combretum apiculatum is dominant species throughout the *Combretum* wooded grassland area in the western boundary of MNP. *Sehima nervosum* is the dominant grass species throughout this habitat and there are scattered patches of *chrysopogon plumulosus* and *Aristida adscennionis,* particularly where the land has recently been disturbed. South of Kiolu River in the *Combretum* woodland grassland *sehima nervosun* occurs, but is not clearly dominant. *Sorghum veriscolor, Chlysopogon plumulosus Rottboellia exaltata, Cenchrus ciliaris and Themeda trianda* occur in scattered clumps.

Acacia wooded grassland

This covers the Eastern part of the Nyambeni lava flows and the volcanic alluvial soils along the Northeastern boundary of the park. *Acacia tortilis and Acacia Senegal* are abundant on the lower boarder strewn ridges, giving way to *Hyphaene coriacea* in the low swampy areas besides the rivers. *Acacia Senegal and Acacia tortilis* form tall trees near the rivers; *phoenix reclinata* forms the main part of the riverine ticket. *Chloris gayana* is the dominant grass with *Echinochloa haploclada* forming pure stands in the damper places. The better drained grasslands towards the eastern boundary of the Rojewero River are slightly wooded with *Acacia Senegal and Acacia tortilis,* and some nearly pure stands of *Terminalia spinosa* where *Balanites aegyptiaca* is also common. The grass *Sorghum versicolor and Chlysopogon plumulosus* alternate with patches of *Sehima nervosum. Aristida adscensionis* is common where the ground has been disturbed. Other minor community is found along water courses and in the swamps consisting mainly of stands of Doum palm (*Hyphaene multiformis)* and wild date palm (*Phoenix reclinata)* and a network of fig trees. There are also numerous riverine swamps with sedges (*Cyperus spp),* grasses like *Echinochloa haplocoda and Pennisetun mezianum* (Aments, 1975). *Acacia eliator* is feature of permanent rivers and *Acacia robusta* of the less permanent ones. The Tana River has its own

community; the most striking member is *Populus ilicifolia,* the Tana river poplar, and large Ficus species. Further from water there is strip of bush dominated by *Salvadora persica.*

Other conservation areas and adjoining settlements

The area vegetation types ranges between bushland (thickets, open bushland and dense bushland) to woodlands especially in areas where it has not been cleared for settlement and rain-fed agriculture.

Thicket

Areas under this vegetation type show a composite of woody species namely; *Acacia mellifera, A. tortilis and Commiphora africana. Acacia ataxacantha, A. brevispica* and *Combretum exalatum* dominate the shrub layer. Other bushes are composed of *Grewia bicolor, Grewia villosa* while *Grewia tembensis. Aspilia mossambicensis, Achyranthus aspera* and *solanum rechi*i are some of the herbaceous layer species in this vegetation type.

Open Bushland

C. africana trees interspersed with *A. mellifera* and *A. tortilis* are fairly common in this vegetation type where human activities are minimal. Common bushes are those of *G. bicolor, G. villosa* and *Brachiria deflexa, Brachiria laersiodes*. *Cenchrus ciliaris* dominate the herbaceous layer where livestock grazing has not been intense.

Dense bushland

Much of this vegetation type has been cleared for settlement. However, where small pockets still exist, it is dominated by *A. tortilis, A. mellifera, Albizia anathelmintica, Dalbergia melanoxylon* and *Terminalia brownii*. The shrubs may include *G. villosa, G. bicolor, G. tembensis, A. brevispica* and *C. exalatum*. Herbaceous layer where grazing is not intense, is dominated by *A. massambicensis, Trimffetta flavescens* and *S. renchii*.

Woodland

Human settlement has decimated much of this vegetation type. In relatively intact areas the vegetation is still dominated by *A. mellifera, C. africana*, and *A. tortilis* which form the upper canopy. However, in densely populated areas, these species are scattered, dotting the landscape. Shrubs include *C. exalatum* and *G. villosa, Premna resinosa*. The herbaceous layer is composed of *Enteropogon macrostachyus, C. ciliaris* and *Digitaria scalurum* especially where overgrazing has not taken place.

Mwingi and Kora Conservation Areas

The area is characterized by presence or absence of sociological plant species groups. However, there are several plant association dictated by soil types, depth and underlying rock and topography. For instance, *Cordia sinensis – Lawsonia inermis* group of communities are usually found on the floodplains along the Tana River where soils are deep and water is always available. The *Tephrosia noctiflora* is mostly associated and dominant in areas susceptible to flooding. Areas dominated by *Acacia bussei* species have soils mainly with high lime content while *Commiphora rostrata* species dominated areas with shallow soils. Large swath of the of the project area are dominated by *Commiphora* spp, notably *C. africana, C. holtziana* and *C. boiviniana* interspersed with *Lannae triphylla* and *L. Greenwayi*, which give a dense bushland to bushland thicket type of vegetation structure.

The flat to gently undulating, undissected plains are dominated by *Acacia mellifera – Commiphora* spp plant community which forms a transition zone between the undissected plains with *A. mellifera – Douspermum eremophilum* plant community and the dissected plains characterized by *Commipora spp – A.tort*ilis group of plant communities.

Fauna

Mammals

The park is home to a variety of mammals including African Elephant (*Loxodonta africana*), lion (*Panthera leo),* cheetah (*Acynonyx jubatus),* leopard (*Panthera pardus),* eland (*Taurotragus oryx),* waterbuck (*Kobus ellipsiprymnus),* grant's gazelle (*Gazella granti),* oryx (*Oryx beisa),* buffalo (*Syncerus caffer),* reticulated giraffe (*Giraffe carmelopardalis reticulata),* Impala (*Aepyceros melampus),* burshell's zebra (*Equus burshelli),* grevy's zebra (*Equus grevyi),* coke's hartebeest (*Alcelaphus buselaphus cokii),* warthog *(Phacochoerus aethiopicus),* Black Rhinoceros (*Diceros bicornis*), White Rhinoceros (*Ceratotherium simum*), Dik dik *(Madequa kirkii),* Waterbuck *(Kubus ellipsiprymnus),* Bohor reedbuck (*Redunca redunca),* Hyaena (*Crocota crocota),* Marsh mongoose (*Herpestes paludinosus),* Wild cat (*Felis libyca),* Kongoni *(Alcelaphus bucelaphus),* Gerenuk (*Litocranius walleri),* Lesser kudu (*Tragelaphus imberbis),* Bush pig (*Potamochoerus porcus*, Baboon (*Papio Anubis),* Porcupine (*Hystrix cristata)* and Hippopotamus *(Hippopotamus amphibious)*.

Wildlife Numbers and their Distribution

Most of the wildlife species are widely distributed both inside and outside the protected areas in Meru Conservation Area, with Meru National Park being an important habitat for most of these wildlife species. Distribution of wildlife is dictated by seasonal changes with MCA being a key dry seasons grazing area while adjoining community grazing area serve as wildlife dispersal habitat during the wet seasons. Wildlife dispersion is well correlated with prevailing environmental gradient as dictated by rainfall and soils that characterize existing agro-ecological zones. The agro-ecological zones range from zone III to VI, from South to North of MCA respectively, where productivity correlates with rainfall amount. These mosaics of habitats influence faunal distribution within the MCA, with wetter areas recording higher wildlife densities. For instance, MNP recorded the highest proportion of elephants counted in 2007 with

only a few recorded in Kora NP, Bisanadi and Mwingi National Reserves. It also had a higher number of buffalo and giraffe, although more individuals of these species were found outside protected areas. Zebra and impala pre-dominated MNP and BNR. Grant gazelle, Gerenuk and lesser kudu pre-dominated MNP and community grazing area north of the park with a few individuals distributed randomly in the rest of the MCA. In general over 70% of wildlife were confined within protected areas of the MCA with a few exceptions for elephant, grevy's zebra, oryx, kudu, gerenuk, ostrich and grant's gazelle, depending on the season. Figure 1 shows the wildlife species total numbers counted during the short wet season in different localities within the MCA. Meru NP had the highest, followed by community grazing area north of the park while Mwingi National reserve had the least. The numbers in MNP are expected to be more as it has recently benefited from a wildlife restocking programme where nine (9) different wildlife species were translocated. In total the park has received over 3000 individuals of different species of zebra (1350 individuals) and impala (1366 individuals) accounting for the highest translocatees. A good proportion of the wildlife number was probably missed due to poor visibility from the air as a result of the dense canopy cover in some sections of the park.

Amphibians

Meru NP was inventoried recently as opposed to other conservation areas within the MCA. According to Wasongo (2003) MNP is habitat for eleven species of amphibians belonging to six families (Table 1). The *Acacia* wooded grassland had the highest species abundance as well as richness with a total of 173 individuals falling in ten species. Eight species (113 individuals) were recorded from the *Combretum* wooded grassland, while the *Acacia-Commiphora* bushland had seven species (144 individuals). Two species, *Phrynomantis bifasciatus* and *Hemisus marmoratus* were exclusively recorded in the *Acacia* wooded grassland. *Ptychadena mascareniensis* and *Bufo gutturalis* were both absent in the *Acacia-Commiphora* bushland. *Bufo garmani* did not occur in the *Combretum* wooded grassland while *Xenopus laevis* was not recorded in the *Acacia* wooded grassland. Five species (*Ptychadena porosissima, Ptychadena anchietae, Phrynobatrachus natalensis, Bufo maculatus and Hyperolius viridiflavus ferniquei*) were common to all vegetation communities.

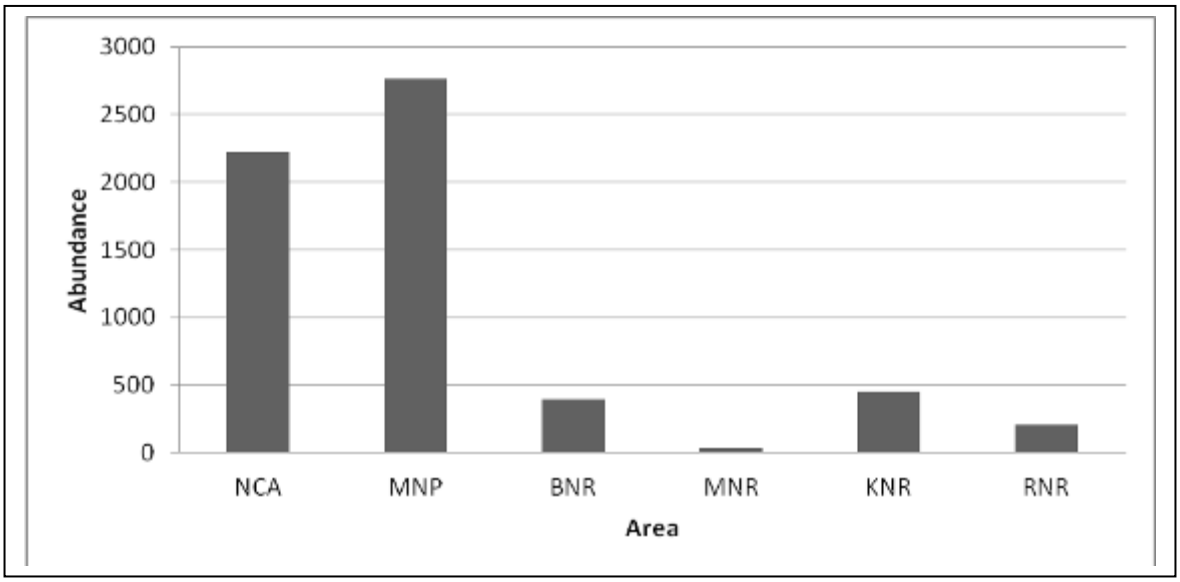

Figure 6 Wildlife species total numbers counted indifferent localities within the MCA

Table 5 Abundance of amphibian species in MNP (Source: Wasongo, 2003).

Family	Species	Abundance
Ranidae	*Ptychadena porosissima*	71
	Ptychadena mascareniensis	31
	Ptychadena anchietae	57
	Phrynobatrachus natalensis	27
Bufinidae	*Bufo maculates*	37
	Bufo garmani	32
	Bufo gutturalis	23
Hyperoliidae	*Hyperolius viridiflavus ferniquei*	91
Hemisotidae	*Hemisus marmoratus*	27
Microhylidae	*Phrynomantis bifasciatus*	8
Pipidae	*Xenopus laevis*	26

One of the species, *Hyperolius v. ferniquei*, a sub-species of the "viridiflavus complex" is endemic to Kenya. It, however, has a range extension including areas of Central Kenya. The taxonomy is still not resolved for many forms (e.g. *Ptychadena mascareniensis, Phrynobatrachus natalensis*). Hence, there could probably be more species and/or endemics for Kenya or Meru involved.

Reptiles

The reptiles present in the park include Nile crocodiles, several species of snakes, turtles, tortoises and monitor lizards.

Among the various protected areas within the MCA, Meru National Park is reported to have the highest collection of reptilian species (Appendix 1). Existing records show presence of 17 snakes and 11 lizard species in Meru National Park. The park is also important for crocodiles that inhabit the Tana River, which forms the boundary between Meru NP- Bisanadi National Reserve and Mwingi NR- Kora National Park. Kora NP, however, is also reputed as an important habitat for reptilian species although the specimens previously collected here are fewer compared to those from Meru NP. Similarly, although Mwingi and Bisanadi National Reserves show limited reptilian specimen collection, they are also importance herpetofauna habitats. The herpetofauna diversity differences among conservation areas does not reflect their reptilian or amphibian conservation importance but could be indicative of intensities of past surveys in each area meaning Meru NP has had more surveys compared to other areas. This scenario is more likely due to accessibility of the park owing to existing road network. The MCA area in general is expected to have similarity in herpetofauna species composition and diversity as it has similar geographical features, vegetation and climate. The only difference may arise probably with amphibian species with Meru National Park having higher species diversity due to its numerous rivers and streams traversing the park creating conducive habitats for amphibians.

