



Activity Report 140

Community-based
Environmental Management
Program for Malaria Control in
Kampala and Jinja, Uganda
Final Report

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Acronyms

EM	environmental management
NGO	nongovernmental organization
SOP	standard operating practices
EHP	Environmental Health Project
hrs	hours
IRS	indoor residual insecticide spraying
ITN	insecticide-treated net
IVM	integrated vector management
KAP	knowledge, attitudes and practices survey
KCC	Kampala City Council
km	kilometers
LC	local council
m	meter
ml	milliliters
MOH	Ministry of Health
NMCP	National Malaria Control Program
OC	officer-in-charge, Police Barracks
SSA	sub-Saharan Africa
UI	millionth of a liter (of blood)
USAID	United States Agency for International Development
VIP	Ventilated Improved Pit Latrine
VBD	vector-borne diseases
WHO	World Health Organization

What Is Environmental Management for Vector Control?

Environmental management for vector control aims to induce changes in ecosystems to help reduce their receptivity to the propagation of disease vectors. Disease vectors are organisms that play a key role in the transmission of certain diseases. Vector-borne diseases (VBD) include malaria, yellow fever, schistosomiasis (bilharzia), filariasis and plague. The vast majority of vectors are blood-sucking insects, of which mosquitoes are the best-known group because they transmit malaria. These diseases place a heavy burden on local populations and have dire consequences for the economies of endemic countries.

The distribution of VBD depends directly on the ecological requirements of the local vector species. Very often, the aquatic environment is of critical importance to their life cycles. Environmental management for vector control therefore frequently aims at introducing changes in the local hydrology or in water-use practices. Conversely, development projects focusing on infrastructure (most notably, water resources development projects) may inadvertently lead to changes in the environment that result in a deterioration of the VBD situation.

There is a distinction between environmental modification and environmental manipulation worth noting. Modification implies permanent changes such as landscaping, drainage, land reclamation and filling. It will often entail minor or major infrastructure projects and requires significant capital investment. Manipulation is a recurrent activity, requiring proper planning and operation, such as removing aquatic weeds from irrigation and drainage canals. In agro-ecosystems, environmental manipulation can often be incorporated into conventional agricultural practices. Its costs are usually modest but recurrent. Many environmental manipulation operations require infrastructure development.

Environmental management for vector control is not intended to replace other control strategies. Rather, it provides a basis on which other methods such as chemical controls can build in a complementary fashion, while reducing the environmental costs and resistance risks incurred by excessive use of insecticides. It also adds resilience to the results of control programs, important at times of economic instability or social unrest. Clear decision-making criteria and procedures in an Integrated Vector Management (IVM) framework will ensure the most cost-effective combination of measures for each local situation. Environmental management for vector control is a particularly powerful approach in the context of development projects, especially infrastructure projects such as dams, irrigation schemes, roads and railroads, airports, flood control projects and urban developments. These usually offer important opportunities to minimize adverse effects for the health of local and resettled populations and, indeed, to promote their health status in an efficient and sustainable manner.

Extract from (Lindsay et al., 2004). For detailed descriptions of environmental management, the reader can refer to the “Manual on Environmental Management for Mosquito Control” produced by the World Health Organization (WHO, 1982).

Executive Summary

In the early 1990s in cities in sub-Saharan Africa, malaria was controlled using environmental management (EM) for vector control. What this approach lacked in effectiveness, compared with the residual insecticides that appeared on the scene in the 1950s, was largely made up by its sustainability. Yet today malaria control in Africa is focused almost entirely on the use of antimalarials and insecticide-treated bednets, not on biophysical environmental modifications or on strengthened social systems to perform effective environmental manipulation. While drugs and insecticides are extremely effective weapons, their initial promise has been undermined by the development of resistance and growing concerns for some about the long-term costs and environmental impact.

This report describes the activities and findings of a two-year study designed to assess the strengths and weaknesses of a community-based EM program for malaria control in two Ugandan cities: Kampala and Jinja. The overall goal was to test the use of EM in urban areas and, if successful, generate useful lessons for expanding EM in these and other cities.

Kampala and Jinja are both situated close to the equator and experience a tropical climate with rain falling throughout much of the year. Kampala is the nation's capital and is built on rolling hills and valleys. Housing there is confined largely to the hills, while in the valley floors, where water collects, are areas of market gardening, swamps and brick pits. It is in these valley bottoms where anopheline breeding sites abound. In Jinja, the hills are less pronounced and the valleys broader, collecting water that drains into Lake Victoria. Both cities are essentially rural outside the main commercial centers.

Four sites were selected for the study, two in Kampala (Kitebi & Kikulu) and two in Jinja (Police Barracks & Loco Estate). Both sites in Kampala were in small valleys with extensive areas of flooded brick pits, while in Jinja they were estates close to farmland or swamps.

The first year activities focused on collecting essential data and preparing action plans. Routine entomological and clinical surveys were performed to determine the sources of vectors and the level of malaria transmission at each study site, and the results revealed a complex picture. Generally malaria transmission was low in all sites, with anopheline mosquitoes being far less common than the abundant culicine mosquitoes. Anopheline mosquitoes occurred in a wide variety of different water bodies at each study site. In Kampala, brick pits, tire ruts and puddles were the predominant sites favored by the major malaria vector, *Anopheles gambiae s.l.* In Jinja, few anopheline larvae were found near the Police Barracks, while in Loco Estate most were on the edges of the extensive swamp bordering the settlement. The level of infection with malaria parasites was similar in children living in all study sites (14-29%), except for Loco where the prevalence was markedly higher (36-46%).

The study team provided local communities and health departments with this evidence and technical support to help them develop action plans for the environmental management of malaria. A key element of the approach was to actively involve the communities and municipal authorities in the

decision-making processes. This involved project staff facilitating discussions within the study communities and key people from relevant municipal and governmental departments.

The action plans were specific to the ecology and social make-up in each site. In Kampala, the interventions included filling puddles, introducing larvivorous fish and improving drainage. In Jinja, the plans focused on building and repairing drainage channels and soak-pits.

The action plans were implemented in the second year, in Kitebi (Kampala) and the Police Barracks (Jinja). The other two communities were followed as non-intervention controls. Community residents in Police Barracks were highly active and had the strong support of the local Municipal and District health authorities. Community participation and support from local officials were noticeably less in Kitebi. Entomological and clinical surveys were continued in order to assess the impact of environmental management on the level of transmission and infection experienced in the intervention sites, as compared to controls.

Results from both intervention sites provide evidence that the actions taken reduced the number of potential breeding sites for anopheline mosquitoes and the numbers of anopheline larvae and pupae. Collections of adult mosquitoes from sentinel houses suggest that there was also a reduction in malaria transmission, as indicated by a drop in the number of adult mosquitoes collected. Most important, the interventions were associated with reductions in malaria prevalence of 11% in the Police Barracks and 36% in Kitebi, providing important evidence of the potential benefits of EM for reducing malaria transmission in urban areas.

In this study, the team was unable to use larvicides to further reduce the numbers of anopheline larvae in certain types of breeding sites (e.g., brick pits). The activity did not result in the reduction of the number of culicine mosquitoes found indoors, probably because mosquito abatement activities in pit latrines were not carried out. This was a serious oversight since during the interventions people in the local communities were still being bitten by large numbers of nuisance mosquitoes. Thus, the communities may have perceived that the EM interventions were less successful than was actually the case.

The findings from this pilot study suggest that EM was successful at reducing malaria transmission in urban settings. EHP recommends that further work be undertaken to determine practical means of implementing environmental management at a larger scale in Uganda's cities, including addressing the operational problems of community participation, public sector capacity and support, and financial sustainability.

1. Introduction

1.1. The growing problem of urban malaria

During the last 40 years, the population of sub-Saharan Africa (SSA) has almost trebled, growing by more than 15 million people each year, to the present level of over 600 million (www.fao.org). As the population continues to grow, people move away from the countryside to the cities, attracted by the hope of a better life. At present, one third of Africans in SSA live in cities, and this proportion is likely to grow in the future. In fact, it is estimated that more than half of all Africans will live in cities by 2015. Thus the urban environment will become an increasingly important feature of African life.

Although malaria is primarily a rural disease, it can also be a considerable drain on populations living on the fringes of urban settlements, causing significant morbidity and mortality while also reducing productivity (Trape 1987, Bouganalih et al. 1993, Baujat et al. 1997, Beier et al. 2003). Following discussions with the city council health authorities and study communities in both Kampala and Jinja, it was clear that malaria was a significant public health problem in these cities. This problem is likely to grow as a result of the increase in parasite strains resistant to chloroquine (Babirye et al. 2000). In Kampala, malaria is presently the leading cause of morbidity and absenteeism in schools and workplaces, and 60% of the health budget is spent on its control (Uganda Ministry of Health, unpublished data). A similar picture emerges in the city of Jinja where malaria is the most common diagnosis made in municipal health outpatient units, accounting for 46% of diagnoses in children under five and 37% in those over five years (HMIS 105, 2000).

At present the major foci of malaria control in Kampala include the case management of clinical episodes of malaria, the promotion of insecticide-treated nets (ITNs), focal indoor residual insecticide spraying (IRS), presumptive treatment of malaria in pregnant women and environmental management (EM). EM, through a process of social mobilization and community participation, is being encouraged by the Ministry of Health and includes filling small water collections, clearing bushes around homes and closing windows early in the evening.