Deltamethrin

Deltamethrin is a pyrethroid insecticide that kills insects on contact and through digestion. It is used to control apple and pear suckers, plum fruit moth, caterpillars on brassicas, pea moth, aphids (apples, plums, hops), winter moth (apples and plums), codling and tortrix moths (apples). Control of aphids, mealy bugs, scale insects, and whitefly on glasshouse cucumbers, tomatoes, peppers, potted plants, and ornamentals. It also controls numerous insect pests of field crops. Formulations include emulsifiable concentrates, wettable powders, ULV and flowable formulations and granules. There are no known incompatibilities with other common insecticides and fungicides.

Deltamethrin is a synthetic insecticide based structurally on natural pyrethrins, which rapidly paralyze the insect nervous system giving a quick knockdown effect. Deltamethrin has a rapidly disabling effect on feeding insects and for this reason there is hope that it may be useful to control the vectors of "non-persistent" viruses (viruses that can be passed on by the vector within a few minutes of starting to feed on the plant). Deltamethrin's mode of action is thought to be mainly central in action, or at least originate in higher nerve centers of the brain. Death of insects seems to be due to irreversible damage to the nervous system occurring when poisoning lasts more than a few hours. Deltamethrin poisoning occurs through cuticular penetration or oral uptake. The susceptibility of insects is dependent on a variety of factors and can vary, as with many insecticides, according to the environmental conditions. Flies are most susceptible to pyrethroid poisoning shortly before dawn. The LD50 drops by the factor of 2 as compared to full daylight activity.

Many pyrethroids are not very active against cattle ticks, but some alpha cyano compounds (of which deltamethrin is one) have higher activity than organophosphates or amidines, the former standard compounds for this purpose. Deltamethrin has very good residual activity for outdoor uses (field crops, cattle dip, tsetse) and for indoor uses (mosquitoes, stable flies, horsefiles, fleas,

cockroaches, stored product insects). Deltamethrin has very broad spectrum control. It is considered the most powerful of the synthetic pyrethroids. It is up to three orders more active than some pyrethroids.

Effect on mammals

The signs of poisoning produced in rats by deltamethrin are not the same as those produced by other pyrethroids. Especially characteristic are rolling convulsions. The site of action is considered to be central with little or none of the peripheral component demonstrated for other pyrethroids. The sequence of signs is clearly defined, progressing from chewing, salivation, and pawing to rolling convulsions, tonic seizures, and death. Blood pressure begins to drop promptly, but slowly; it tends to normalize about the time choreoathetosis (abnormal movements of the body of a combined choreic and athetoid pattern) begins but falls precipitously prior to death. The early signs, including choreoathetosis, are reversible, but rats that exhibit a tonic seizure and shock almost always die promptly.

Acute exposure effects in humans include the following: ataxia, convulsions leading to muscle fibrillation and paralysis, dermatitis, edema, diarrhea, dyspnea, headache, hepatic microsomal enzyme induction, irritability, peripheral vascular collapse, rhinorrhea, serum alkaline phosphatase elevation, tinnitus, tremors, vomiting and death due to respiratory failure. Allergic reactions have included the following effects: anaphylaxis, bronchospasm, eosinophilia, fever, hypersensitivity pneumonia, pallor, pollinosis, sweating, sudden swelling of the face, eyelids, lips and mucous membranes, and tachycardia.

Studies have shown many cases of dermal deltamethrin poisoning after agricultural use with inadequate handling precautions, and many cases of accidental or suicidal poisoning by the oral route at doses estimated to be 2- 250 mg/kg. Oral ingestion caused epigastric pain, nausea, vomiting and coarse muscular fasciculations. With doses of 100-250 mg/kg, coma was caused within 15-20 minutes.

Effect on reptiles and amphibians

The mechanism of action of pyrethroids, including deltamethrin, is the same for target and non-target organisms. Pyrethroids are less toxic to mammals compared to insects due to mammals' higher body temperature, larger body size, and decreased sensitivity of the ion channel sites.

Non target organisms like reptiles and amphibians can be affected directly through poisoning when they eat contaminated insects or indirectly because the Deltamethrin reduce the food availability leading to organisms starving to death. Amphibians can also be affected through cuticular penetration depending on the quantity of product in contact with their skin. Deltamethrin is said to be moderately to highly toxic to fish under laboratory conditions. However, when products are used according to the label, deltamethrin is less likely to affect fish. This is because it is more likely to be bound to the sediment.

Critical Species

Deltamethrin is mostly effective against invertebrates and its efficacy is dependent on time of day. For insects, application shortly after dawn will have good results for flies and, therefore, Tsetse flies. Unfortunately, it has the potential to affect non-target species. Pyrethroids are less toxic to mammals compared to insects due to mammals' higher body temperature, larger body size, and decreased sensitivity of the ion channel sites. However, heavy use or acute exposure may results to death of animals. Reptiles and amphibians are susceptible through feeding on dead insects or staving due to reduction of their food base. Also cuticular penetration has also been reported to impact negatively on amphibians.

Table 6 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Project Component	**Positive Impact**	**Negative Impact**	**Mitigation Measures**	**Responsibility**	**Time Frame**	**Monitoring Period**
Environmental and socio-economic Parameters						
Deltamethrin Exposure to insects	• Eradication of Tse-Tse flies	• Control of non-target species	• Application of pesticide before down for its effectiveness against flies • Use compounds with minimal outdoor residual longevity	• Contractor	Application phase	Application phase
Exposure Deltamethrin to reptiles and amphibians		• Reduction of reptilian and amphibian population	• Use of deltamethrins compounds that are not active on other insects • Use of optimum concentrations to eradicate tse-tse flies. • Use of deltamethrin concentrations with minimal cuticular penetration	• Contractor	Application phase	Application phase
Exposure of Deltamethrin to mammalian species		• Reduction of mammalian populations	• Avoid concentrations with acute exposure to mammalian species • Use appropriate deltamethrin handling procedures	• Contractor	• Application phase	Application phase

Table 7 Work Plan: Project implementation timeline

Name	Position	Activities	Weeks (in the form of a Bar Chart) 1	2	3	4	5	6	7	8	9	10	11	12
Joseph Maitima	Lead Consultant	Lead the project Conduct Public Participation Report writing and supervise other consultants												
Vincent Oduor	Consultant Lead EIA Expert	GIS specialist and Assist Lead Consultant in preparing NEMA Study Report												
John Githaiga	Consultant	Aquatic biologist and Water specialist												
Robert Chira	Consultant Lead EIA Expert	Wild Life Specialist												
Titus Imboma	Consultant	Ornithologist												
Dr. Charles Warui	Consultant	Invertebrate Biologists												
Phoebe Mukiria	Consultant	Entomologist												
Githaiga Wagate	Consultant Lead EIA Expert	Toxicologist and public Health												

Table 8 Table 8: Field Visits and Investigation

Items of Work/Activities	Weeks Program from date the assignment starts												
	1	2	3	4	5	6	7	8	9	10	11	12	
Visits to District Commissioners / District Officers (DOs) to set dates for formal meetings with Chiefs and sector leaders in the designated SAT application areas													
Formal meetings with local administrators, community leaders and residents in the designated SAT application areas													
Consultants familiarization tour of MCA													
Meetings with KWS Staff in the four conservation areas (Meru, Kora National parks, Bisanadi and Mwingi game reserves)													

Project Alternatives

Introduction

The consideration of alternatives is one of the more proactive sides of environmental impacts assessment – enhancing the project design through examining options instead of only focusing on the more defensive task of reducing adverse impacts of a single design. This calls for the comparison of feasible alternatives for the proposed project site, implementation, technology, and/or operational alternatives.

Alternatives have been compared in terms of their potential environmental impacts, suitability under local conditions, and acceptability by neighbouring land users.

The Proposed Alternative

The EIA study report has been prepared for submission to NEMA; facts, findings and recommendations/ proposals of which are based on the proposed site, design, materials and proposed technologies. This helps in evaluating and examining the foreseeable effects of the project on the environment and therefore assisting in addressing how the proposed development has to ensure that all environmental measures are complied with during the premises preparation and during operational phase.

The alternative consists of the proponent's final proposal with the inclusion of the legal guidelines, regulations and procedures as stipulated in the EMCA, 1999 which aims to reduce environmental impacts to the maximum extent practicable. Appropriate Environmental Management Plans have been prepared as per the proposed project.

Relocation alternative

Relocation option to a different site is an option for the project implementation. At the moment, the proponent has considered all other possible locations and has found MCA to be the best suited site for the project. Finding an alternative place with the same climatic, geographical, bio-physical characteristics and above all the same tsetse and trypanosomiasis challenge with MCA may not be possible. Relocating the project therefore will bring in technical obstacles that will make it difficult for the proponent to recapitalize the objectives. Besides, relocating the project will still leave MCA tsetse infested.

While we appreciate that monetary costs should not be used to justify a wrong project, this would also result in extra costs in terms of money and time as whatever has been done and paid to date would be a direct loss to the proponent. This may also lead to a No Action Alternative situation. The other consequence is that it would discourage both foreign and local investors especially in the livestock sector that needs a lot of public and private investors to reduce the many obstacles to production. In consideration of the above concerns and assessment of the current proposed MCA, relocation of the project is not a viable option. The problem is further aggravated by the fixed characteristics of land and the bottlenecks of the planning policy. The other question is, how will tsetse and trypanosomiasis be eradicated in MCA if the proposed project is relocated and how will the associated impacts be different?

The no action alternative

The No Action Alternative in respect to the proposed project implies that the status quo is maintained. This option is the most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions. The anticipated environmental impacts resulting from the application on SAT (use of deltamethrin) would not occur.

This option will however, involve several losses both to the project proponent for not carrying out the mandated responsibilities and the many beneficiaries of the project (livestock keepers; land users; development stakeholders, society and government). Livestock keepers will continue to incur looses, due to livestock deaths, low productivity and all the trypanosomiasis negative aspects outlined in the project document. The No Project Option is the least preferred with reasons such that there will be no benefits in livestock production, forfeiture of economic benefits that would accrue to the beneficiaries, the public and the government, and it could also discourage investors wishing to invest in the livestock sector. From the analysis, it becomes apparent that the No Action Alternative is not the appropriate alternative.

Alternative technologies and layout

Various alternative tsetse eradication technologies have been considered by the proponent and various professionals involved i.e. the entomologists, tsetse biologists, environmentalists, livestock health specialists, conservationists, public health specialists and SAT application specialists. After extensive discussions and relevant considerations over a long period of time, the various options were assessed and the most optimal technology was found to be SAT and was agreed as per the proposed plans, materials and technology.

The comparison of alternatives

Under the proposed SAT application alternative, the project would eradicate tsetse and trypanosomiasis in MCA and would empower farmers to make better use of their lands provide livelihood opportunities directly and indirectly to the public. Under the No Action Alternative, there would be no change in the trypanosomiasis challenge at all. There would be no benefits to anybody and neither would there be the insignificant environmental impacts.

Provided the environmental impact mitigation measures are implemented as well as adoption of sound chemical use and management practices, negative impacts will be avoided/ minimized. However, commitments related to SAT application alternative would ensure that potential impacts are minimized to levels of insignificance as envisaged in the EMP.

Conclusion

All the alternative options analyzed have implications, which make the current SAT application option proposed by the proponent to be more viable. It is concluded that:

- The available SAT application alternative is likely to increase the returns to investment that the proponent wishes to be if the current proposed activities were to be approved
- MCA is the best for the project finding another location would not be feasible. Because of this, the proposed project may not be relocated to an alternative site.

- The neighbourhood, where the proposed activities are located already shows land use for livestock production is not profitable due to trypanosomiasis. The proposed development will cause temporary negative impacts but as is well documented no of the impacts will be permanent.

Mitigation for the Proposed Action

Mitigation measures, including best chemical use and management practices have been recommended in this study report and when diligently implemented will help to protect the physical, ecological and socio-economic environment of the project area. Commitments included in this report, as well as licenses and other authorizations that would be issued, are designed to avoid environmental damage in accordance with the Environmental Management and Co-ordination Act, 1999.

The Proponent undertakes to incorporate all necessary measures to ensure adverse impacts are mitigated to the maximum extent practicable.

Impacts Identification, Analysis and Mitigation Measures

SAT applications involve a series of defined physical operations which include site preparation; building of shelters and storage rooms etc. All are potentially considerable sources of particular impacts both significant and insignificant. Main impacts occur during the operational phase which involves aerial spraying of deltamethrin over natural and human occupied areas. There are also potential impacts associated with decommissioning of the project.

There are similar projects of SAT application in Botswana and Ghana where we can make references to specific areas of interest on the particular impacts expected from the proposed project. Recommendations from this study may result in some alterations in the design of some of the activities depending on the findings. Impacts are examined under two categories, i.e, negative environmental impacts and positive environmental impacts. The various impacts in these two categories are then examined in order of their level of importance and significance. For impact identification a checklist was employed to identify possible impact from the project and a matrix to determine the significance of each identified impacts.

Environmental Impacts Matrix

An environmental impact identification matrix was developed which covered the main anticipated impacts (positive, negative, major, minor, long and short term and any cumulative, synergistic or secondary impacts) of the project. The matrix lists impact types under broad headings with more detailed project specific impact categories. These impacts are divided into the project preparation, operation and decommissioning Phases of the project. This is shown in the table below**.** It is assumed that mitigation measures will be implemented for all aspects and project areas including inside the conservation areas and the areas of human occupation.

Table 9 Environmental impacts analysis criteria

Criteria for environmental impacts analysis

Classification Criteria	Types of impact; causes and definitions
Character	Positive impacts: They represent environmental benefits; e.g. disease control or recovery of degraded areas. Negative impacts: they cause harm or deterioration to a component or global environment.
Cause – effect relationships	Primary impacts: Usually placed directly and often associated with the operation, and maintenance of a facilities or activities. They are obvious and quantifiable. Secondary impacts: They are indirect or induced changes that could occur subsequently or in different places as a result of the implementation of the action.
Time of occurrence	Latent impact: it occurs some time after the beginning of the activity that caused the impact. Immediate impact: it is manifested at the beginning of the proposed activity. Critical time: period during which the highest degree of impact takes place.
Interrelationship of actions with alterations	Simple impact: it is manifested on a single environmental component, without inducing new alterations, accumulation, or synergy. Cumulative impact: it results from past, present, and reasonably expected future actions.
Extension	Specific impact: it produces a localized alteration. Partial impact: it implies an appreciable incidence in the area under study. Extreme impact: it is identified in a large part of the land area. Total impact: it is present throughout the environment under study.
Persistence	Temporary impact: it implies a non-permanent alteration and is usually brief Permanent impact: it entails an indefinite alteration.
Recovery capacity of the environment	Irrecoverable impact: it impedes environmental recovery. Irreversible impact: those that make it impossible or extremely difficult for the environment to revert to its original condition. Reversible impacts: those that allow a measurable recovery of the environment in short, medium, or long term due to natural process Fugitive impacts: those that allow immediate recovery once the activity is over, and do not require mitigation practices.

Environmental Impact Appraisal Criteria

Criteria Used to evaluate

Character (positive, negative, or neutral; the latter is the one below the acceptable threshold according to environmental regulations).

Level of disturbance in the environment (significant, regular, or limited).

Importance from the point of view of natural resources and environmental quality (high, medium, and low).

Risk of occurrence (very probable, probable, unlikely).

Extension of the area or land involved (regional, local, specific)

Duration (permanent throughout the project, average or during the project operation and short or during the project stage).

Reversibility to return to initial conditions (reversible if human assistance is not required, partial if human assistance is required, and irreversible if a new environmental condition needs to be generated).

Impact Classification (Positive impacts ranked from 1-5 = low to high: Negative indicated by –ve sign)

	Positive$^{(1-5)}$	Negative $^{(-1 \text{ to } -5)}$	Score	Overall assessment
Character	High^{4}	Medium $^{-3}$	1	Positive
Disturbance (D	Regular(2)	Regular$^{(-1)}$	1	Positive
Importance (S	High$^{(5)}$	Medium$^{(-2)}$	3	Positive
Occurrence (O)	Very Probable$^{(3)}$	Probable$^{(-1)}$	2	Positive
Extension (E)	Regional$^{(3)}$	Local$^{(-1)}$	2	Positive
Duration (D)	Permanent$^{(3)}$	Average$^{(-2)}$	1	Positive
Reversibility (R)	Reversible$^{(3)}$	Reversible l$_{(-2)}$	1	Positive
TOTAL	23	-ve12	11	Positive

Impact Appraisal = C X (D + S + O + E + D + R)

Overall assessment CX = 11: Positive impacts outweigh negative by the ration of 23:12. The project is highly positive on environmental considerations

Interpretation of Impact analysis	
Negative(-)	
Severe	> (-) 15
Moderate	(-) 15 > (-) 9
Compatible	< (-) 9
Positive (+)	
High	> (+) 15
Medium	(+) 15 > (+) 9
Low	< (+) 9

Impact evaluation summary

The project has an overall impact factor of positive 11. The positive impacts amount to 23 while the negative impacts amount to –ve 8.

This can be summarized as high positive impacts and moderate –ve impacts

Phase							
	Social Economic & Cultural						
Planning		Water	Flora	Fauna	Noise	ECONOMY	HEALTH
	Stake holders Consultants	-II	+III	+III	+III	+III	+III
	EIA Report Preparation	+II	+III	+III	+III	+III	+III
Operation	Movements within SAT operation areas		-I	-II	-II		
	Construction of structures	-I	-I	-I	-I	-I	+III
	Aircraft runway (if necessary)	-I	-I	-I	-II		-I
	Storage of deltamethrin	-II		-I			-II
	Storage of aircraft and automobile fuels	-II			-I		-II
	Spray flight operations (sorties)			-I	-iI	-II	
	occupation	-II	-I	-II	-I	+I	
	Traffic	-I	-I	-I	-II	+II	+I

	Waste Management	-I	-I	-I			-I
Decommissioning	Decamping	-II	-I	-I	-I	-II	-II

Key categories of impacts (+) Positive (-) Negative: I Low; II Medium; III High

Table 10 Impacts of Proposed Activities to the Environment

Impacts on Water Resources

Activity	Environmental Aspect	Potential Environmental Impact	Mitigating Measures	Time Frame& Responsibility	Indicators to be monitored
Site excavation, grading; and offloading of construction materials at the site.	Spills of oil and other hazardous chemicals from construction equipment	Ground water contamination through leaching Contamination of surface water through storm water run-off Legal non-compliance	Spill prevention procedures & response plan Off-site maintenance of fuel powered equipment and vehicles Spill control kit is available on site. Training of staff on spill response plan and procedure	Main contractor- prior to construction	A record of incidents be kept on site for inspection Visual observation Records of staff training Complaints from workers and neighbours during/prior to inspection.
Storage of Deltamethrin and other chemicals in use	Pollution due to spillage or unsafe use	Poisoning of organisms Ground and surface water contamination and hazards to human health	Chemical should be stored in appropriately designed rooms and used according to specifications	Proponent and contractor during operations phase	Spillage on the camp grounds, medical checkups on camp occupants and visual inspections on affected organisms
Occupancy of the camp by workers and visitors	Solid waste disposal	Ground water contamination through leaching and surface water contamination through run off	Provide suitable solid waste containers Temporary storage at the solid waste cubicles Contract a licensed solid waste transporter	Proponent / contractor during operations	Visual observation on litter in the compound Waste tracking documents. A record of incidents

Loading of Chemical on to the aircraft	Pollution due to spillage during loading of chemical	Ground water contamination and possible pollution to surface water	Chemical should be handled by experienced professionals with mechanisms and apparatus to trap any spillage during loading	All the time aircrafts are loaded with chemicals. / Contractor	Visual observation on the ground
Spaying of chemical	Chemical pollution on flowing and stagnant water bodies	Water pollution and poisoning of the aquatic organisms. Hazardous to people, animals, and all water users in general	Aircraft to avoid spraying on water bodies as much as possible. Public awareness for people to avoid use of water exposed to chemical.	During spraying time. Proponent, residents and the contractors	Use of non-piped water exposed during the spraying. Movement of animals and people during the spray time.
Handling of containers with chemical	Organisms getting into contact with chemical	Chemical poisoning	Putting in place safe disposal mechanisms	Throughout the project operations phase.	Littering of empty containers in the compound

Table 11 Impacts on Biodiversity

Activity	**Environmental Aspect**	**Potential Environmental Impact**	**Mitigating Measures**	**Time Frame& Responsibility**	**Indicators to be monitored**
Clearing in campsite construction site and access roads	Changes in plant and animal biodiversity	Loss of above and below ground biodiversity	Preserve indigenous plants as much as possible	During site preparation and construction Responsibility: The proponent and contractor	Changes in the number of indigenous plants, birds and insects
Site excavation and offloading of campsite	Changes in biodiversity and landscape	Loss of above and below ground	Preserve indigenous plants as much as	During site preparation and operation	Changes in biodiversity

materials.		biodiversity	possible	Responsibility: The proponent and contractor	
Noise	Noise to peoples and wildlife in the operation areas	Disturbance to people & wildlife within the National Parks and Reserves	Maintain low noise (to the recommended levels of decibels) Awareness of noise and dates and times of noise	During and operation Responsibility: The proponent and contractor	Complaints from people and other stakeholders in the operation areas
Solid Waste Management	Dumping of materials	Contamination	All solid wastes must be disposed to designated sites and handled by licensed individuals or firms	During operation. Responsibility: The proponent and contractor	Visual observation or complaints from people in the camp or in the operation areas or visitors
Liquid Waste management	Disposal of hazardous liquid wastes in undesignated areas	Contamination	All liquid wastes must be disposed to designated sites and handled by licensed individuals or firms	During operation. Responsibility: The proponent and contractor	Visual observation or complaints from people in the operation areas or visitors
Use of fire	Ignition of wild or unmanaged fires within and outside the site	Destruction of habitats for wildlife and property	Installation of fire warning signs and fire fighting equipments	During construction and occupancy of the camp. Responsibility: The proponent and contractor	Presence of dry matter and litter
Spraying Deltamethrin	Chemical contacts with nocturnal animals, nests, insects, aquatic animals and ground dwellers	Poisoning leading to possible deaths, possible impacts on reproductive systems of the organisms	Maintain the concentration of the chemical to the specified concentrations. Avoid spraying outside designated areas	During spraying. Responsibility: Contractor	Monitor numbers, behaviour and population structures of organisms in the spray area
Flying Aircraft low to the ground	Accidental crushing of the aircraft with night	Deaths and injuries on organisms in	Maintain a first aid facility at a	During the spray period/ time	Monitor the affected organisms between

	flying insects and birds	contact with aircraft	convenient place fo all in the camp and within the spray area. Ground observations the day following spraying to find and treat injured animals		spray periods and the day following spray night.
Handling of containers with chemical	People and animals getting into contact with contaminated containers	Chemical poisoning of organisms	Contaminated containers to be disposed in an appropriate site and warning signs put in place	The entire period of the operations. Responsibility: Proponent and contractor	Ground observations on the littered empty containers

Table 12 Impacts on Socio-economics

Activity	Environmental Aspect	Potential Environmental Impact	Mitigating Measures	Time Frame& Responsibility	Indicators to be Monitored
Handling of chemicals	Chemical spills to the environment	Poisoning of organisms including those of economical value	Contaminated containers to be disposed in an appropriate site and warning signs put in place	Throughout the project period. Responsibility: Contractor and Proponent	Ground observations on the littered empty containers
Spraying of chemical (deltamethrin) “	Chemical pollution to the environment (food commodities, fish in ponds *Miraa* and vegetables etc.,)	Chemical poisoning on non target organisms	Public awareness on the spray operations and safety measures on people and organisms Treatment facilities on	Throughout the project period. Responsibility: Contractor and Proponent	Observations on affected people and organisms

			the affected people and organisms		
	Chemical on non-target insects	Poisoning of non-target commercial insects (e.g., bees)	Spraying to be done at night when bees are inactive No honey harvesting to be done during the period of spray	During the spray time / days	Insect populations in the spray areas Bee in hives within the spray area.
	Chemical on vegetables and *Miraa*	Chemical effects on people who chew *Miraa.*	No *Miraa* harvesting during the days of spraying	Within a few days following the spraying time	*Miraa* harvesting during the spray time.
Noise	Noise pollution	People or wildlife affected negatively	Observe recommended noise levels	During operation and decommissioning Responsibility: Contractor	Noise levels
Air Quality	Pollution by particulate matter	Contamination by dust and other aerosols	Wet the ground if driving in dusty roads	During operation and decommissioning Responsibility: Contractor	Particles in the atmosphere
Water quantity and quality	Effects on water quality and quantity	Poor and scarcity of water for project operators and the neighbouring community	Rational use of water resources, and avoid contamination. Construct camp away from the rivers and dams	During operation Responsibility: Proponent and contractor	Water flow, quality (chemical and solutes composition)
Energy sources	Interruptions in the availability of sources of energy within the project areas	Lack of energy for residents in the operation areas	Avoid wasteful burning of vegetation and destruction of electric poles .	During operation, camp occupation Responsibility: Proponent and contractor	Changes in availability of wood fuel and electricity

Security	Dangers to people and property	Impacts on land use, property ownership, and freedom of association	Enhance security	During operation , occupation and decommissioning Responsibility: Proponent and contractor	Incidences of insecurity
Access to markets	Blockage of movements for people and livestock	Impacts on prices on farm produce	Avoid blockage of people movement paths	During operation Responsibility: Proponent and contractor	Complaints of people on changes in movements
Cultural and social activities	Interference with local social and cultural events	Impacts on freedom of association and movement	Rights of people observed	During operation, occupation Responsibility: Proponent and contractor	Complaints of people on the effects on their social and cultural events

Table 13 Environmental and Social Monitoring Plan (ESMP)

Impacts on People

Impacts	**Recommended Measures**	**Responsibility**	**Time Frame**	**Monitoring Plan**	**How to Monitor**	**Cost (Ksh)**
Sickness from drinking contaminated water /food	Ensure all drinking water is stored in enclosed places or indoors .Ensure food is stored indoors during the night of the spray	Respondent and consultants	During the spray time	Assessing the number of people affected after every spray campaign	Asking the affected individual to report such incidences	20,000
Skin/ eye etc. irritations on contact with chemical	Minimize people's movement during the time of spraying	Respondent and consultants	During the spray time	Assessing the number of people affected after every spray campaign	Asking the affected individual to report such incidences	20,000
Consuming food contaminated with deltamethrin (e.g., *Miraa*, vegetables)	Ensure proper public awareness on how to handle *Miraa* and foods like garden vegetables during the night of spraying	Respondent and consultants	During the spray time	Assessing the number of people affected after every spray campaign	Asking the affected individual to report such incidences	20,000

Table 14 Impacts on non-target insects

Impacts	Recommended Measures	Responsibility	Time Frame	Monitoring Plan	How to Monitor	Cost (Ksh)
Death of bees	Areas with bees to be sprayed at night when bees are inactive	Respondent and consultants	During the spray time	Assessing the extent to which the bees are affected after every spray campaign	Making observations in the areas sprayed	40,000
Death of insect Plant pollinators	Areas with pollinating plants to be sprayed at night when insects are inactive Spray during the dry season when there is no pollination taking place	Respondent and consultants	During the spray time	Assessing the extent to which the pollinator insects are affected after every spray campaign	Making observations in the areas sprayed	40,000
Chemical on insects	Spray during the dry season most insects are in	Respondent and consultants	During the spray time	Assessing the extent to which the insects have been	Making observations in the areas sprayed	50,000

	hibernation			affected		
Chemical on water – poison of aquatic insects	Sparing to skip large stagnant water bodies	Respondent and consultants	During the spray time	Assessing the extent to which the aquatic insects have been affected after every spray campaign	Making observations in the aquatic areas sprayed	50,000
Chemical on insect food resources	Spraying to be done at night when most insects are not feeding	Respondent and consultants	During the spray time	Observe	Making observations in the areas sprayed	50,000