1.2. Building urban partnerships for malaria control

The stimulus for this activity came from Michael Okia (senior medical entomologist, National Malaria Control Program), who sought to develop community-led malaria control activities based on EM. Regular meetings to guide this activity and disseminate information were held between members of the study team, study communities, local government and USAID. Key actors in this activity included Peter Langi (program manager, National Malaria Control Program), Albert Kilian,

(malaria technical advisor, USAID), Ambrose Onapa (principal entomologist, Vector Control Division) and Michael Okia (senior medical entomologist, National Malaria Control Program).

1.3. Objectives

The activity had three objectives in its first year:

- Identify areas in each city that appear to be at higher risk for malaria and confirm local transmission
- In selected areas where local transmission has been confirmed, identify and characterize anopheline breeding sites in terms of larval presence and productivity, location, permanence, land use, ownership and other relevant variables
- Develop stakeholder groups and use a participatory process for preparing an action plan to eliminate or manage productive breeding sites through source reduction

The first year effort resulted in the identification of two study sites, a detailed identification and characterization of the breeding sites, engagement of the district health authorities and target communities, and the development of an intervention plan to reduce mosquito breeding in the two sites.

In the second year, the activity had the following five objectives:

- Implement the interventions to reduce mosquito breeding in the two study sites in Kitebi, Kampala and the Police Barracks in Jinja
- Survey the breeding sites in the two study sites to monitor the reduction of anopheline larvae
- Assess the impact of mosquito control on malaria transmission and prevalence
- Document improvements in strengthening linkages between the district authorities, the National Malaria Control Program and the private sector
- Develop recommendations working with the municipal authorities to institutionalize feasible and appropriate control measures

Chapter 2 describes the methodologies used in the study. Chapter 3 summarizes the planned and actual interventions for both study sites. Study findings are described in Chapters 4, 5 and 6. Chapter 4 presents the entomological findings, Chapter 5 offers the clinical findings and Chapter 6 describes the social science findings. The key recommendations for expanding environmental management in Uganda are shown in Chapter 7.

1.4. Study plan

The study took place in two cities: Kampala and Jinja. These urban centers are experiencing extremely different economic fortunes and have markedly disparate malaria ecologies. Kampala has a population of around one million inhabitants, although it swells to over two million during the day. The capital is booming economically and there are a considerable number of high-quality houses being constructed across the many small hills and valleys in the city. High annual rainfall results in the rapid run-off of large volumes of water from the hillsides that collects in the valley

bottoms, often causing flooding. As a consequence, many of the valley floors are too wet for housing, and are covered with swamps, agricultural land for market gardening and sometimes clay that is excavated to make bricks for local houses. Often the brick pits are extensive, illustrating the high demand for building bricks in the growing city.

In marked contrast, Jinja is a smaller city with a population of 65,000 residents covering an area of 28 km² (Jinja Municipal Council, unpublished document). The city is close to the shore of Lake Victoria, and about 33% of the area is covered in swampland. It has experienced major industrial development in the 1960s, but during the last 30 years, it has been in decline. As a result, much of the infrastructure requires renovation, particularly in the large housing estates on the outskirts of the city.

Many lowland areas in both cities are peppered with numerous collections of small manmade waterbodies. Since much of the water is stagnant and exposed to sunlight, these sites are ideal breeding places for *Anopheles gambiae sensu stricto*, the chief vector of malaria in Uganda and indeed in Africa. The present activity set out to establish whether larval control by environmental management in Kampala and Jinja could be used to reduce malaria in local communities. An important aspect of this intervention was the development of an action plan by the communities in partnership with the city health authorities. It was anticipated that a strategy developed in this manner would be both an effective and sustainable method of malaria control in urban areas.

1.5. Benefits

This project was designed to create or strengthen partnerships to work on urban health issues in Uganda in five ways:

- Reducing anopheline breeding and malaria transmission and possibly, malaria prevalence in the interventions sites (The beneficiaries of this reduction would be residents in the intervention areas, primarily young children under five and non-immune adults)
- Demonstrating a model for malaria control in urban settings in Uganda that could serve as the basis for replication and scale-up in other cities in Uganda as well as in other cities in Africa
- Creating or strengthening cross-sectoral links between the municipal health department and other municipal agencies with executive duties or regulatory authority over the spaces and land types related to anopheline breeding sites
- Strengthening connections between the municipal health department and the private sector, including community groups and commercial enterprises as well as others that may offer services to help implement the action plan
- Re-establishing connections between the vector control unit of the National Malaria Control Program and local officials in the two municipalities, particularly at various levels of the local council system

1.6. Conclusion

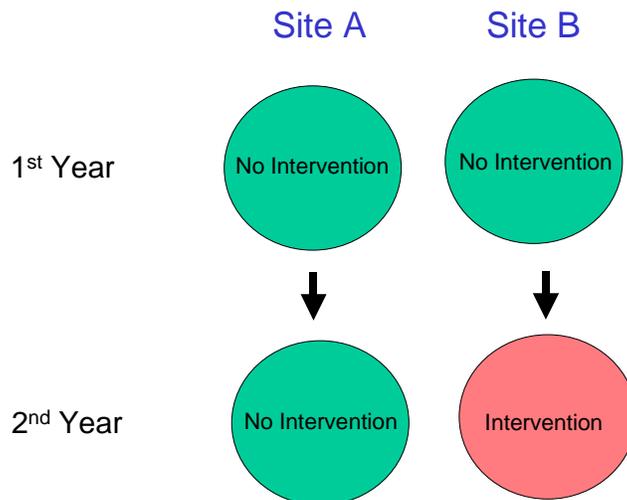
This activity was a case study for community-led malaria control programs based on environmental management and will serve to assist the development of improved procedures for the control of malaria in Kampala and Jinja and other cities in Uganda and throughout Africa.

2. Methodology

2.1. Study design

The pilot study took place in two sites in each city, over a two-year period, from September 2003 to June 2004 (Figure 2.1). In the pre-intervention year, baseline entomological and parasitological data were collected and plans for interventions developed by the community, with the cooperation of the local health authorities and the EHP team. In the intervention year (year two), attempts were made to control mosquito larvae in one of each pair of sites in each city. Repeat entomological and parasitological surveys were made in the second year to measure any impact of the intervention. This work was supported by qualitative research to assess the attitudes and practices of key players during the interventions.

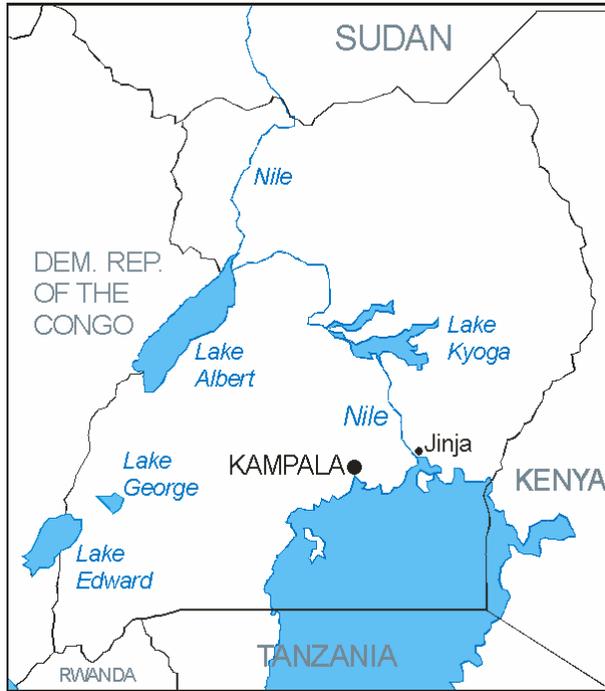
Figure 2.1. Study design for Kampala and Jinja



2.2. Study sites

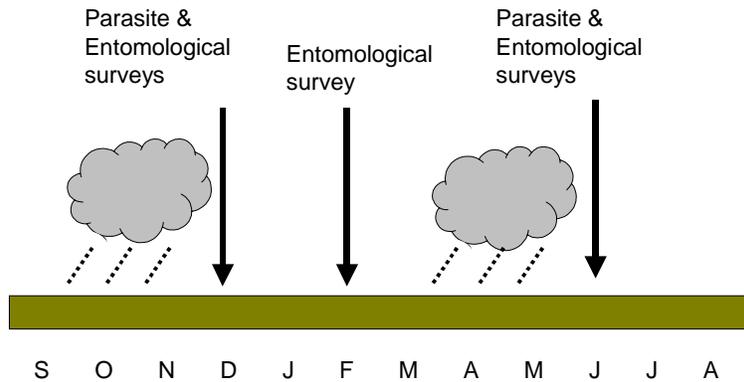
The study was carried out in Kampala, at Kitebi ($0^{\circ} 17' 15''$ - $0^{\circ} 18' 00''$ N, $32^{\circ} 32' 15''$ - $32^{\circ} 33' 00''$ E) in Rubaga Division, and Kikulu in Kawempe Division ($0^{\circ} 21' 45''$ - $0^{\circ} 22' 30''$ N, $32^{\circ} 35' 15''$ - $32^{\circ} 36' 00''$ E) and in Jinja, at the Police Barracks ($0^{\circ} 27' 00''$ - $0^{\circ} 26' 15''$ N, $33^{\circ} 12' 00''$ - $33^{\circ} 12' 45''$ E) and Loco Estate ($0^{\circ} 24' 45''$ - $0^{\circ} 25' 30''$ N, $33^{\circ} 12' 45''$ - $33^{\circ} 13' 30''$ E; Figure 2.2). The settlements in Kampala were areas of new housing, with a mixture of lower and middle-income families. In contrast, the sites in Jinja were purposely designed housing estates, constructed about 60–90 years ago for local industrial and public service workers.