Table 15 Impacts on mammals

Impacts	**Recommended Measures**	**Responsibility**	**Time Frame**	**Monitoring Plan**	**How to Monitor**	**Cost (Ksh)**
Effects from drinking contaminated water /food	Spraying is done at night when most animals are not active	Contractor and Proponent	During the operations phase	Observe animal behaviour in between the cycles and make necessary adjustments before the next cycle	Observations	20,000

Skin/ eye etc. irritations on contact with chemical	-as above-	Contractor and Proponent	During the operations phase	- As above -	Observations	30,000
Consuming food contaminated with deltamethrin (e.g., grass and vegetables)	- As above-	Contractor and Proponent	During the operations phase	- As above -	Observations	10,000

Table 16 Impacts on reptiles and amphibians

Impacts	**Recommended Measures**	**Responsibility**	**Time Frame**	**Monitoring Plan**	**How to Monitor**	**Cost (Ksh)**
Poison from contaminated water	Avoid spraying over water bodies known to be rich in reptiles and amphibians	Contractor / Proponent	During the operations phase	Observe organisms behaviour and make water chemical analysis	Field observations and water chemical analysis	40,000
Effects on reproduction – especially breeding areas	Avoid spraying in the breeding areas of aquatic organisms, especially those with open water as there are no tsetse in water	Contractor / Proponent	During the operations phase	Observe organisms behaviour and make water chemical analysis	Field observations and water chemical analysis	50,000

Effects of eating contaminated foods	Spray at night when most of t he organisms are not active.	Contractor / Proponent	During the operations phase	Observe organisms behaviour and make water chemical analysis	Field observations and water chemical analysis	60,000

Table 17 Impacts on avian fauna (Birds)

Impacts	**Recommended Measures**	**Responsibility**	**Time Frame**	**Monitoring Plan**	**How to Monitor**	**Cost (Ksh)**
Birds eating sprayed insects	Spray at night when most birds are not feeding	Contractor/ Proponent	During the operations phase	Observe the behaviour of insectivorous birds	Field surveys and observations	40,000
Birds contacting chemical	Spray at night when most birds are not feeding	Contractor/ Proponent	During the operations phase	Observe the behaviour of insectivorous birds	Field surveys and observations	50,000
Effects on birds breeding areas	Avoid spray during the bird's breeding season	Contractor/ Proponent	During the operations phase	Observe the behaviour of insectivorous birds	Field surveys and observations	40,000

Table 18 Impacts on invertebrates

Impacts	Recommended Measures	Responsibility	Time Frame	Monitoring Plan	How to Monitor	Cost (Ksh)
Direct chemical poisoning of invertebrates	Avoid using chemical concentrations that are lethal to invertebrates	Contractor / Proponent	During the operations phase	Observe indicators for dead invertebrates	Field surveys and observations	50,000
Effects of contaminated water on invertebrates	Make sure chemical concentrations in water bodies is not too high to kill invertebrates	Contractor / Proponent	During the operations phase	Observe indicators for dead invertebrates	Field surveys and observations	60,000
Effects from Contaminated invertebrate habitats	Avoid too much chemical accumulation in areas rich with invertebrates	Contractor / Proponent	During the operations phase	Observe indicators for dead invertebrates	Field surveys and observations	40,000

Table 19 Impacts on Society

Impacts	Recommended Measures	Responsibility	Time Frame	Monitoring Plan	How to Monitor	Cost (Ksh)

Effects on social and cultural gatherings (e.g., markets)	As much as possible there should be no social or cultural gatherings during the night of spraying. If there should such a gathering there should be good public awareness on how to avoid getting into contact with deltamethrin	Proponent, the contractor and the residents	During the spraying time	The public to be made aware and avoid meeting during the spray night	Observations and making inquiry	20,000
Effects on communal resources like water, grazing lands etc.,	Communities to avoid making use of such common facilities within the time specified by the project staff and experts	Proponent and the contractor	During the spraying time	The public to be made aware and avoid using the facilities during the spray night	Observations and making inquiry	40,000
Effects on social institutions like schools and churches	Public awareness campaigns to include all social institutions in the project area	Proponent and Consultant	During the spraying time	Assess the number of in the institutions who are affected	Observations and making inquiry	50,000

Table 20 Proposed Mitigation Measures

Mitigation measure to reduce effects of negative impacts

NEGATIVE IMPACT	MITIGATION
Chemical spillage Spillage of deltamethrin or other chemicals in use may occur out of accidents or negligence. These may get to humans organisms or pollute the environment in general	• Good education on first aid on chemical poisoning • Maintain a detoxication or treatment facility at the site • Maintain an health care facility with antidotes for all expected poisoning
Air quality: This may be negatively impacted upon by dust emanating from transport trucks and traffic fumes during operations stages. This will have effects on construction workers and residents.	• Wetting the roads during operations • Use of personal protective clothing and appliances • Use of well maintained vehicles
Vegetation loss: Loss of vegetation on specific sites to be covered by buildings is expected during camp construction.	• Constructions should keep off 6m of riparian vegetation around rivers and dams • Try as much as possible to retain existing plants especially those that are of conservation value and other commercial utilities.
Noise: This is expected to rise during operation from spray aircrafts flight activities and movements transport trucks. This is expected to impact on people in the operation working in the project and residents in the project areas. It will also impact negatively on wildlife in the conservation areas.	• Ensure that trucks, vehicles, and auxiliary equipments are in good mechanical conditions. • Provide ear muffs to project workers. • Liaise with affected communities to be fully aware on the operation times (dates and times of the day)
Increased water demand: Increasing water consumption will occur both during project operation phase.	• Ensure sustainable use and conservation of water by the project staff around the camps and areas of operation.

Human health and safety: There will be many risks to human health during the project operation phase. These will include Contacts with deltamethrin, consumption of polluted food substances. Possible accidents from tracks, aircrafts, falling objects, etc.	• Putting safe systems of work during operation i.e. appointment of safety supervisors, provision of welfare facilities, appointment of first aiders, arrangements for emergency services etc. • Provision of personal protective clothing and appliances e.g. helmets, gloves, earmuffs, respiratory protectors, overalls, protective shoes and safety harnesses. • Proper ventilation of confined spaces. • Erection and posting of safety signs where applicable. • Provision of adequate workmen compensation insurance cover during operation. • proper garbage disposal and effluent surface spillage control
Fire Risks: Fire outbreaks are a serious yet possible risk during operation. These can come as a result of use of faulty or wrong electrical appliances; careless use of inflammable materials.	• Provision of operational fire fighting appliances. • Observance and practice of safe working procedures when working with flammable substances. • Isolation of flammable substances • Use of standard electrical appliances • Electrical installations to be undertaken only by qualified registered experts. • Provision of adequate, operational and accessible fire exit. • Training of personnel on fire safety.
Waste management: Some quantities of liquid and solid waste may be generated during the operation phase. These are; waste paper, plastic containers, cans, used water, human wastes etc.	• Put in place waste management systems (e.g, sorting solid wastes into designated bins). • Recycling the wastes wherever possible. • Dispose the wastes into authorized areas using licensed waste management firms or individuals

Identification of Impacts

In order to accurately identify the environmental impacts, the following environmental issues were considered pertinent and important for the coverage based on considerations of physical and natural environments, social welfare, economic and cultural environments.

Physical Environment

1. Water quality aspects for both surface water sources like piped water, storm water, and other related aspects
2. Soil conditions, soil contamination and landscape alterations/degradation associated with the proposed project.
3. Drainage patterns especially in relation to wastewater effluents, oil and chemical spillages, refrigerants/coolants discharges channelled into the drainage ditches.
4. Air quality aspects especially atmospheric emissions and related discharges from machinery like diesel run engines etc.
5. Noise and vibration (sonic factors) where applicable

Natural Environment

1. Natural flora and fauna from the proposed development and the adjacent ecosystems where applicable. (i.e., effects to natural plants and animals where applicable).
2. Effects on water flow patterns especially during the rainy seasons and quality aspects, user interference and contamination.
3. Topography: effects on soil and landscape.

Social welfare, Economic and Cultural Environment

1. Determination of implications to the human society distribution, demographic details, settlement patterns, changes to the cultural lifestyle and indigenous knowledge of the local society/public where applicable.
2. Implications on the employees, visitors and public health, safety and related hazards/risks such as HIV/AIDS, consumption of contaminated intravenous infusions products due to disease outbreaks, sanitary facilities, etc.
3. Aesthetic, landscape alterations and changes to infrastructural facilities, among others.
4. Effects associated with the construction and operation activities and related handling and disposal of wastes generated during the operations.
5. Effects associated with income generation opportunities created by the project due to the upcoming operations.
6. Introduction of nuisances, such as pests and related multiplication breeding sites.

Operational Phase

This is the most significant portion that needs to be addressed under this subtitle. Proper management plan for this phase will ensure a long lasting environmentally sound development.

Positive Impacts (Economic and social benefits)

Optimal utilization of the land

Residents of the area of intervention are currently un able to use their land profitably due to trypanosomiasis. Despite their area being better suited for livestock compared to crop cultivation, they are un able to keep livestock. Eradication of trypanosomiasis through the proposed project will enable them to keep livestock.

Land Values

With eradication of trypanosomiasis, the value of land will significantly increase due to increase in productivity. The increase in production will stimulate investments in farming and herding both by the local residents and even by foreign investors.

Employment

The proposed project will increase employment both directly to the local communities engaged in livestock rearing and indirect to people engaged in trade, transportation and other services related to farming.

Promotion of development

The proposed project has the potential to influence the commercial trends in the area in various ways and in the long run the multiplier effect will lead to development and reduction of poverty. The proposed project shall contribute in overcoming the challenges of today's life including strategies for alleviating poverty and promoting sustainable development.

Increase government revenue

The proposed project shall generate tax revenue for the government directly and indirectly. The local government for example will have more residents of higher income group from whom taxes will be collected.

Economic returns and promotion of secondary business

Economic-investment by the livestock owners shall increase wealth. The livestock owners will enjoy higher income generated through the livestock, milk and hides. The project shall also create market for goods and services to the local communities who will have better purchasing power. Many secondary businesses are also likely to spring up after trypanosomiasis eradication.

Promotion of social cohesion

The development will bring together people with diverse traditions and culture. It will lead to promotion of cultural cohesion due to elimination of conflicts on access to grazing areas.

Predicted negative impacts and potential mitigating measures

This part includes impacts during implementation/construction phase, operation phase and decommissioning phases of the project.

Chemical spills and contamination

Deltamethrin may spill over during handling (loading and unloading) and contaminate the soil/ water on come into contact with people. If this is in high concentrations it may cause negative effects on organisms and people. Improper disposal of chemical containers may result in hazardous re-use

Potential Mitigation Measures

- Ensure chemicals are handled by well trained personnel qualified to handle chemicals
- Storage of chemicals should be in the right containers and stored in well designed rooms
- There should be appropriate contingencies for a cleanup of chemical spills within the camp, and within the SAT application area should the unlikely events of an accident occur.
- Chemical containers must be handled by qualified persons and not let to the hand of uniformed people.

Surface water

As rain falls on a certain area, part of the rainwater is lost through evaporation in the air or percolation into the ground while the remaining overflows the surface as surface runoff storm water. The runoff from catchments is largely influenced by the size of the catchments, topography, the imperviousness of the surface and open surface.

During SAT application surface water will be sprayed upon and chemical concentration will vary based of the volume of water and the surface area of the sprayed area body. Depending on the concentration of the chemical in water there is likely to be significant impacts on aquatic organisms (see section in this report on impacts on aquatic organisms).

Potential Mitigation Measures

- Open waters as much as possible should be covered with suitable and approved materials to avoid contamination.

- Consumption of water on small surface water bodies by all organisms after spray operations should be limited especially during the 2 to 3 days after spraying before the chemical settles down to the sediments and some of it disintegrates.
- Water generated from roof catchments should not be consumed by humans and should be fed to the livestock. In this connection, it is recommended that gutters should be diverted to pour water away from the collection / storage tanks in case there will be rain after the spray period.

Noise and vibration

Noise is the unwanted sound that can affect job performance, safety, and health. Psychological effects of noise include annoyance and disruption of concentration. Physical effects include loss of hearing, pain, nausea, and interference with communications when the exposure is severe. Flight operations will be generating noise and hence affecting the immediate environment; i.e. other operations in the operation areas.

Potential Mitigation Measures

- Aircrafts should be in good mechanical state to reduce noise resulting from flights.
- There should be no unnecessary flights and running of machineries and vehicles.
- There should be a proper public awareness campaign to inform residents and all stakeholders on the levels of noise expected and the possible impacts especially because the aircrafts will be flying close to the ground.
- Workers should be provided with relevant personal protective equipment/ materials such as earmuffs and earplugs when operating when they work in noisy environment.

Air Quality

The construction activities on the camp site will result into increased dust and gas emissions. Construction and service machineries and trucks (including small vehicles) generate hazardous exhaust fumes such as Carbon Oxides (COx), Sulphur Oxides (SOx) and Nitrogen Oxides (NOx). Dust particles caused by vibrations of machines and vehicle movement suspends in the air mostly during dry spells. Diesel engines emit black carbon, which absorbs sunlight and warms the atmosphere and micro-particles. Unseen and odourless, microscopic particles of air pollution is very harmful. Exhaust from diesel engines and dust swirl into an insidious cocktail of tiny particles that can spend weeks airborne. The most harmful are the smallest, less than 2.5 microns in diameter; when inhaled, the lungs or pass directly into the bloodstream and damage arteries.

Potential Mitigation Measures

- Provide Personal Protective Equipment (PPE) such as nose masks to the workers on site.
- Regular and prompt maintenance of construction machinery and equipment. This will minimize generation of noxious gases and other suspended particulate matter.

- Control over areas generating dust particles. Such areas should be regularly cleaned or sprinkled with water to reduce dust. The areas can be enclosed to mitigate effects of wind on them.
- Workers should be trained to understand the hazards that may be generated in such work environments.
- Workers should be encouraged to go for regular health check-ups to ascertain their health standards.
- Enclose the site with dust-proof net during the construction.

Oil Leaks and Spills

It is important to note that oil/grease spills are prevalent in construction sites and in most areas that make use of petroleum products. Such products contain detrimental elements to the environment. They contain such heavy metals as mercury, lead, and sulphur among others. Though this may not be common at the site, it is wise to control and observe the little that could occur especially during maintenance of the involved machinery.

Potential Mitigation Measures

- All machinery must be keenly observed not to leak oils on the ground. This can be affected through regular maintenance of the machinery.
- Maintenance must be carried out in a designated area (protected service bays) and where oils are completely restrained from reaching the ground. Such areas should be covered to avoid storm water from carrying away oils into the soil or water systems. Waste water/ wash water from these areas should be properly disposed.
- All oil products and materials should be stored in site stores or in the contractor's yard. They should be handled appropriately to avoid spills and leaks.
- Car wash areas and other places handling oil activities within the site must be well managed and the drains from these areas controlled. Oil interceptors must be installed along the drainage channels leading from such areas.

Solid Waste

Construction and occupation of operation camp will result into increased solid wastes within the sites. Such waste materials include excavated soil, stones, construction debris, wood, broken glasses, containers, rods of metal, pieces of iron sheets, vegetation litter on the site, kitchen materials and other house refuse especially during the occupation of the project etc.

On completion, the site will be generating waste products from various operations and activities. Removal and disposal of house refuse comes under public cleaning and is very important and costly item on the local authorities' budgets. If it is not removed promptly away from the generation points, it accumulates in large heaps harbouring rats, flies and vermin which disseminate germs of disease. A good deal depends upon the mutual cooperation between the local authorities and the public. Proper maintenance and use of dustbins is the key to the satisfactory solution of the problem of sanitary storage and collection of refuse without causing nuisance.

Potential Mitigation Measures

- The contractor or proponent should work hand in hand with NEMA, private refuse handlers, environmental experts and the Naivasha Municipal Council to facilitate sound waste handling, and disposal from the site. All wastes must be taken to the approved dumpsites. The wastes should be properly segregated and separated to encourage recycling of some useful waste materials; i.e. some excavated stone materials can be used as backfills. (Use of an integrated solid waste management system; through a hierarchy of options: source reduction, recycling, composting and reuse, and sanitary land filling).

- There should be several bins. The bins should have a close fitting cover. The receptacle(s) must be kept in a good condition, and sanitarily cleaned by frequent washing and disinfecting. The first action should be reduction of waste at source and all residents and shop owners must be encouraged and sensitised on reduction or waste. Biodegradable wastes should be composted for use in the gardens. There should be several bins clearly labelled and possibly colour coded to handle various categories of waste. Plastics and polythene materials should be sold or given away to the approved plastic recyclers while paper waste should be sold to waste paper recyclers. Glass waste should be sold to glass manufacturers for recycling. Tins and scrap metal/waste metals should be sold to approved scrap metal dealers or steel rolling mills for recycling. Wastes from wood and related products should be re-used or sold out for re-use elsewhere or as firewood. Any unrecyclable waste should be disposed in approved dump sites and as per the Waste management Regulations.

- The contractor or proponent should work hand in hand with private refuse handlers, NEMA and the Local County Naivasha Authorities to facilitate sound waste management as per the prevailing regulatory provisions.

Ecological Impacts: Flora and Fauna

Vegetation has a great effect on the general and localized environment and normally can modify microclimate. Usually, the flora creates a good environment for habitats thus the two may go together more often than not. In consequence, de-vegetation may result to negative effects on the fauna. Singly, the proposed project may appear of no long lasting irreversible ecological impact. Owing to the fact that a the project intends to locally eradicate tsetse flies from the ecosystem ideally one would expect effects on the food chain of tsetse but based on known information tsetse feeds only on animal blood and its absence in the ecosystem has no direct negative impacts on animal populations. However, absence of tsetse flies in the ecosystem will gradually result in loss of immunity to trypanosomiasis among the wildlife. In case of resurgence of tsetse flies and the likely consequence of trypanosomiasis infestation, the effects on wildlife may be big due to lack of immunity. For the wildlife populations to lose immunity the immunity it will take a number of generations and the risk is only if there is a resurgence of tsetse in the eradicated areas. With the success of the operation to eradicate tsetse flies from MCA and the subsequent protection of the area from tsetse re-infestation through the permanent barriers and the current ecological isolation of populations, there is little chance that re- infatuation will take place. This assumption has been shown to be true by the SAT application in Botswana there for nearly 10 years after application no tsetse has been observed in the eradicated areas.

From literature trypanosomiasis is also transmitted in a very small way by biting flies. The formulation of deltamethrin may not eradicate biting flies in the conservation areas and therefore there may be a small residual population of trypanosomes within the wildlife population that may be capable of retaining the required immunity among the wildlife especially the rhino populations that in a sanctuary.

Mitigation

- After eradication of tsetse flies erect suitable barriers to prevent tsetse re-infestation in the eradicated areas.
- Maintain frequent monitoring of tsetse flies and trypanosomiasis in MCA to make sure there is no re-infestation
- Although tsetse will be eradicated, there is a small amount of trypanosomiasis transmitted mechanically from animal to animal through biting flies. To make sure this transmission remains within the wildlife population's efforts must be made to avoid mixing wildlife and livestock populations.

Public safety, traffic, Occupational Health and Safety (OHS)

During operation, there will be increased noise pollution from the flying aircrafts. This is considered as negative impacts it significantly affects people and other organisms in the environment especially because the aircrafts will be flying very low. The residents and workforce involved would be more subjected to environmental hazards form excessive noise.

Operations will be done at night when most people and domestic animals are indoors. In the parks and reserves most animals are known to be inactive except a few nocturnal feeders that are active at night.

Mitigation measures

- Hold adequate public awareness among all the population residing within the areas where SAT will be applied. The awareness should include how to handle food items that are likely to be left outside overnight, drinking water, and all other possible receptors of deltamethrin.
- There should proper instructions on how to avoid or reduce contacts with chemical on the people whose work will require them to be outside in the open during the SAT application nights. Some of them should be informed on the kind of protection they can wear or use to avoid excessive contact with chemicals.
- People should be informed to refrain from collecting or consuming insects or other organisms that may fall victim of the sprayed chemical to avoid consuming the chemical as well.
- People should be taught on how to wash their body surfaces that may get in contact with the chemical
- In the unlikely event that that there will be individuals seriously affected by the chemical, people should be taught on how to treat themselves.

Accident prevention and Emergency Response Plan (ERP)

Emergencies and disasters are realities of everyday life. Stakeholders must therefore be sensitized and prepared on how to react during both the construction and occupational phases of the operations camp. Absence of such plans may be risky since there would be no guidelines to handle or control emergencies if they occur. Efforts must be made to prepare for all possible disasters around the operations camp, the stores where the chemical is stored, the aircrafts landing base (airstrip) and put in place contingencies in the unlikely event that there is an accident with an aircraft during the spray operations. It is the responsibility of the proponent and the contractor to make sure the is adequate preparation to prevent any type of accident and in case they occur, there should be a well planned an emergency response plan and all concerned players in implementing the plan are well informed.

The proponent and the contractor shall take all necessary steps to prevent accidents in the entire project cycle. All safety procedures shall be followed as discussed elsewhere in this report while measures to prevent and manage fires shall be taken as discussed elsewhere in this report. For further management of any foreseeable accidents, the proponent shall develop an ERP which shall be documented and all the residents shall be provided with the requisite training if necessary.
The ERP shall typically contain all information on all likely types of emergencies likely to be encountered mainly accidents and fires. The ERP shall include actions to be taken in case of emergencies and shall display emergency contacts (ambulance, doctors, police and fire engines) telephone list; simple instructions on do and don'ts in various emergencies such as fires, etc. The ERP shall also provide for basic First Aid training to some of the potential residents. The ERP shall also promote good neighbouriness which shall go a long way in emergency response. Such plans must be properly documented and made available to all.

Fire preparedness

Fire outbreaks are common in Kenya and they usually subject detrimental effects to the environment. Fire causes both economic and social drawbacks. There are operations that are prone to such outbreaks at construction sites and more so aircraft operations. It is therefore always important to consider the issue of fire.

Potential Mitigation Measures

Recommended Fire fighting equipment: Potential causes of fire are many and varied from electrical faults either at the operations camp or in the aircraft itself, smoking, gas leaks, carelessness etc.
Fire incidences result to economic and social drawbacks. It is therefore always important to consider the issue of fire by bringing in the element of preparedness. In this regard, the design should provide and recommend implementation of fundamental fire fighting measures and control facilities.

- The contractor should have in place a fire fighting engine on 4WD vehicle to be stand by during spray operations and positioned in a central place where it can easily more to any point of the spray area should there be need even at night.

- The contractor should install an automatic fire alarm system within the operations camp and provide 2No. 9kgs water or powder fire extinguisher for every house in the operations camp. Provide 2No. powder or carbon dioxide extinguishers for the ground floor where there is parking
- All installations to follow Fire Masters requirements approval.
- Ensure that all fire fighting equipment are strategically positioned, well maintained and serviced.
- Provide fire hazard signs such as 'No Smoking' signs, Direction to exit in case of any fire incidence and emergence contact numbers should be provided as well.
- Measures prescribed for the negative impacts as a way of conflict resolution and neighbourhood association.

Public Participation

Introduction

Public participation (PP) in decision making is a core issue of good environmental governance. Participation rights and representation, as well as accountability and transparency are among seven key elements of environmental governance (World Resources 2002-2004). The rights of access to information and public participation in decision-making in environmental matters are among the three pillars of the Aarhus Convention. Public participation at different levels raises accountability and reliability of decisions, lessens risks of possible conflicts and inconsistencies and facilitates implementation.

Public participation in decision making is an essential part of environmental impact assessment (EIA) process, which has become a widely applicable tool for environmental decision making in the world since 70s, ensuring consideration of environmental concerns within the planning. Different countries practice different levels of public involvement. While more successful democracies have gone much forward in this sense, some of the newly emerged democracies have introduced EIA systems just recently.

The aim of this public participation process was to make sure that the stakeholders, Interested and Affected Parties (I&APs) as well as the general public are informed, are able to contribute inputs and to engage in the formal process.

Methodology

The consultation was conducted through a questionnaire administered in a series of focus group discussions in the four affected counties. The counties covered were Kitui (Tseikuru area), Tharaka Nithi (Tharaka area bordering Meru National Park), Isiolo (Garba-Tulla area) and Meru County (Igembe South). Considering proximity to the parks and national reserves, the application of SAT will include areas with human settlements adjacent to the parks and reserves found in the above counties, hence these are the areas which were covered by the public participation exercise.

During the introduction of the entire workshop, the consultant informed all the participants of the intended activity and the areas that will be affected. He presented the details of the chemical to be use in the SAT application, he also explained the nature of the chemical (synthetic pyrethroids -deltamethrin) and all the known effects on the environment based on the dosage to be used.

In addition to verbal explanations the consultant presents a facts summary sheet to all the participants. This handout was in English and the participants who could not read were helped by others and an interpreter helped those who could not read well. The hand out is presented in the appendix.

Questions regarding confidentiality

Each discussion was started by an invitation of the participants to air their views on what they perceived to be the environmental concerns on the proposed SAT application. Participants were furthermore reassured that, although the proceedings of each focus group discussion would be transcribed, none of the material would be made public in a manner that would link any individual to any particular statement made. It was explicitly stated at the beginning of each focus group discussion that the transcriptions would be kept confidential, and

that they will be used only for statistical purposes. It was emphasized in each case that the researchers were interested in the environmental issues that were identified, and that these would be referred to in a generic manner, protecting the identity of our informants.

Content of Consultation

The basic information of the persons consulted included district of origin, location, sub-location, occupation, designation and gender.

In addition, opinions, suggestions and requirements for the project, including the necessity for implementing the Sequential Aerosol Technique (SAT) in the Meru Conservation area (MCA); roles that the project might play in the region, activities and beneficial organisms that would be affected, environmental issues and proposed mitigation measures, and improvement of living conditions, environmental benefits and impact of the project.

Degree of public participation

As indicated in table 22, the gender composition for participation in survey comprised of 87% male and 13% females. For sector composition, civil servants as sector leaders, farmers, and provincial administration accounted for 41%, 36%, and 7% respectively.