Figure 2.2. Map of the study area showing city locations



The typical pattern of rainfall in the Lake Victoria Basin consists of two annual rains each year; from March to May, and from September to November, interspersed with dry periods. However, in recent years the pattern appears to be changing, resulting in less clearly defined rainy seasons compared with the typical pattern. Nonetheless, the study team assumed that the highest peaks in malaria transmission occurred toward the end of each rainy season, in June and December. It is for this reason that parasitological and entomological surveys were conducted during these months (see Figure 2.3). To assess transmission during the dry season an additional entomological survey was carried out in February.

Figure 2.3 Survey schedule



Standard operating practices used during this investigation are shown in Appendix A. The data collection sheets are in Appendix B.

2.3. Entomology

2.3.1. Larval collections

During the study, six larval surveys were carried out in November 2002, February 2003, June 2003, November 2003, February 2004 and June 2004. These surveys were conducted during both wet seasons and the intervening dry season in both the pre-intervention and intervention years.

Larval collections took place between 12:00 and 17:00 hrs. A maximum of 60 dips with a standard dipper (400 ml) was made in each type of water body. Sampling was proportional to the surface area of the different types of habitat. No more than six dips were made within a focal habitat within a 10 m² area or every 10 m, if the habitat was linear. The number of 3rd and 4th stage mosquito larvae and pupae of anopheline and culicine mosquitoes were recorded in each dip. At all sites, the presence of sunlight or shade, water temperature, pH, and the presence of large aquatic animals and algae were recorded. Approximately 50 anopheline larvae or pupae were identified according to species from each type of habitat from each site during each survey (see Appendix A for the standard operating procedures for larval collections).

2.3.2. Adult mosquito collections

Twenty-one houses, each with a child under five years old and occupied the previous night, were selected at random within 200 m from the nearest large breeding site. If it was impossible to enter one of the selected houses, then the next nearest available house was surveyed. Each morning seven houses were sampled for indoor-resting mosquitoes using pyrethrum spray catches in one bedroom of each house between 06:00 and 10:00 hrs. on three separate days. Mosquitoes were identified according to species and the salivary glands of females dissected for the detection of sporozoites. The number of children (under 10 year old) and adults were recorded at each visit (see Appendix A).

2.4. Clinical surveillance

2.4.1. Cross-sectional surveys

Cross-sectional clinical surveys were carried out in November-December 2002, June 2003, December 2003, and June 2004. A total of 220 children, ages six months to five years, were examined at each study site and were selected from the community living within 200 m of the edge of the settlement nearest the main breeding sites. The parent or guardian of each child was asked whether the child slept under an insecticide-treated bednet, if the walls of the house have been sprayed with insecticide, insecticide coils or aerosols (Doom), whether the child had traveled out of the city in the last month, and if the child had been treated for malaria in the last week. Children diagnosed as sick by the doctor were treated free of charge or, for complicated cases, referred to the relevant government health center for therapy. A finger-prick sample of blood was taken from each child to prepare blood films that were examined by an experienced technician for the presence of malaria parasites using microscopy (see Appendix A for standard operating procedures for the clinical surveillance).

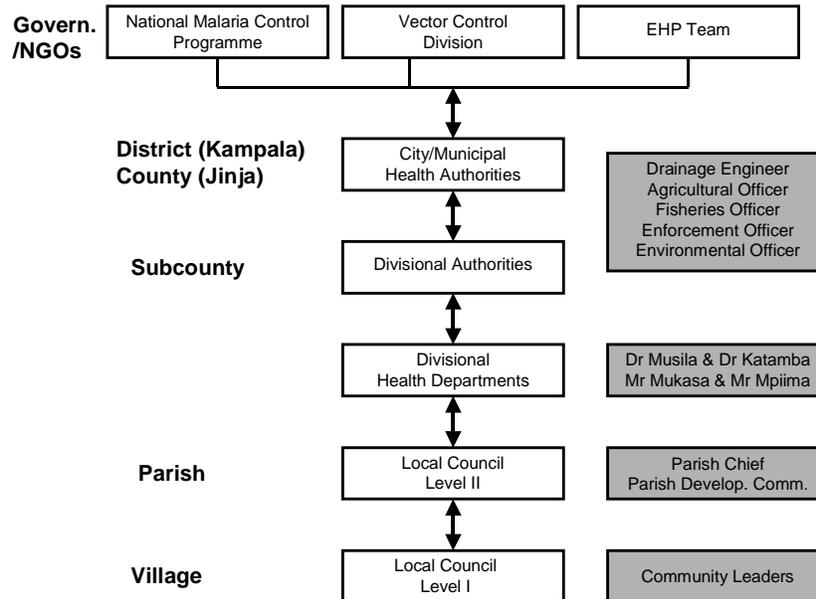
2.4.2. Health facility records

Additional data were collected from local health centers serving each of the four sites in order to assess the seasonality of malaria. The number of patients reporting to the health facilities was recorded monthly. Those with malaria were separated from other conditions. A patient was recorded as having malaria on the basis of a positive malaria blood slide and/or clinical symptoms.

2.5. Community sensitization & the role of local health authorities

The organizational structure shown in Figure 2.4 was used to inform key partners about the purpose of and findings from this activity and to develop an action plan for the interventions.

Figure 2.4. Organizational structure used for facilitating development of intervention strategy. Boxes in grey show key personnel.



The role of the local health authorities was to ensure that they were actively involved in the development of the action plan, that information about the project was relayed to elected and appointed officials in the councils, and that discussions were initiated with relevant authorities in the urban councils to ensure that no other major interventions took place in the study sites.

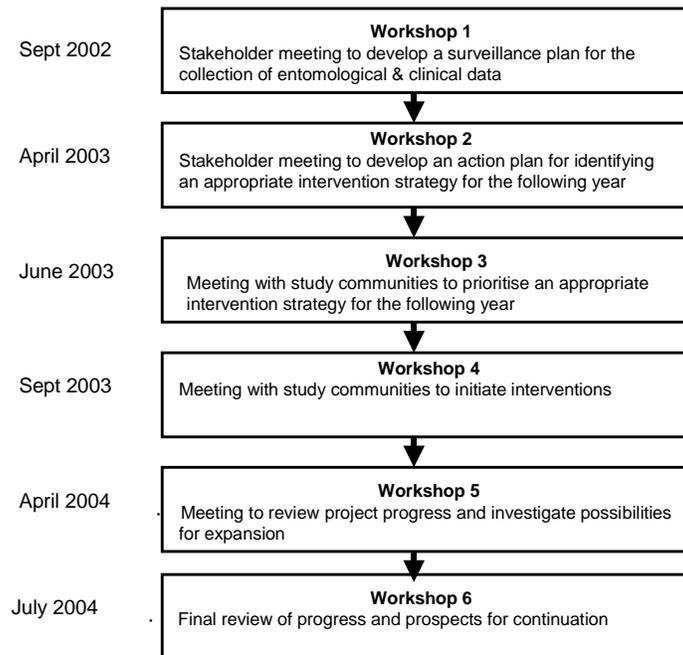
Awareness raising, community acceptance and appreciation of the intended activity proceeded after first contacting the chairpersons of each study community. Actual sensitization necessitated household visits because of the nature of the intended activity (parasitological surveillance and household spraying). Dr. Timothy Musila, with the public health department in Rubaga, and Dr. Katamba, the medical officer in charge of Kawempe, contacted the village chairpersons in these areas and organized the teams that conducted the sensitization. Brick makers as well as existing youth and women groups and NGOs focusing on health were also included in the sensitization.

2.5.1. Preparation of the communities

Before house spraying, the EHP team was assisted in their activities by the zonal coordinators for Kitebi, the entomology team for Kikulu, the nurse-in-charge of the Police Barracks and the Secretary for the Environment, Loco. On a designated day, mothers or guardians were asked to bring their children to the nursery school where they were informed about the study objectives, and informed consent was elicited before recruitment of the children into the study. After mobilization of the community, the surveys were carried out at all sites.

Six workshops were held in each city during the two-year period to help guide the process, seek to develop ownership of the project and disseminate information among the key stakeholders (Figure 2.5). The first workshop was designed to construct an action plan for the collection of entomological and clinical data during the first year of the study. The second workshop allowed the team to inform key stakeholders about the findings from the first surveys and help develop an action plan for beginning the process of identifying a series of measures to be used for EM. These were tailored to the specific requirements of each study community. Both workshops were facilitated by health sector personnel since the aims of the workshops were focused largely on issues of scientific design and institutional support. For the third workshop the emphasis turned to the communities themselves. Therefore, the third series of workshops were held in the communities so that anyone from the local sites who wished to could attend. The number of health sector personnel was also kept to a minimum in order to allow community members to have their views heard. Brick makers as well as existing youth and women groups and NGOs focusing on health were also included in this part of the sensitization effort. During the meeting, research staff and health sector personnel acted as expert resources, to be called upon when needed. Study communities prioritized the types of interventions they wished to see practiced. The conclusions of these meetings were then discussed again in smaller meetings with village leaders, key members of the health sector and the research team until a consensus was reached on the best strategy for environmental management at each site. The fourth workshop was held at the beginning of the second year to update key partners about the progress of the activities. The fifth workshop was arranged to discuss progress and obstacles to EM in the intervention communities and to begin discussions about how this work might be expanded in the future. The final workshop evaluated the major findings, discussed the lessons learned and how best to continue this work. Many other smaller meetings supported this major meeting framework during the course of the activity.