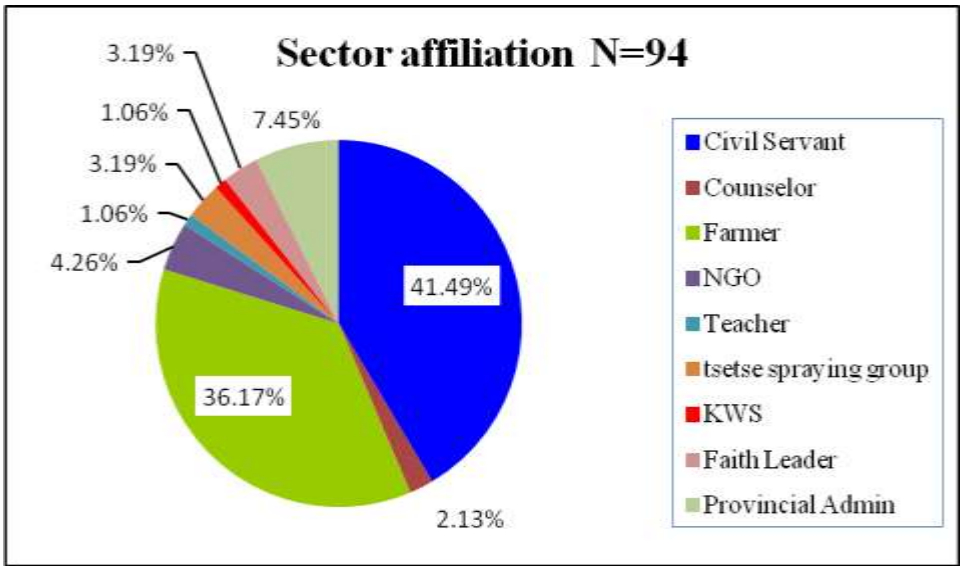

Figure 7 An analysis of gender and occupation of the workshop participants

Regulatory requirements for public consultation

***National* legislation**

After the enactment of EMCA 1999 in Kenya, environmental awareness campaign was initiated by the National Environment Management Authority (NEMA) who was mandated to enforce the environmental legislation in Kenya. The effect was the enactment of subsidiary regulations such as Environmental (Impact Assessment/Audit) Regulation 2003. This regulation made it mandatory for consultation and public participation for the approval of development projects. The need to consult communities on projects with potential impacts to their lives was thus a premier concern during the EIA process i.e. Part III Section 17 (1)(2). Section 17(1) of the regulations states "*During the process of conducting an EIA study, the project proponent shall in consultation with the Authority seek the views of persons who may be affected by the project*".

Public participation in impact assessment - international context

Principle 10 of the Declaration of the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (Brazil, 1992) emphasizes that environmental issues are best handled with the participation of all concerned citizens, at the relevant level. Agenda 21 adopted by UNCED recognized the important role of public participation in Environmental Impact Assessment (EIA) in achieving sustainable development (item 23.2 of Agenda 21). The World Summit on Sustainable Development in Johannesburg, South Africa, in 2002 developed further these provisions (United Nations, 2006). The principles promoted by these conferences are fully integrated into the provisions of the UNECE Convention on Environmental Impact Assessment in a Trans-boundary Context, which came into force in 1997 (United Nations, 2006).

Public views and environmental issues of concern to the public

Among the samples, about 19% responded on the question on the names of organisms that may be affected by the intervention, 17.1% responded on what should be done to reduce the effects of the activity and another 20.2% answered the question on the time of the year SAT should be applied. The majority of the participants did not respond on the questions concerning the environmental concerns and mitigations measures to reduce the effects of SAT.

Table 21 A list indicating the schedule of meetings held during the site visits

District	**# of participants**		**Grand Total**
	Female	**Male**	
Garba-Tulla	1	14	15
Tharaka	1	18	19
Tseikuru	4	17	21
Igembe	6	33	39
Grand Total	**12**	**82**	**94**

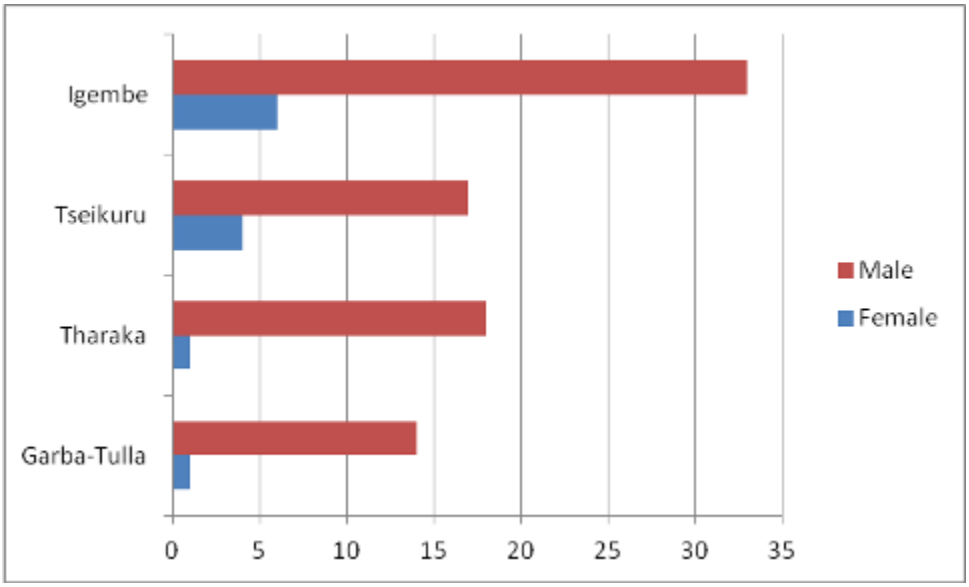

Figure 8 A comparison of the male female attendance in the four meetings held

Analysis of participant responses

All the responses from participants were analyzed based on those who raised concerns on various issues as per the questionnaire. The number of respondents who raised the same issues per meeting is shown in the table below, and the total of respondents with the same view is shown in the second last column. The percentage of the total respondents with the same view is shown in the last column.

Table 22Analysis of Responses from the four workshops

	Districts					
Question/Response	Garba-Tulla	Igembe	Tharaka	Tseikuru	Total	Percentage of total *N*
Total Number of Respondents (N)	15	39	19	21	94	
What are the environmental issues that concern you the most about the proposed activity?						
Air Pollution	4	12	8	4	28	29.8
Bees	1	1	1	3	6	6.4
Chemical residue in soil	1	4	3	1	9	9.6
Environment and Bio-diversity		6	2	2	10	10.6
Fish	2	2		1	5	5.3
human beings		1		1	2	2.1
Livestock	2	1	1	3	7	7.4
Miraa		2			2	2.1
No Answer	2	4	4	2	12	12.8
None	2	3		1	6	6.4
Reduced fruit production	1	3		1	5	5.3
Wildlife Habitat				2	2	2.1
What mitigation measures do you want put in place to reduce effects of SAT?						
Public awareness	4	10	5	5	24	25.5
Adequate Baseline surveys	4			1	5	5.3
Avoid harvesting period		2			2	2.1
Avoid spraying on water bodies	2		2	3	7	7.4
Compensate commercial fish farmers for death of fish		2			2	2.1

Compensate those who incur loses		2			2	2.1
Consultation with Ministry of Fishery	1	4			5	5.3
Miraa farmers should be advised to harvest before the activity		2			2	2.1
None		1			1	1.1
Provision of alternative option			1	2	3	3.2
Public awareness	3	9	6	5	23	24.5
Request Government Support		1			1	1.1
Spray during dry season		1	1		2	2.1
Use correct chemical dosage	2	5	4	5	16	17.0
Because SAT will carried out at night is there anything that can be done to reduce the impact						
Alternative feeding sites should be provided			1		1	1.1
Avoid spraying on water bodies	1	2			3	3.2
Compensate those who incur loses				1	1	1.1
Correct dosage should be issued		2	2		4	4.3
Do nothing	2				2	2.1
During dry season			1		1	1.1
Enclose Everything	1		1		2	2.1
No answer	1	3		2	6	6.4
No effects	5	18	8	8	39	41.5
Public Awareness	5	12	4	5	26	27.7
Request Government Support			1	1	2	2.1
Spray at night		1		4	5	5.3
Provision of alternative options			1		1	1.1

What time of the year might SAT application have less impact						
During dry season	10	5	12	13	40	42.6
Spray during rainy season		31	4	2	37	39.4
No answer	2	1		2	5	5.3
No specific time	3	1	3	4	11	11.7
Action that should be taken to avoid/reduce effects						
Avoid harvesting period		9		1	10	10.6
Compensate those who incur loses	1				1	1.1
No Answer	7	8	3	2	20	21.3
Public awareness	4	12	5	6	27	28.7
Some activities can be delayed during this exercise		1			1	1.1
Spray at night		1	5	3	9	9.6
spray during rainy season		3	1		4	4.3
Spray selectively avoiding water bodies	3				3	3.2
Use correct chemical dosage		5	5	9	19	20.2
What activities or beneficial organisms that may be affected by the proposed activity						
Ants		1	1		2	2.1
Bees	3	8	10	9	30	31.9
Birds		2	1		3	3.2
Fish	3	4	1	1	9	9.6
Fruits and vegetables	2	6	1	2	11	11.7
human beings		1	1	1	3	3.2
Livestock		1		1	2	2.1
microorganisms in soil and water	1		1	2	4	4.3

Miraa		9			9	9.6
No Answer	4	4	1	2	11	11.7
None	2	3	1	3	9	9.6
Water			1		1	1.1
Reason for supporting the government's efforts in eradicating tsetse flies in your area						
80% of the people depend on livestock for their livelihood	3			1	4	4.3
Because I have experinced the effects of trypanosomiasis		2	1	1	4	4.3
Because it is a free help				1	1	1.1
Because the government supports the activity		1	1	1	3	3.2
Eradicating tsetse flies will improve livestockhealth and productivity	5	16	7	8	36	38.3
Eradicating tsetse flies will improve tourism		1		1	2	2.1
Eradicating tsetse flies will promote economic development		4		1	5	5.3
Eradicating tsetse flies will reduce the problem of human sleeping sickness	1	6	4	1	12	12.8
It will promote livestock products to the EU market			2		2	2.1
No Answer	3	8	2	2	15	16.0
Reduction of tsetse flies will improve the dairy industry		1	1		2	2.1
Trypanosomiasis is the major problem in this area and flies may reinfest other areas	3		1	4	8	8.5
If these effects do occur, how can their impacts on the society be reduced						
Avoid spraying water bodies	2			1	3	3.2
Compensate those who incur loses	3	11	6	3	23	24.5

First Aid should be provided		2	1	2	5	5.3
No Answer	5	10	4	4	23	24.5
Public awareness	4	14	6	8	32	34.0
Request Government Support	1		2		3	3.2
Some activities can be delayed during this exercise		2			2	2.1
Use correct chemical dosage				3	3	3.2

Minutes of public meeting

MINUTES OF PUBLIC MEETING IN RESPECT OF

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED SEQUENTIAL AEROSOL TECHNIQUE (SAT) APPLICATION IN MERU CONSERVATION AREA (MCA) HELD AT

***TSEIKURU* ON 3RD DECEMBER 2012**

AGENDA		
1	Welcome and Introduction	District Veterinary Officer (DVO)
2	Purpose of the Meeting	Consultant
	Conducting the meeting	Consultant
3	Overview of the proposed SAT Activity	Consultant
4	Environmental and Public Participation Process	Consultant
5	Discussion session	All
6	Way forward	Consultant
7	Closure	Consultant

DISCUSSION POINTS

ITEM	**DESCRIPTION**	**PERSON**
1	**Welcome and Introduction**	DVO
1.1	The District Veterinary Officer (DVO), Tseikuru welcomed all present and introduced the consultants. The meeting started at 9.00 am with a word of prayer from the AIC pastor.	
2	**Purpose of the meeting**	Consultant

	The consultant presented an overview of the purpose of the public participation meeting. He stated that the meeting was an opportunity to: • Provided key stakeholders with information regarding the proposed SAT application by KENTTEC • Provided an overview of the Environmental Impact Assessment (EIA) and Public Participation Process being followed for the proposed activity • Provided an opportunity for key stakeholders to seek clarification and raise environmental concerns if there is concerning the proposed SAT application and provide input in the proposed activity	
3	**Conducting the meeting**	Consultant
3.1	He requested that all phones be switched to silence mode and that discussions be reserved for the end of presentation. He urged everybody to participate in the deliberations freely without fear of victimization.	
3.2	He explained that an EIA is the process of identifying, predicting, evaluating & mitigating the biophysical, social, economic and other relevant effects of a proposed development prior to the development taking place.	
4	**Overview of the proposed SAT Activity**	Consultant
4.1	He presented the overall process as one that is to conduct environmental impacts assessment for the proposed SAT applications by PATTEC in order to guide on methods of how to avoid or minimize impacts associated with SAT applications and to provide the statutory requirement document for EIA approval by the National Environment Management Authority (NEMA).	
5	**Environmental and Public Participation Process**	Consultant
5.1	The public participation process is intended to ensure that all interested and affected parties (I&APs) are made aware of a proposed activity, have access to information about the activity and its potential impacts and are given the opportunity to voice their opinions and concerns about the proposed activity. He explained that public participation is a communication tool to inform stakeholders of a proposed project. He stated that it is a tool to receive and integrate the comments of the stakeholders into the relevant phases of a proposed project. He noted that public participation is not a public relations or marketing exercise and that it is not a means to satisfy grievances but	

	rather an opportunity to record comments.	
5.2	The consultant outlined the different specialist studies which were planned for this project. These were: 1. Toxicological; 2. Ornithological; 3. Water resources and aquatic biology; 4. Ecological Assessment;	
6	**Discussion session**	All
6.1	He opened the floor for discussion. The following questions /comments /issues were raised:	Consultant