Figure 2.5. Schedule for major meetings



2.5.2. Knowledge, attitudes and practices (KAP) surveys

Interviews were carried out in Kitebi and Jinja Police Barracks in the second year to investigate the factors influencing community participation in this activity. The specific objectives were to:

- Establish the knowledge, attitudes and practices of the community regarding intervention activities
- Ascertain the various factors influencing the participation of the community in EM activities in the study site
- Assess the contribution of the health promoters and public health personnel to the project

Toward the end of the second year, 55 community members were interviewed in Kitebi and 50 at the Police Barracks. In addition, 11 community leaders and 3 public health personnel were selected from municipal and district councils in Kitebi and 12 community leaders and 5 public health personnel in Jinja. Interviews were carried out in April 2004 between 09:00 and 18:00 hrs. The primary methods of data collection included personal interviews, key informant interviews and focus group discussions. The interviews were conducted in English and Luganda with the questionnaires administered by the researchers. Tape recorders were used to record data from the key informant interviews.

Several questions were asked around three sub-themes to capture the knowledge, attitudes and practices of the community regarding EM intervention activities. They were: factors influencing the participation of the community in EM activities; contributions of the health promoters and public health personnel to the project; and the sustainability of EM for malaria control.

2.5.3. Ethical approval

The mothers of children in the study were informed about the study objectives and informed consent was elicited from the mothers or guardians before recruitment into the study. Household owners also agreed to have their homes sprayed to collect mosquitoes. This study was approved by the National Council for Science and Technology in Uganda and the Ethical Advisory Committee at the University of Durham in the United Kingdom.

2.5.4. Sample size considerations

This study was essentially a pilot project designed to determine the level of transmission and intensity of infection in different urban settings. The design of the entomological surveillance was based on classical methods, and the sample size was sufficient to capture some of the variations inherent in this type of sampling. The study team hoped to be able to show that the larval intervention would reduce mosquito biting by 50%. The team assumed that each mosquito collected in each house was capable of biting people in the room. Assuming that the average number of mosquitoes collected in each house is 12 (SD=6), at the 95% level of significance and 80% power, the study required 21 houses to be sprayed in each site during each survey to demonstrate a 50% reduction in mosquitoes. This assumed that parasite prevalence would vary from 40–60%. In order to show a 33% reduction in infection associated with an intervention, this required a sample size of between 107 and 214 children to be screened in each group, at the 95% level of significance and 80% power. The team selected a total of 220 children to be screened at each site to allow for children who would have to be removed from the study if they purchased an ITN during the study. The level of anopheline abundance and the prevalence of parasitaemia in study children were both lower than expected so that the power of the surveys to detect a decrease was less than expected.

2.5.5. Data analysis

Data were recorded using EPIINFO and Excel, and analyzed using SPSS and EPIINFO software.

3. Action Plan and Intervention

The planned interventions developed during the first year by the study communities, supported by the local health authorities and EHP team, are summarized below. Note that not all these activities were achieved.

Table 3.1 Planned interventions

Problem	Solution	Mechanism for intervention
Kitebi – Kampala		
Active brick pits	Larviciding with <i>Bacillus thuringiensis var. israelensis</i> , with a possible financial contribution from landlords of brick pits	Larviciding by technical team
Mature brick pits	Introduction of larvivorous fish	EHP team to purchase fish for management by community
Blocked drains (small)	De-silting & clearing rubbish	Community lead supported by equipment purchased by EHP (e.g., boots, gloves, rakes, brooms, wheel barrows)
Blocked drains (major)	De-silting & clearing rubbish	Community & Kampala City Council (KCC) to carry out
Puddles in town	Filling with rubble (<i>murrām</i>), planting grass (<i>Paspalum</i> spp.) or larviciding. Stop using top soil for brick-making	EHP team to work with KCC to organize transport of murrām & grass. The community to fill holes, supervised by engineer
Puddles in the market gardens	Drainage, growing coco yams and sweet potatoes without pooling in the fields and larviciding where necessary	Education by EHP team
Police Barracks – Jinja		
Blocked drains	De-silting, clearing rubbish & repairing & planting grass	Community lead & local builder
Puddles in town	Filling with rubble (<i>murrām</i>) or larviciding	EHP team to work with the police & local authorities to organize transport of murrām & grass. The community to fill holes, supervised by engineer,
Broken cess pits	Repair	Community lead & local builder

In the second year, larval control was carried out in Kitebi, Kampala, and the Police Barracks, Jinja, with Kikulu and Loco as the respective controls. The communities themselves, supported by the district and municipal health authorities, with the technical assistance of the study team and city engineers, led both sets of interventions. The communities organized most interventions themselves, assisted by the local health authorities.

3.1. EM activities

The interventions in Kitebi and the Police Barracks, Jinja, commenced in August 2003. Nearly all the larger engineering works were carried out in September and October 2003. Unblocking drains and filling small puddles continued through the second year in the Police Barracks, but not in Kitebi.

In Kitebi, one large main drainage channel, about 300 m in length, was constructed by linking together a chain of brick pits (Figure 3.1). In addition, about 65 m of medium-sized drainage channels were cleared of rubbish, de-silted and widened to prevent water stagnation. Two hundred truck loads (1,400 tons) of murrum were delivered to the site to fill-in water logged areas that could not be drained. This work was carried out by 10 laborers from Kitebi overseen by the chairwoman and 10 local coordinators (one in each zone). These people were paid about USH 25,000/person/month (USD\$12.70). About 50 larvivorous fish (*Gambusia* spp.) from local ponds were added to 50 brick pits in the study area. After January 2004, very little additional work was done. The community did not keep up the clearance of drains and many smaller drains soon became clogged with rubbish.

Figure 3.1. Construction of a new drainage channel in Kitebi, Kampala



At the Police Barracks, approximately 200 m of new concrete drainage channels (Figure 7.1) were constructed and broken channels repaired. Fifteen soak pits were built to remove water accumulating around stand pipes and broken manhole covers were repaired or replaced with new

ones (n=15). All exposed ground was transplanted with grass (*Paspalum* spp) to reduce soil erosion by rainwater, and the drains were de-silted on a weekly basis. During the dry season many young seedlings died from lack of water and new plants were transplanted to replace those that perished. This work was carried out by the community, supervised and assisted by 15 health promoters and the municipal environmental engineer, officer-in-charge and the nursing sister at the barracks. All these individuals were well motivated and worked well with the community.

Figure 3.2. Construction of new road surface, new drainage channel and planting of grass plants at the Police Barracks, Jinja



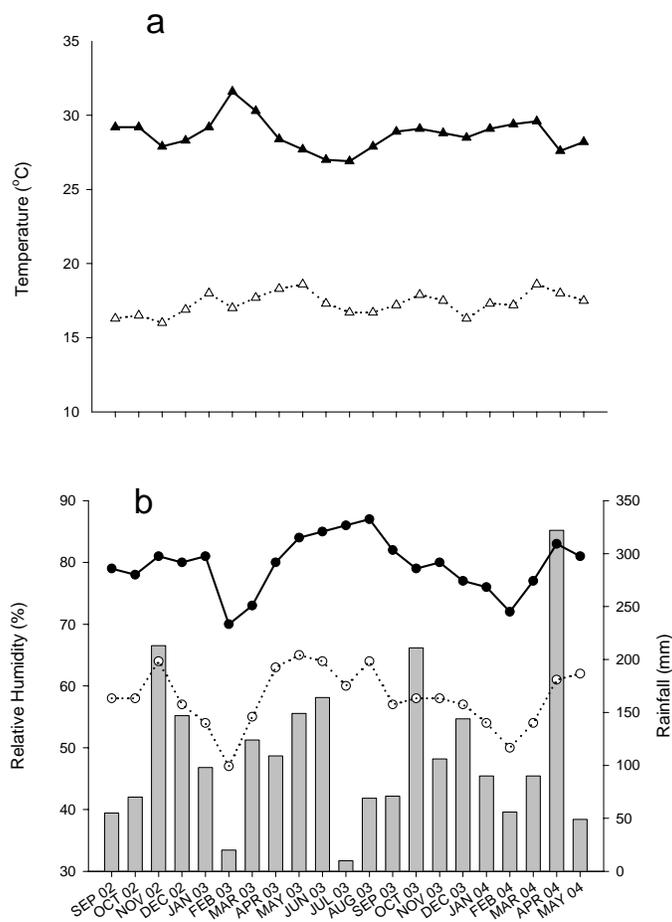
The study team had always assumed that larval control by EM alone would not be sufficient to reduce transmission of malaria to very low levels. For this reason, the project had planned to use *Bacillus thuringiensis var israeliensis* (Bti) to reduce the aquatic stages of mosquitoes. Although an application was made to the Uganda National Council for Science and Technology on Sept. 25, 2003, permission to use this product was not given within the activity period.

4. Entomology Findings

4.1. Meteorology

Monthly summaries of temperature, relative humidity and rainfall from Jinja weather station are shown in Figure 4.1. These data demonstrate the consistent environmental conditions typical of sites along the equator.

Figure 4.1. Meteorology in Jinja during the study, where “a” is maximum and minimum monthly temperature and “b” is maximum and minimum relative humidity and total monthly rainfall.

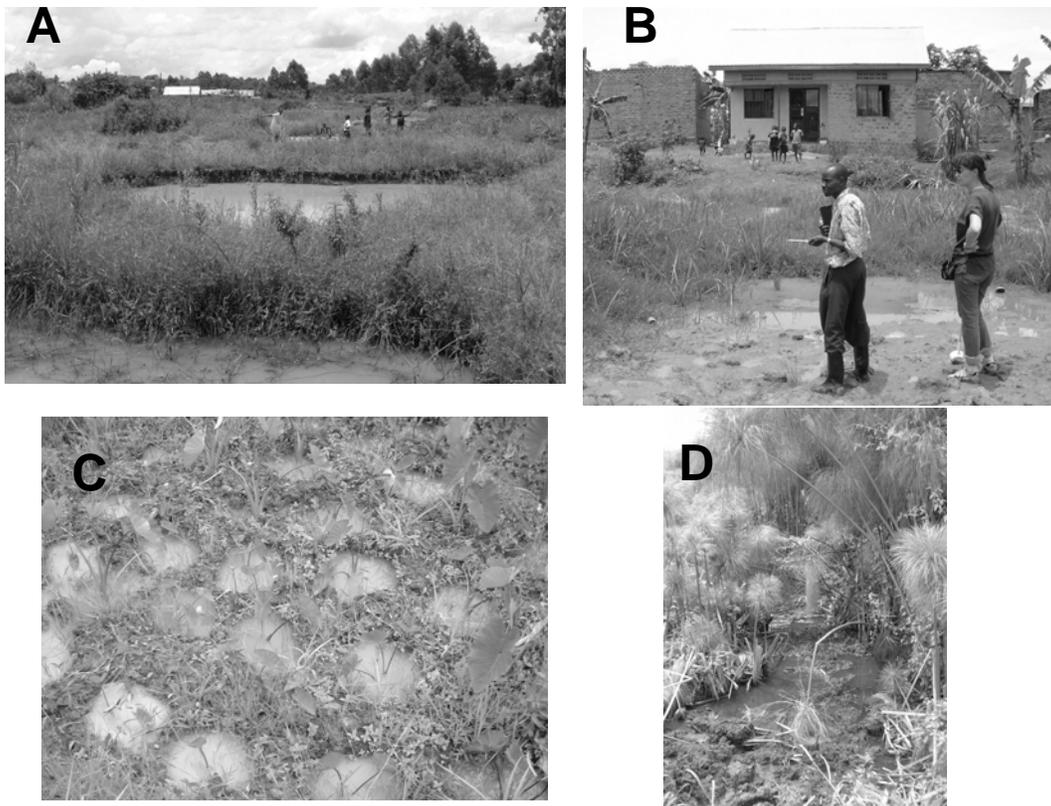


4.2. Breeding habitats

The major breeding habitats for each study site (Figure 4.2) vary widely both between and within sites. Almost any small water body can support the aquatic stages of anopheline mosquitoes, including both dirty and clean water.

In Kampala, brick and sand pits, tire ruts and puddles were the predominant sites favored by the major malaria vector, *Anopheles gambiae s.l.* In Jinja, few anopheline larvae were found near the Police Barracks in puddles and drains, while in Loco Village most were found in puddles and pools on the edges of the extensive swamp bordering the settlement.

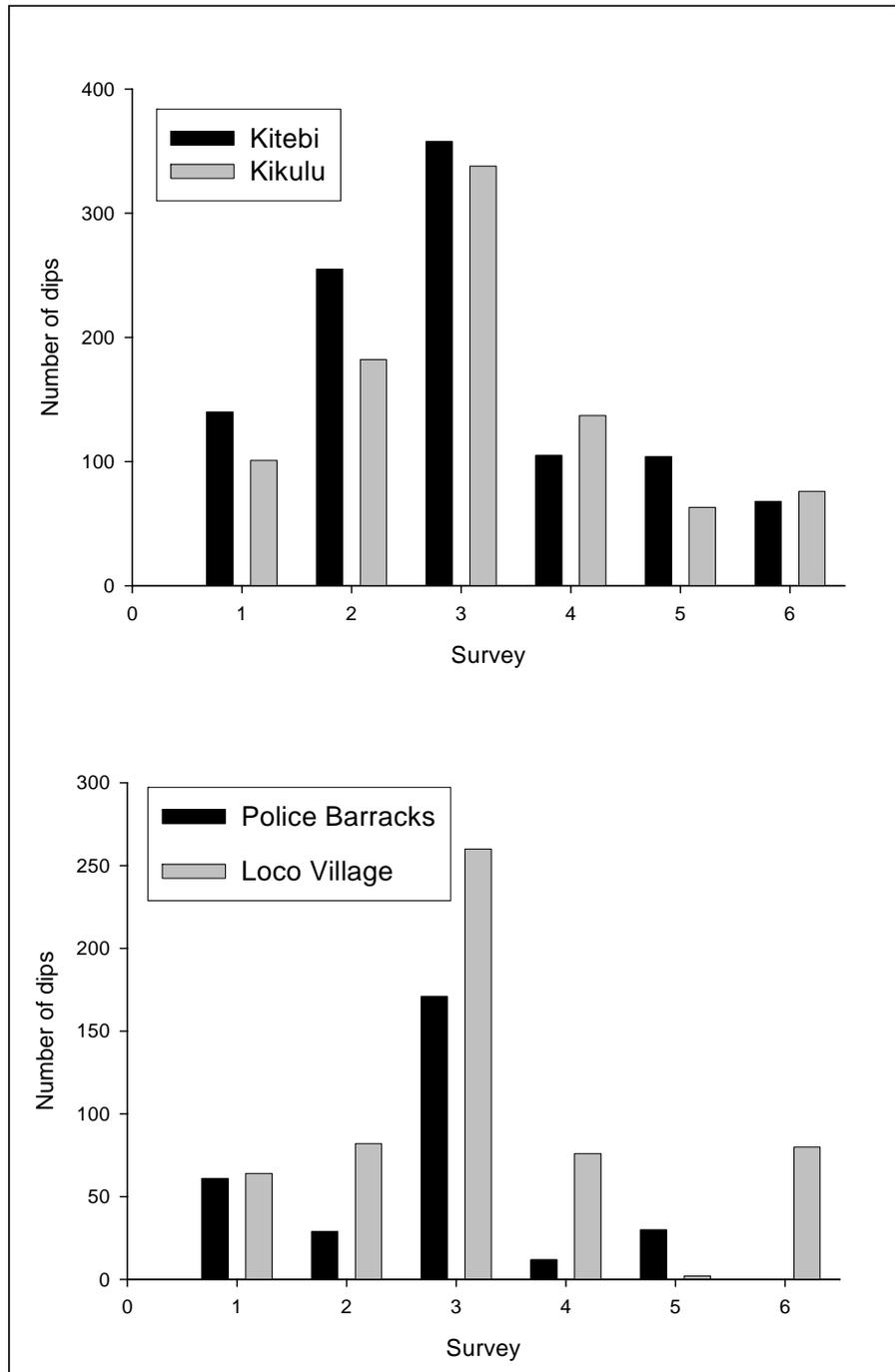
Figure 4.2. Typical breeding habitat of *An. Gambiae*: A. flooded brick pit; B. a puddle; C. puddling at the base of coco yams; D. pools next to a papyrus swamp



In Photo A above, brick pits are dug to get the clay to make bricks that are then baked in nearby kilns. After use, the pits are filled with water. In many areas they form a network of extensive and productive breeding habitats. The pits are too large to shade since vegetation nearby is cut either to cover piles of bricks waiting to be baked, to prevent the soft bricks from being spoiled by rain, or for the firewood needed to fire the kilns. The brick pits appear unregulated. Young men from the local communities and outside the area rent land from a local landlord to build their pits. Once an area is exhausted of clay for bricks the land is often used for building houses or industrial buildings. While many older pits have fish that act as efficient predators of mosquito larvae, these newly dug brick pits become the most important source of mosquitoes.

During the second year of the study fewer dips were made in all study sites (63.2% in Kitebi, 55.5% in Kikulu, 83.9% in the Police Barracks and 61.1% in Loco Village (Figure 4.3)). Note in Figure 4.3 that Dips 1-3 occurred in the first year and Dips 4-6 were in the second year when interventions took place.

Figure 4.3. Larval surveillance in study sites.



Surveys 1-3 occurred in the pre-intervention year and Surveys 4-6 were post intervention. Black bars represent intervention sites and gray bars signify control sites.

These data suggest that there was a substantial drop in larvae in water bodies available in all study sites, particularly in the Police Barracks. The reduction in breeding habitats achieved in the intervention sites (Kitebi and the Police Barracks) was a direct result of the source reduction activities associated with the project. In contrast, the reduction in available habitat sites in Kitebi resulted from a decline in brick-making activities, especially a reduction in the number of newly dug pits. There was also a rapid growth of grass in this area and many small water bodies previously exposed to the sun became shaded, making these sites unsuitable for Anophelines. In the control site of Loco Village the decline in aquatic habitats occurred as a result of decline in agricultural activities in the neighborhood. This area borders a large area of papyrus swamp and many people were cutting down the vegetation to grow crops on the fringes of the swamp. During the intervention year many of these farming activities declined, resulting in fewer sites for anopheline mosquitoes to exploit.