Questions	Response	Respondent
What will happen to water bodies like river Tana?	The company that will be hired will use an aircraft that has the ability to switch on and off depending on demand, the water bodies will therefore be excluded from the spray. But the company that will be hired will explain everything including how to handle the chemical. At this point it will not be wise to give public awareness before NEMA gives an ok to this project. The project will go in stages. The chemical deltamethrin will be in very low dosages. There will be four cycles of spraying designed based on the life cycle of tsetse flies.	Consultant
Does PATTEC know the area under Kora National Park?	Kora has an area of 500km2 which is infested with tsetse flies. A study will be done in all the parks to determine their biodiversity.	PATTEC/KENTTEC
What will happen to the bees? Will the smell of deltamethrin cause bees to bite human beings in the village?	Deltamethrin is toxic to honeybees only under laboratory conditions. It does not harm bees in the field, and a formulated product actually has a repellent effect.	Consultant
What will happen to the vegetables?	Deltamethrin is in the chemical class of Pyrethroids. These are broad-spectrum insecticides, and sprayed frequently on the vegetables and fruits to prevent and to cure the plant diseases and pests. It is not considered toxic to plants when formulated products are used according to label directions.	Consultant
What will happen to livestock?	Topically administered deltamethrin remains mostly on the hair-coat of the treated animals and is very poorly absorbed through the skin. Treated animals can ingest deltamethrin through licking or grooming. A large amount of it is excreted unchanged through the faeces. The absorbed deltamethrin is quickly metabolized in the liver to non-toxic metabolites that are excreted through urine. However, cats lack this enzyme and cannot	Consultant

	metabolize most synthetic pyrethroids. This is why most synthetic pyrethroids are toxic to cats. As a general rule deltamethrin products are approved for use on dairy animals and on laying hens in many countries.	
What will happen to the bees?	Under laboratory conditions, deltamethrin is highly toxic for honey-bees with a contact LD50 of 0.051 µg/bee. Field trials and actual usage have established that deltamethrin formulations have a repellent action, which means that, in practice, the hazard for bees is low.	Consultant
What will happen to fish?	Deltamethrin is not mobile in the environment because of its strong adsorption on particles, its insolubility in water, and very low rates of application; however, it still presents risks to the ecosystem in which it is applied. Under laboratory conditions, deltamethrin has been found to be highly toxic to a range of aquatic organisms such as amphibians, crustaceans, molluscs, and various forms of plankton. Although these laboratory investigations demonstrate that the chemical is harmful to fish, field studies have not confirmed this finding. Additionally, because deltamethrin reduces local insect populations, its use can indirectly cause the proliferation of algal blooms. With fewer insect-consumers to control algae population growth, these blooms can in turn harm fish and other aquatic life through clogging gills and decreasing the water's level of oxygen.	Consultant

7	**Way forward**	
	▪ Inclusion of I&AP comments in Final Environmental Impact Report ▪ Submission of Final Environmental Impact Report to National Environment Management Authorities (NEMA) ▪ Authority review ▪ Notify I&APs of Decision	
8	**Closure**	
	Without any further issues being raised, the consultant thanked everyone for their attendance and contributions. He encouraged comments to be forwarded to him through the DVOs, DPHOs, District Zoologists or through any other line ministry. (Details of which were provided on the board).	

MINUTES OF PUBLIC MEETING IN RESPECT OF

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED SEQUENTIAL AEROSOL TECHNIQUE (SAT) APPLICATION IN MERU CONSERVATION AREA (MCA) HELD AT

MARIMANTI **ON 4TH DECEMBER 2012**

AGENDA		
1	Welcome and Introduction	District Veterinary Officer (DVO)
2	Purpose of the meeting	Consultant
3	Conducting the meeting	
4	Overview of the proposed SAT Activity	Consultant
5	Environmental and Public Participation Process	Consultant

6	Discussion session	All
7	Way forward	Consultant
8	Closure	Consultant

DISCUSSION POINTS		
ITEM	**DESCRIPTION**	**PERSON**
1	**Welcome and Introduction**	DVO
1.1	All present were welcomed and the agenda confirmed. The meeting started at 10.26 am with a word of prayer.	
		DC
2	**Purpose of the meeting**	
	The consultant presented an overview of the purpose of the public participation meeting. He stated that the meeting was an opportunity to: • Provided key stakeholders with information regarding the proposed SAT application by KENTECH • Provided an overview of the Environmental Impact Assessment (EIA) and Public Participation Process being followed for the proposed activity • Provided an opportunity for key stakeholders to seek clarification and raise environmental concerns if there is concerning the proposed SAT application and provide input in the proposed activity • Record concerns raised and include them in the report	
3	**Conducting the meeting**	
3.1	He requested that all phones be switched to silence mode and that discussions be reserved for the end of presentation. He urged everybody to participate in the deliberations freely without fear of victimization.	
3.2	He explained that an EIA is the process of identifying, predicting, evaluating & mitigating the biophysical, social, economic and other relevant effects of a proposed development prior to the development taking place.	

4	**Overview of the proposed SAT Activity**	
4.1	He presented the overall process as one that is to conduct environmental impacts assessment for the proposed SAT applications by PATTEC/KENTTEC in order to guide on methods of how to avoid or minimize impacts associated with SAT applications and to provide the statutory requirement document for EIA approval by the National Environment Management Authority (NEMA).	
5	**Environmental and Public Participation Process**	
5.1	The public participation process is intended to ensure that all interested and affected parties (I&APs) are made aware of a proposed activity, have access to information about the activity and its potential impacts and are given the opportunity to voice their opinions and concerns about the proposed activity. He explained that public participation is a communication tool to inform stakeholders of a proposed project. He stated that it is a tool to receive and integrate the comments of the stakeholders into the relevant phases of a proposed project. He noted that public participation is not a public relations or marketing exercise and that it is not a means to satisfy grievances but rather an opportunity to record comments.	
5.2	The consultant outlined the different specialist studies which were planned for this project. These were: 5. Toxicological; 6. Ornithological; 7. Water resources and aquatic biology; 8. Ecological Assessment;	
6	**Discussion session**	
6.1	He opened the floor for discussion. The following questions /comments /issues were raised:	Consultant

Questions	Response	Respondent
What will happen to the invertebrates?	Researchers have observed that deltamethrin has no effects on earthworms when the soil was treated with 12.5 g/ha of deltamethrin for 28 days.1	PATTEC
What area will be targeted for spraying?	A map was drawn on the board showing the area to be affected. Also the PATTEC official mentioned the names of the areas to be affected	Consultant
What will happen to the area that will not be targeted for spraying?	Spraying will only be done in areas infested with tsetse flies	Consultant
What will happen to waters bodies?	The company that will be hired will use an aircraft that has the ability to switch on and off depending on demand, the water bodies will therefore be excluded from the spray. But the company that will be hired will explain everything including how to handle the chemical. At this point it will not be wise to give public awareness before NEMA gives an ok to this project. The project will go in stages. The chemical deltamethrin will be in very low dosages. There will be four cycles of spraying designed based on the life cycle of tsetse flies.	Consultant
What will happen to the bees?	Under laboratory conditions, deltamethrin is highly toxic for honey-bees with a contact LD50 of 0.051 µg/bee. Field trials and actual usage have established that deltamethrin formulations have a repellent action, which means that, in practice, the hazard for bees is low.	Consultant
At what time of the year will spraying be done?	The decision will be done by KENTECH but this will depend on NEMAs approval	Consultant
What will be the long term effect of deltamethrin on the environment?	Unlike DDT, pyrethroids do not persist in the environment for long periods of time. Though they stay on nets for several months, in soil they break down into less toxic products, with a half-life of about one month.	Consultant

In Okavango delta, what stopped reinvasion of flies	In Okavango delta, there are natural barriers; unfortunately, we do not have natural barriers in MCA. KENTECH has plans of erecting targets to act as barriers.	Consultant

7	**Way forward**	
	▪ Inclusion of I&AP comments in Final Environmental Impact Report ▪ Submission of Final Environmental Impact Report to National Environment Management Authorities (NEMA) ▪ Notify I&APs of Decision	
8	**Closure**	
	Without any further issues being raised, the consultant thanked everyone for their attendance and contributions. He encouraged comments to be forwarded to him through the DVOs, DPHOs, District Zoologists or through any other line ministry. (Details of which were provided on the board).	

PUBLIC PARTICIPATION

MINUTES OF PUBLIC MEETING IN RESPECT OF

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED SEQUENTIAL AEROSOL TECHNIQUE (SAT) APPLICATION IN MERU CONSERVATION AREA (MCA) HELD AT

MAUA **ON 5TH DECEMBER 2012**

AGENDA		
1	Welcome and Introduction	District Veterinary Officer (DVO)
2	Purpose of the meeting	Consultant
3	Conducting the meeting	
4	Overview of the proposed SAT Activity	Consultant
5	Environmental and Public Participation Process	Consultant
6	Discussion session	All
7	Way forward	Consultant

8	Closure	Consultant

DISCUSSION POINTS		
ITEM	**DESCRIPTION**	**PERSON**
1	**Welcome and Introduction**	DVO
1.1	All present were welcomed and the agenda confirmed. The meeting started with a word of prayer.	DVO
	The District Commissioner (DC) in his welcoming speech welcomed all present and stressed that; 1. the handout to be given to farmers should be in a simple understandable language, preferably, vernacular 2. the proposed tsetse eradication method should be environment friendly 3. all concerns of the farmers should be thoroughly addressed.	DC
2	**Purpose of the meeting**	
	The consultant presented an overview of the purpose of the public participation meeting. He stated that the meeting was an opportunity to: • Provided key stakeholders with information regarding the proposed SAT application by KENTECH • Provided an overview of the Environmental Impact Assessment (EIA) and Public Participation Process being followed for the proposed activity • Provided an opportunity for key stakeholders to seek clarification and raise environmental concerns if there is concerning the proposed SAT application and provide input in the proposed activity	Consultant
3	**Conduct of the meeting**	
3.1	He requested that all phones be switched to silence mode and that discussions be reserved for the end of presentation. He urged everybody to participate in the deliberations freely without fear of victimization.	Consultant
3.2	He explained that an EIA is the process of identifying, predicting, evaluating & mitigating the biophysical, social, economic and other relevant	Consultant

	effects of a proposed development prior to the development taking place	
4	**Overview of the proposed SAT Activity**	
4.1	He presented the overall process as one that is to conduct environmental impacts assessment for the proposed SAT applications by PATTEC in order to guide on methods of how to avoid or minimize impacts associated with SAT applications and to provide the statutory requirement document for EIA approval by the National Environment Management Authority (NEMA).	Consultant
5	**Environmental and Public Participation Process**	
5.1	The public participation process is intended to ensure that all interested and affected parties (I&APs) are made aware of a proposed activity, have access to information about the activity and its potential impacts and are given the opportunity to voice their opinions and concerns about the proposed activity. He explained that public participation is a communication tool to inform stakeholders of a proposed project. He stated that it is a tool to receive and integrate the comments of the stakeholders into the relevant phases of a proposed project. He noted that public participation is not a public relations or marketing exercise and that it is not a means to satisfy grievances but rather an opportunity to record comments.	
5.2	The consultant outlined the different specialist studies which were planned for this project. These were: 9. Toxicological; 10. Ornithological; 11. Water resources and aquatic biology; 12. Ecological Assessment;	
6	**Discussion session**	
6.1	He opened the floor for discussion. The following questions /comments /issues were raised:	Consultant

Questions	Response	Respondent
Does deltamethrin have the same effects as DDT?	Unlike DDT, pyrethroids do not persist in the environment for long periods of time. Though they stay on nets for several months, in soil they break down into less toxic products, with a half-life of about one month.	PATTEC
What mitigation factors will you put in place to avoid eradicating the fingerlings which feed on the aquatic invertebrates which are said to suffer from the effects of deltamethrin?	Deltamethrin is not mobile in the environment because of its strong adsorption on particles, its insolubility in water, and very low rates of application; however, it still presents risks to the ecosystem in which it is applied. Under laboratory conditions, deltamethrin has been found to be highly toxic to a range of aquatic organisms such as amphibians, crustaceans, molluscs, and various forms of plankton. Although these laboratory investigations demonstrate that the chemical is harmful to fish, field studies have not confirmed this finding.	Consultant
KENTECH should spray other areas and avoid khat (*miraa*) growing areas. Farmers in Meru may find it an economical to wait for five days to harvest khat.	Khat can be harvested after 5 days. Farmers should harvest khat before spraying and then wait for five days after.	Consultant
Will vegetables also require five days break?	Vegetables, oranges and mangoes will require the same number of days	Consultant

7	**Way forward**	
	▪ Inclusion of I&AP comments in Final Environmental Impact Report ▪ Submission of Final Environmental Impact Report to National Environment Management Authorities (NEMA) ▪ Notify I&APs of Decision	
8	**Closure**	
	Without any further issues being raised, the consultant thanked everyone for their attendance and contributions. He encouraged comments to be forwarded to him through the DVOs, DPHOs, District Zoologists or through any other line ministry. (Details of which were provided on the board).	