The number of aquatic stages of anopheline and culicine mosquitoes collected during the study are shown in Figures 4.4 and 4.5, respectively.

Figure 4.4 Total number of aquatic stages of anopheline mosquitoes during the study period. Surveys 1-3 occurred in the pre-intervention year and Surveys 4-6 were post intervention. Black bars represent intervention sites and gray bars signify control sites.

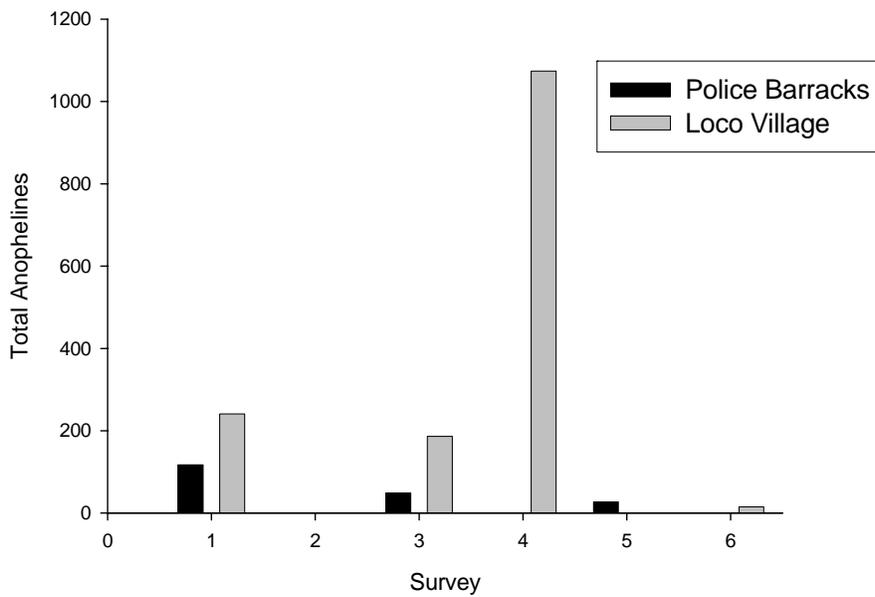
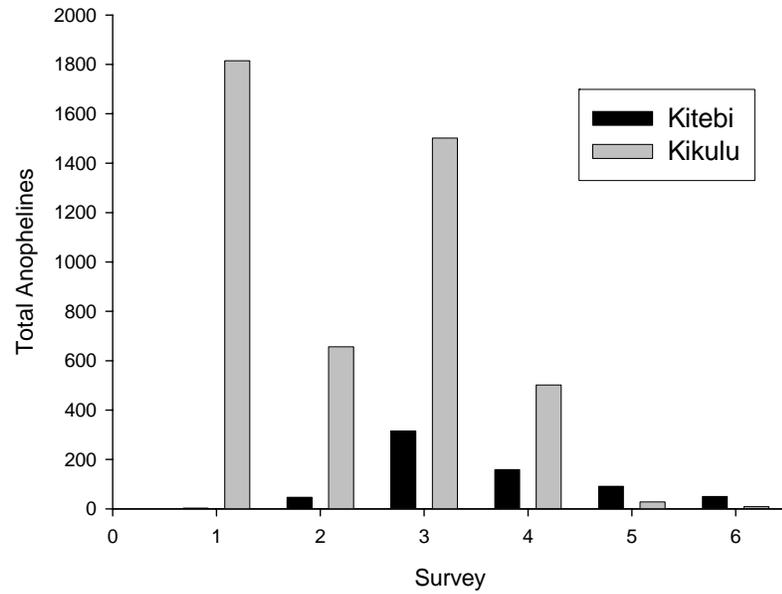
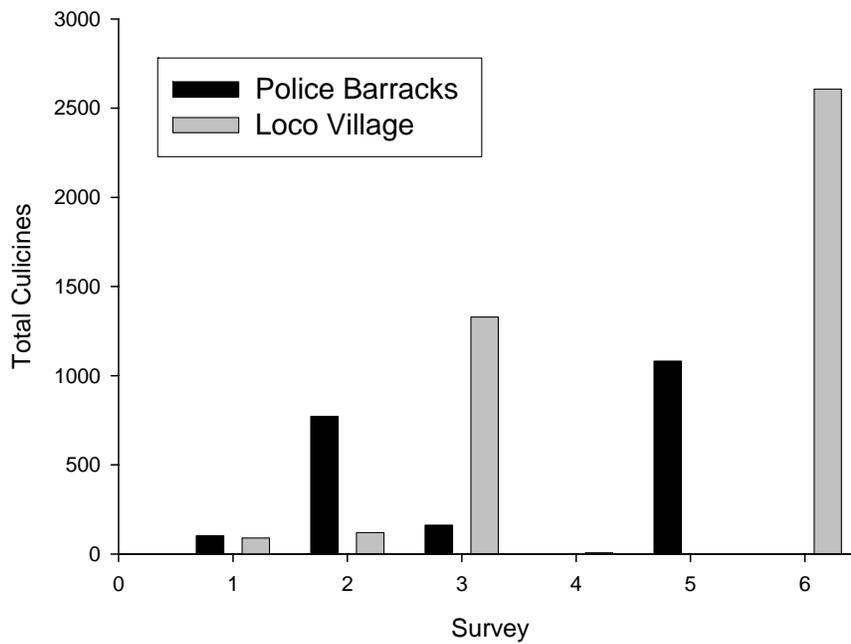
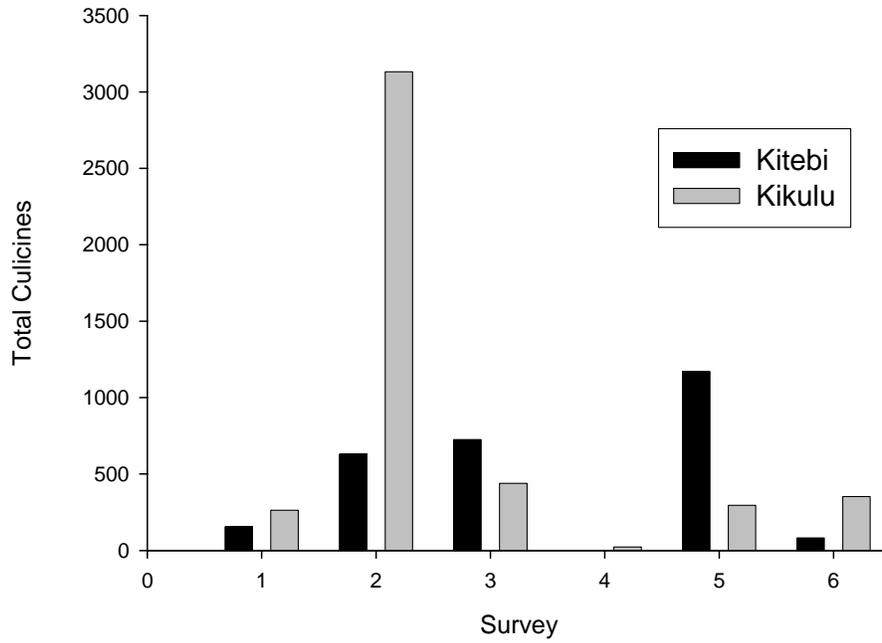
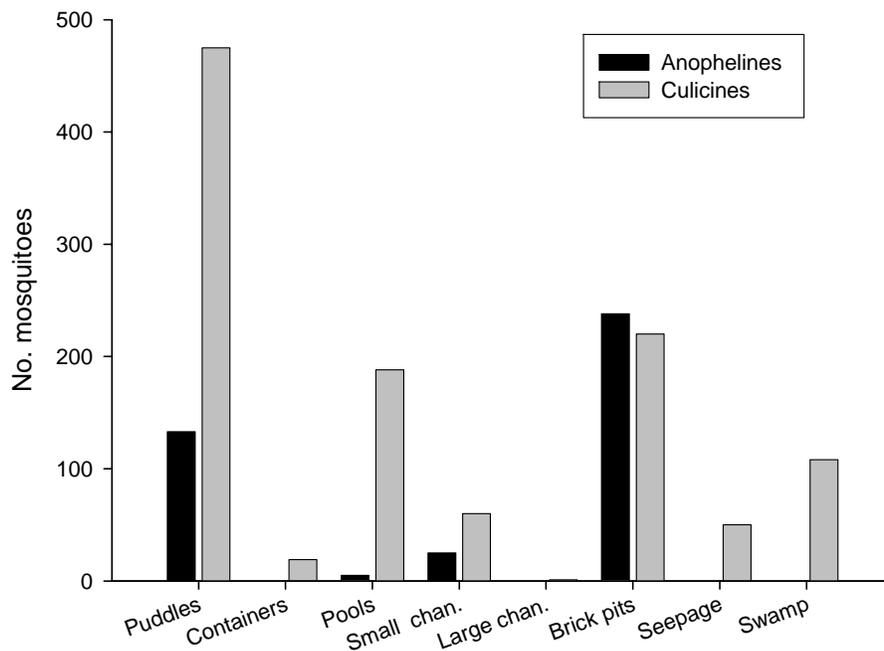


Figure 4.5. Total number of aquatic stages of culicine mosquitoes during the study period. Surveys 1-3 occurred in the pre-intervention year and surveys 4-6 were post intervention. Black bars represent intervention sites and gray bars signify control sites.