MINUTES OF PUBLIC MEETING IN RESPECT OF

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED SEQUENTIAL AEROSOL TECHNIQUE (SAT) APPLICATION IN MERU CONSERVATION AREA (MCA) HELD AT

***KINNA* ON 6TH DECEMBER 2012**

AGENDA		
1	Welcome and Introduction	District Veterinary Officer (DVO), Garba-Tulla
2	Purpose of the meeting	Consultant
	Conducting the meeting	
3	Overview of the proposed SAT Activity	Consultant
4	Environmental and Public Participation Process	Consultant
5	Discussion session	All
6	Way forward	Consultant
7	Closure	Consultant
DISCUSSION POINTS		

ITEM	DESCRIPTION	PERSON
1	**Welcome and Introduction**	DVO
1.1	All present were welcomed and the agenda confirmed. The meeting started at 12.50 am with a word of prayer.	
2	**Purpose of the meeting**	Consultant
	The consultant presented an overview of the purpose of the public participation meeting. He stated that the meeting was an opportunity to: • Provided key stakeholders with information regarding the proposed SAT application by KENTECH • Provided an overview of the Environmental Impact Assessment (EIA) and Public Participation Process being followed for the proposed activity • Provided an opportunity for key stakeholders to seek clarification and raise environmental concerns if there is concerning the proposed SAT application and provide input in the proposed activity • Record concerns raised and include them in the report	
3	**Conduct of the meeting**	Consultant
3.1	He requested that all phones be switched to silence mode and that discussions be reserved for the end of presentation. He urged everybody to participate in the deliberations freely without fear of victimization.	
3.2	He explained that an EIA is the process of identifying, predicting, evaluating & mitigating the biophysical, social, economic and other relevant effects of a proposed development prior to the development taking place.	
4	**Overview of the proposed SAT Activity**	Consultant
4.1	He presented the overall process as one that is to conduct environmental impacts assessment for the proposed SAT applications by PATTEC in order to guide on methods of how to avoid or minimize impacts associated with SAT applications and to provide the statutory requirement document for EIA	

	approval by the National Environment Management Authority (NEMA).	
5	**Environmental and Public Participation Process**	Consultant
5.1	The public participation process is intended to ensure that all interested and affected parties (I&APs) are made aware of a proposed activity, have access to information about the activity and its potential impacts and are given the opportunity to voice their opinions and concerns about the proposed activity. He further explained that public participation is a communication tool to inform stakeholders of a proposed project. He stated that it is a tool to receive and integrate the comments of the stakeholders into the relevant phases of a proposed project. He noted that public participation is not a public relations or marketing exercise and that it is not a means to satisfy grievances but rather an opportunity to record comments.	
5.2	The consultant outlined the different specialist studies which were planned for this project. These were: 13. Toxicological; 14. Ornithological; 15. Water resources and aquatic biology; 16. Ecological Assessment;	
6	**Discussion session**	Consultant
6.1	He opened the floor for discussion. The following questions /comments /issues were raised:	Consultant

Questions	Response	Respondent
Will this chemical affect our livestock, particularly sheep and goats?	Topically administered deltamethrin remains mostly on the hair-coat of the treated animals and is very poorly absorbed through the skin. Treated animals can ingest deltamethrin through licking or grooming. A large amount of it is excreted unchanged through the faeces. The absorbed deltamethrin is quickly metabolized in the liver to non-toxic metabolites that are excreted through urine. However, cats lack this enzyme and cannot metabolize most synthetic pyrethroids. This is why most synthetic pyrethroids are toxic to cats. As a general rule deltamethrin products are approved for use on dairy animals and on laying hens in many countries.	PATTEC
What will be the impact of this drug, has it been tried anywhere?	It has been tried in other African countries like Ghana and Okavango Delta in Botswana. In Kenya this is the first time, but we do not anticipate any problem.	Consultant
Will this drug interfere with our water pans?	Under laboratory conditions, technical grade deltamethrin is moderately to highly toxic to fish depending on the fish species. In field applications, deltamethrin is not expected to affect fish when used properly because it binds tightly to soil and breaks down quickly.	Consultant
If this drug is not harmful to human beings, then I suggest you spray everywhere including fish ponds since *boranas* do not eat fish	Effects of deltamethrin on human health and the environment depend on how much deltamethrin is present and the length and frequency of exposure. Effects also depend on the health of a person and/or certain environmental factors.	Consultant
If this chemical drops in the soil, for how long will it survive there?	Unlike DDT, pyrethroids do not persist in the environment for long periods of time. Though they stay on nets for several months, in soil they break down into less toxic products, with a half-life of about one month.	Consultant

If this chemical kills tsetse flies, how come it does not kill house flies?	A house fly would require the chemical to be more than 100 times more concentrated than which kills a tsetse fly	Consultant
What will happen to our vegetables?	Deltamethrin is in the chemical class of Pyrethroids. These are broad-spectrum insecticides, and sprayed frequently on the vegetables and fruits to prevent and to cure the plant diseases and pests. It is not considered toxic to plants when formulated products are used according to label directions.	Consultant
How long will it take before the spraying starts?	Due to government's procedures it may not start soon but you will be notified accordingly.	
Since we are faced with two vectors, namely, ticks and tsetse flies, why can't KENTECH bring an accaricide than can target the two?	It is the duty of stakeholders to decide on what to eradicate and what to stay with.	Consultant

7	**Way forward**	
	▪ Inclusion of I&AP comments in Final Environmental Impact Report ▪ Submission of Final Environmental Impact Report to National Environment Management Authorities (NEMA) ▪ Authority review ▪ NEMA Authorization ▪ Notify I&APs of Decision ▪ Appeal Period	
8	**Closure**	
	Without any further issues being raised, the consultant thanked everyone for their attendance and contributions. He encouraged comments to be forwarded to him through the DVOs, DPHOs, District Zoologists or through any other line ministry. (Details of which were provided on the board).	

Conclusion

Application of SAT in the MCA is a technically feasible exercise in terms of technology, efficiency and effectiveness over the expansive tsetse infested area.

The SAT operations shall be executed with adequate environmental safeguards as spelled out in the EMCA 1999 provisions. Environmental monitoring will be done by competent institutions and persons. Similarly environmental concerns shall adequately be addressed and mitigation against adverse effects shall be embedded in the EMP.

Sensitization of communities and stake holders shall be a continuous exercise that will be undertaken before, during, and after SAT application. Implementation of SAT in the MCA shall ensure complete eradication of the perennial tsetse and trypanosomiasis problem. This will lead to increase in crops and livestock productivity, improved wildlife health, livelihoods and ensure food security

The use of the novel SAT technology to eradicate Tsetse and trypanosomiasis in large tracts of land will enable the country achieve the vision of the Heads of State and Governments of Africa as contained in the Decision AHG/156 (XXXVI) of the 36th Assembly of Heads of State and Government to eradicate tsetse and trypanosomiasis in Africa.

It is important that SAT be carried out in the MCA as the benefits accruing from the eradicating tsetse and

trypanosomiasis far outweighs the temporary environmental setbacks that may occur as studies have shown that there is a quick recovery of biodiversity in the ecosystem .

It will be helpful if NEMA can facilitate approval to carry out an Environmental Impact assessment project report on Sequential Aerosol Technique in Meru Conservation Area so that the project can start as soon as possible.

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28.

Appendix 1: A handout on facts sheet on Deltamethrin handed over to all the participants

DELTAMETHRIN

General Fact Sheet

What is deltamethrin?
Deltamethrin is an insecticide belonging to the pyrethroid family. Pyrethroids are the man-made versions of pyrethrins, natural insecticides from *chrysanthemum* flowers. Deltamethrin is used outdoors as an insecticide on lawns, crops and ornamental gardens, golf courses, and indoors as a spot or crack and crevice treatment. In its purest form, deltamethrin is colorless or white to light beige crystals that have no odour. Deltamethrin was first described in 1974 and entered the market in 1978.

What are some products that contain deltamethrin?
Deltamethrin is in a variety of products used to kill a wide range of insects. Deltamethrin can be formulated in insecticide products as aerosols, sprays, dusts, granules and wettable powders. Always take steps to avoid exposure. First Aid instructions will be communicated before SAT applications if any exposure occurs.

What are other uses of Deltamethrin?
Deltamethrin kills insects on contact and through digestion. It is used to control apple and pear suckers, plum fruit moth, caterpillars, pea moth, aphids and moths on apples, plums, tomatoes, peppers, potted plants, and ornamentals. It also controls numerous insect pests of field crops. Formulations include emulsifiable concentrates, wettable powders, and and granules.

How does deltamethrin work?
Deltamethrin can kill insects by direct contact or if they eat it. It disrupts their normal nervous system function. It is less toxic to mammals due to their higher body temperature, larger body size, and decreased sensitivity to the chemical.

How might people be exposed to deltamethrin?
You can be exposed to deltamethrin if you touch, eat, or breathe it in. As an example, it could be breathed in if a fine mist or dust containing deltamethrin gets in the air you breathe in. Exposure to deltamethrin can be limited by reading and following label directions or instructions to be provided at the time of application.

What are some symptoms from a brief exposure to deltamethrin?
When deltamethrin gets on the skin, it can cause skin sensations like prickling, itching, burning, or numbness at that spot. These sensations usually go away within 48 hours. Deltamethrin can be mildly irritating if it gets in the eye. If enough deltamethrin is breathed in, it can cause headaches and dizziness. Although not common, individuals who have ingested large amounts of deltamethrin have experienced nausea, vomiting, abdominal pain, and muscle twitches. Deltamethrin is low in toxicity when it is touched or breathed in and is low to moderately toxic if eaten.

Deltamethrin can affect dogs and cats if they eat, breathe, or touch it. It can cause vomiting, drooling, in-coordination, and muscle tremors if they eat enough of it. If deltamethrin gets on their skin, it can sometimes cause skin sensations

that result in biting, scratching, or licking of the exposed area.

What happens to deltamethrin when it enters the body?

In animal studies, deltamethrin was readily absorbed when it was eaten. Some of the chemical was broken down into other chemicals before they were excreted within 2 days. In a rat study, deltamethrin was poorly absorbed through the skin. The small amount that was absorbed through the skin left the body within 24 hours.

Is deltamethrin likely to contribute to the development of cancer?

The evidence from animal studies indicates that deltamethrin does not cause cancer. The U.S. EPA classifies deltamethrin as Not Likely to Be a Human Carcinogen by all routes of exposure.

Has anyone studied non-cancer effects from long-term exposure to deltamethrin?

Yes, studies have been done using laboratory animals. In multiple studies with mice and dogs, no effects were observed at the highest doses tested, over a 2 year period. Deltamethrin did not cause birth defects in laboratory animals that ate it during their pregnancy.

What happens to deltamethrin in the environment?

When deltamethrin gets in the soil, it has a tendency to bind tightly to soil particles. In the soils it has a half-life ranging from 5.7- 209 days. Half-life is the measure of time it takes for half of the applied amount to break down. The half-life can change based on soil chemistry, temperature, water content and the amount of organic matter in the soil. Deltamethrin does not break down as quickly in soil with a high clay or organic matter content. Deltamethrin is broken down by microbes, light, and water. Its two major breakdown products move more easily in the soil than deltamethrin itself. Deltamethrin is not likely to evaporate into the air or dissolve easily into water. Deltamethrin has a half-life of 5.9-15 days on plant surfaces. It is unlikely to be taken up by plants, since it binds to soil particles so tightly.

Can deltamethrin affect birds, fish, or other wildlife?

Deltamethrin is moderately to highly toxic to fish under laboratory conditions. However, when products are used according to the label, deltamethrin is less likely to affect fish. This is because it is more likely to be bound to the sediment. Deltamethrin is practically non-toxic to birds when they eat it. Deltamethrin is highly toxic to honeybees under laboratory conditions. It did not harm bees in field studies, and formulated products actually had a repellant effect that lasted for 2-3 hours. Earthworms were not affected when soil was treated with deltamethrin. The fact that SAT will be applied at night when bees are less active, the effects on bees will be lower.

Can deltamethrin affect food residues?

In 2006, the United States Department of Agriculture (USDA) Pesticide Data Program (PDP) analyzed 9030 samples of fruits and vegetables for deltamethrin and its parent compound, tralomethrin. Of the samples tested, only one sample had detectable residues and the amount detected was eight times less than the U.S. EPA tolerance level.

In the same study, 133 finished water samples, 133 untreated water samples, 734 peanut butter samples, and 655 samples of poultry breast and thigh were analyzed for deltamethrin and tralomethrin. No samples had detectable residues.

Breakdown of Chemical in Vegetation

About 10 days after use, there are no deltamethrin residues observed on plants. There is no known phytotoxicity to crops.

Information compiled by Ecodym Africa Ltd. from the National Pesticide Information Centre for use in public participation workshops for MCA Environmental Impacts Assessment;
Oregon State University: http://npic.orst.edu.

Appendix 2: The questionnaire used in public consultations

Questionnaire for Public Participation in Sequential Aerosol Technique (SAT) applications in Meru Conservation Area (MCA)

KENTTEC is planning to undertake Sequential Aerosol Technique (SAT) application which is a computerized uniform application of insecticide deletamethrin (synthetic pyrethroid) using a fixed wing aircraft. The insecticide will be applied in ultra low dosages of the active ingredient. Topical applications under laboratory conditions show tsetse flies are about 30x more susceptible to deltamethrin than house flies and about 600x more susceptible than honey bees, although the ambient temperature of these tests is unstated. The toxicity of deltamethrin is related to temperature and falls as mean temperature rises.

The application will be done in four to five cycles separated by about 10 to 15 days apart in order to catch the flies that will be emerging at different times. All the cycles will be done at night and each cycle will be done in one night throughout the region. In addition to chemical applications, the spraying will cause noise from the aircrafts. Most of the SAT application will be within the National Parks and Reserves but also will include some areas with human occupation where tsetse and trypanosomiasis is known to exist.

The purpose of this questionnaire is to get your views, and opinions on what based on your experiences and knowledge of the area proposed for SAT application might be affected by the activity and suggestions on how these effects can be avoided, reduced or mitigated.

Provided with this questionnaire is an information leaflet giving details how the chemical to be used affects the environment and people for your reference.

In order for us to advice the proponent adequately please answer the following questions diligently to give your opinions on the effects of the proposed activities. The answers will be used only for statistical analysis and will never be associated with any individual or institution unless you request us to do so.

1. District.....
2. Location / Organization.....
3. Sub Location/ Designation
   .....

4. Gender: 1. Male ☐ 2. Female ☐

5. Occupation
   a. Farmer ☐
   b. Teacher ☐
   c. Civil servant ☐
   d. Others
      specify.....

6. Is trypanosomiasis (Nagana) a problem in the area that is proposed for the application of SAT?

    a. Yes ☐

    b. No ☐

7. Do you support the government's efforts to eradicate the disease?

    a. Yes ☐

    b. No ☐

8. In the space below give reasons to support your answer in (7) above.

9. What activities or beneficial organisms do you think will be affected by the proposed activity?

10. What actions should be taken to avoid or reduce these effects?

11. If these effects do occur, how can their impacts on the society be reduced (mitigation)?

12. Is there any specific time of the year during which SAT application might have less impact on the activities or organisms you have listed in (6)

13. Because SAT will be applied at night, is there anything that can be done to reduce the impacts identified in (6) above or on any activity in the area?

14. What are the environmental issues that concern you most about the proposed intervention?

15. What mitigation measures in general would you like the proponents to take in order to reduce the effects of SAT in the area it will be applied?

Thank you for your information. Your views and suggestion will be considered.

Appendix 3: Lists of Participants in the four Meetings

A: Tseikuru: Attached

B: Tharaka: Attached

C: Maua: Attached

D: Garba Tulla: Attached

E: Photos of all the 4 Meeting Areas