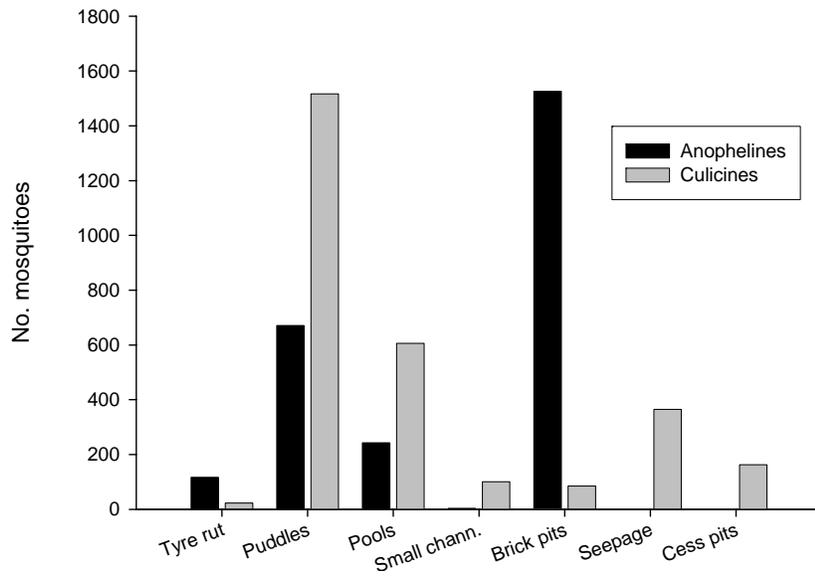


There was a general tendency for there to be fewer anophelines during both dry seasons (Surveys 2 and 5), although the numbers of culicines did not show this trend. This difference illustrates the affinity of *Anopheles gambiae* for ephemeral water bodies compared with the more persistent water bodies favored by culicines (Figure 4.6). It is characteristic of anophelines that the populations of aquatic mosquitoes can vary considerably from week to week. Thus the six surveys carried out in each study site over the two-year activity period do not represent a comprehensive assessment of larval densities, but are more “snapshots” in time. It was evident from the field surveys that there were much fewer breeding sites for anophelines in the intervention sites, particularly in the Police Barracks, where only a small number of mosquitoes were caught during the intervention phase of the activity. However, in all sites the aquatic stages of culicine mosquitoes were relatively common and were mainly associated with heavily polluted water resting in small water channels close to people’s homes.

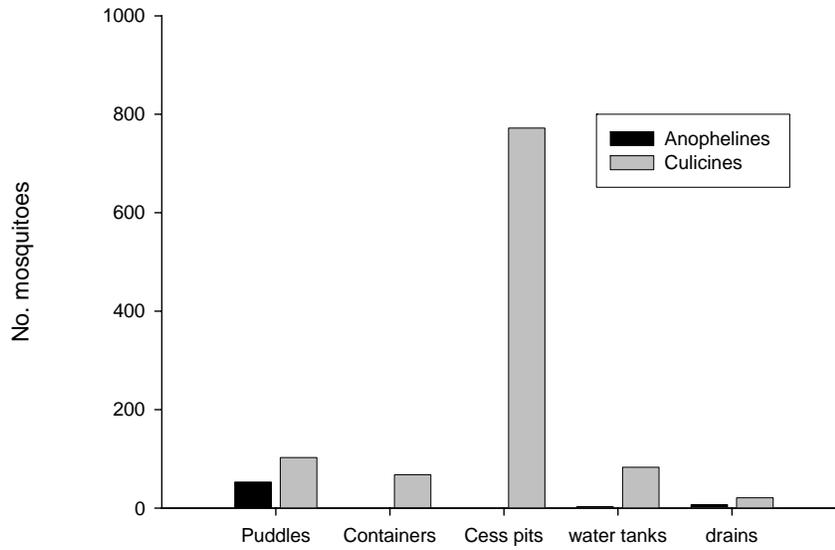
Figure 4.6. Most productive breeding habitats for *An. gambiae* Kitebi, Kampala



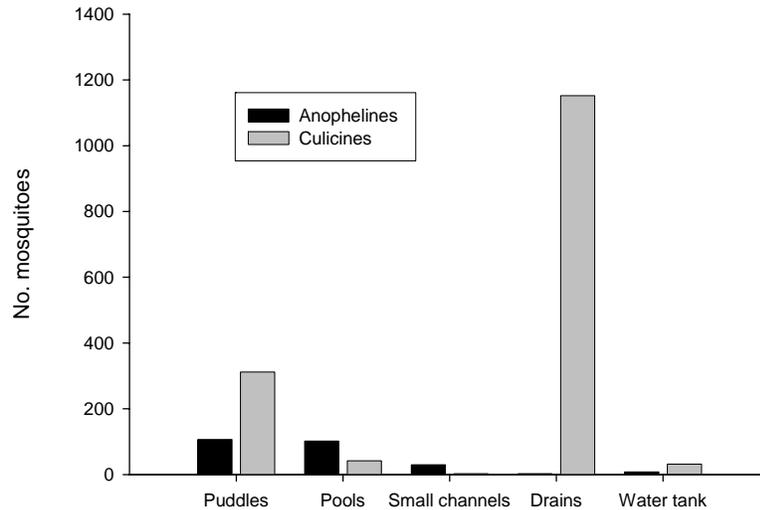
Kikulu, Kampala



Police Barracks, Jinja



Loco Estate, Jinja



4.3. Indoor-resting mosquitoes

The general level of exposure to malaria parasites is low in both cities (Table 4.1). In Kampala between 0.1 to 2.9 *An. gambiae* per house were collected during spray collections, while in Jinja this number was markedly less — with 0 to 0.4 *An. gambiae* being collected from the average house. Although the number of indoor-resting mosquitoes is low, around 11% of the *An. gambiae* collected were infective (i.e., in Kampala: 11.2% Kitebi, 10.6% Kikulu; in Jinja: 15.0% Police Barracks and 9.4% Loco), demonstrating a high rate of infection. Even fewer *An. funestus* were collected in Kampala, indicating the presence of permanently shaded breeding sites such as slow moving grassy-edged streams in this area. Only one *An. funestus* was collected in Jinja, a finding that shows that permanently shaded breeding sites were rare there.

In Kampala the number of *An. gambiae* collected indoors declined in both study sites during the intervention year, but the decline was greater in the intervention site (73%) compared with the control site (27%) (see Figures 4.7 and 4.8). A similar finding was found in Jinja, where the number of *An. gambiae* declined by 83% in the intervention site and by 11% in the control site.

Culicines are clearly a major nuisance mosquito in all study sites since they formed the majority of mosquitoes collected in the home. The population of culicines was relatively stable and appeared unaffected by the interventions aimed against them.

Table 4.1. Indoor mosquito collections. EM introduced into intervention sites before Nov 2003.

Survey date	GM <i>An. gambiae</i>	% infected	GM <i>An. funestus</i>	% infected	GM <i>Cx. quinq.</i>	GM All culicines	GM all mosquitoes
Kitebi, Kampala (intervention site)							
Nov 2002	2.1	9.9 (7/71)	0.25	0 (0/8)	6.7	16.0	19.3
Feb 2003	0.6	4.3 (1/23)	0.16	0 (0/7)	13.0	15.1	16.8
June 2003	2.9	11.7 (12/103)	0.20	0 (0/6)	21.0	23.5	27.8
Nov 2003	1.6	17.3 (9/52)	0.15	0 (0/2)	20.1	22.1	24.5
Feb 2004	0.1	25.0 (1/4)	0.21	0 (1/4)	22.1	26.1	26.7
June 2004	0.5	0 0/16	0.11	0 (1/4)	13.4	14.5	15.3
Kikulu, Kampala (control site)							
Nov 2002	0.8	12.0 (3/25)	0.14	20.0 (1/5)	2.3	2.6	3.5
Feb 2003	0.9	6.5 (2/31)	0.20	14.0 (1/7)	4.1	4.8	6.4
June 2003	0.6	11.1 (2/18)	0.27	0 (0/9)	8.0	8.4	9.5
Nov 2003	1.0	6.1 (2/33)	0.05	0 (0/2)	4.3	6.9	8.9
Feb 2004	0.3	55.6 (5/9)	0.30	0 (1/14)	6.1	7.4	8.6
June 2004	0.4	3.8 (1/26)	0.03	0 (1/4)	6.4	6.5	8.9
Police Barracks, Jinja (intervention site)							
Nov 2002	0.2	28.6 (2/7)	0	-	8.7	8.9	9.3
Feb 2003	0.0	0 (0/0)	0	-	12.4	11.4	11.4
June 2003	0.3	0 (0/9)	0	-	6.0	6.2	6.5
Nov	0.1	0	0	-	7.0	7.3	7.3

Survey date	GM <i>An. gambiae</i>	% infected	GM <i>An. funestus</i>	% infected	GM <i>Cx. quinq.</i>	GM All culicines	GM all mosquitoes
2003		(0/3)					
Feb 2004	0.0	0	0	-	8.2	8.5	8.5
June 2004	0.0	100 (1/1)	0	-	7.3	7.3	7.3
Loco, Jinja (control site)							
Nov 2002	0.3	0 (0/7)	0	-	22.6	23.5	23.8
Feb 2003	0.0	0 (0/1)	0	-	13.6	13.6	13.7
June 2003	0.3	11.1 (1/9)	0	-	29.0	34.9	34.9
Nov 2003	0.4	16.7 (2/12)	0.03	0 (0/1)	39.0	44.6	45.1
Feb 2004	0.1	0 (0/1)	0.0	-	24.5	24.5	24.5
June 2004	0.0	0.1 (1/1)	0		12.6	12.7	12.9

Geometric mean values are average number of mosquitoes/21 houses sprayed. *Cx. quinq.* is *Culex quinquefasciatus*.

Figure 4.7. Female *An. gambiae* collected indoors. Surveys 1-3 occurred in the pre-intervention year and Surveys 4-6 were post intervention. Black bars represent intervention sites and gray bars signify control sites.

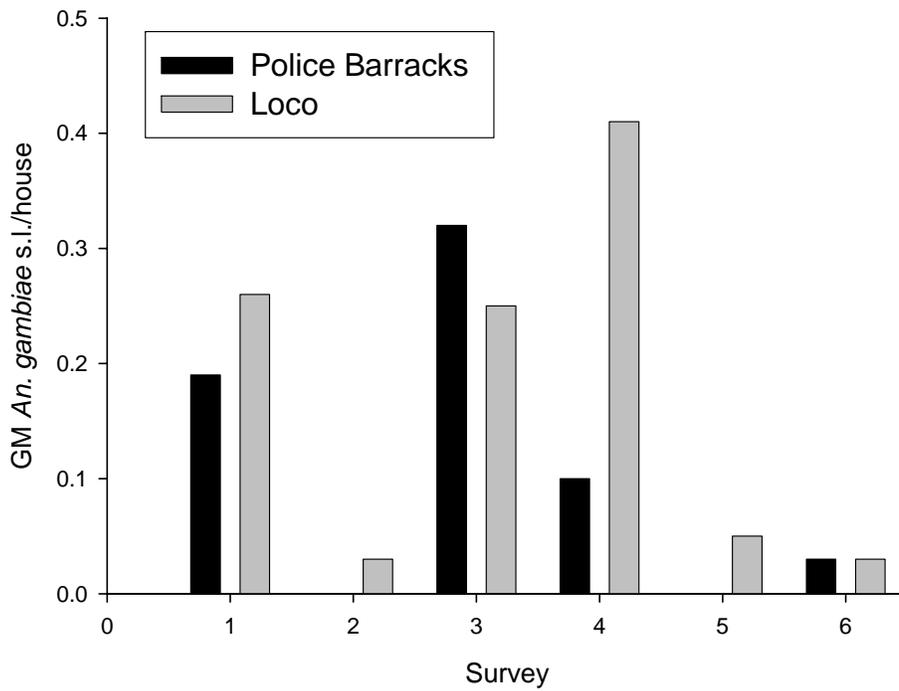
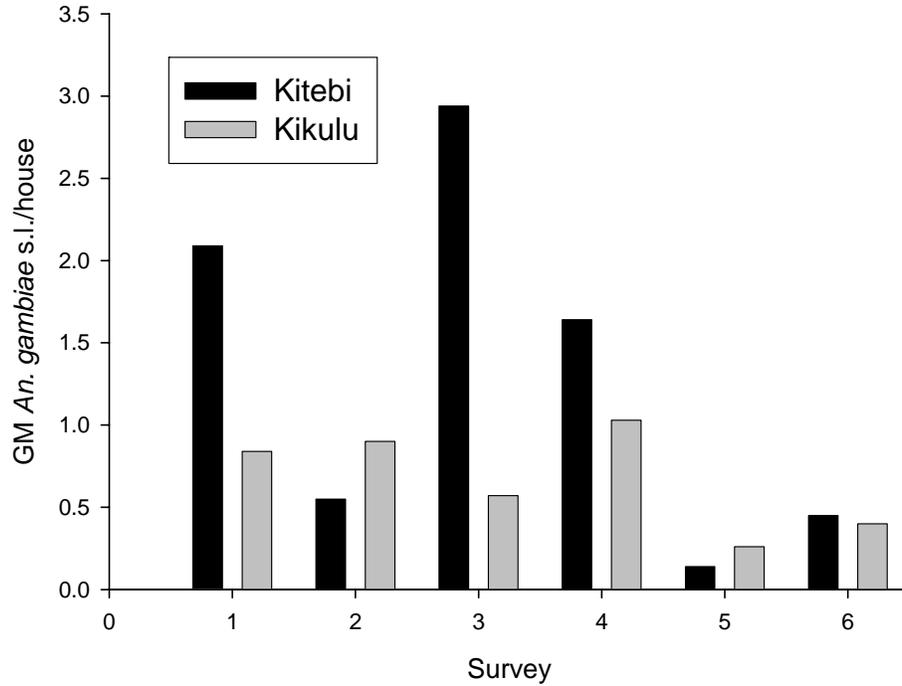
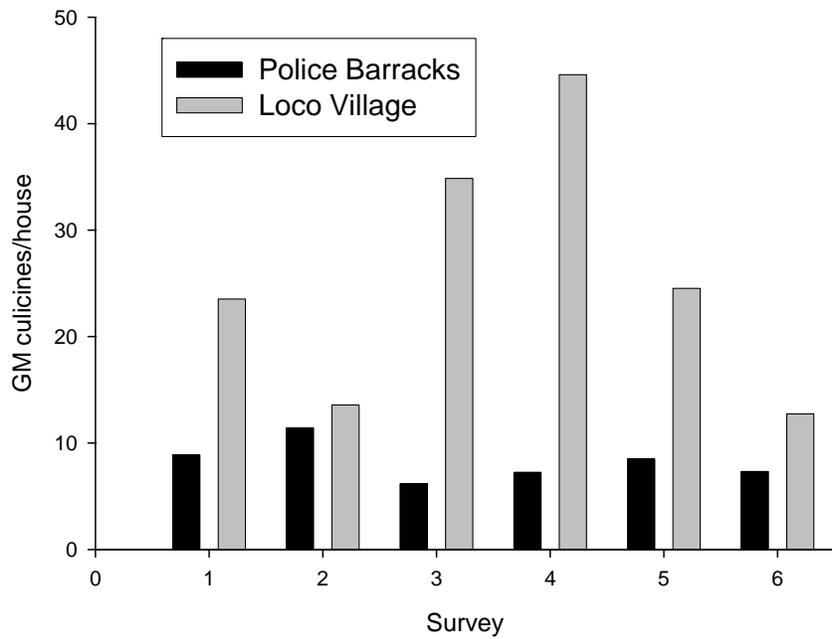
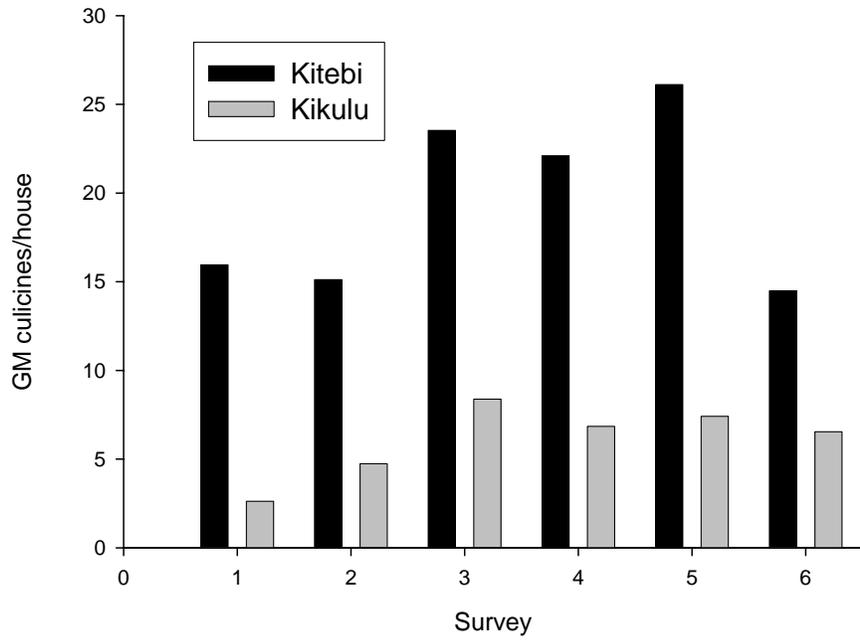


Figure 4.8. Female culicine mosquitoes collected indoors. Surveys 1-3 occurred in the pre-intervention year and Surveys 4-6 were post intervention. Black bars represent intervention sites and gray bars signify control sites.



4.4. Conclusion

These results provide evidence that where EM was practiced it reduced malaria transmission in the study communities. The number of aquatic sites for mosquitoes, the total number of anopheline larvae and pupae and the risk of being bitten by an infective mosquito (assumed to be equivalent to the number of mosquitoes found indoors) all showed evidence of declining in the intervention sites (Kitebi & Police Barracks) compared with the control sites (Kikulu & Loco Village).

This result is encouraging since although the study team had excellent community participation in the Police Barracks, Jinja, the number of anophelines found there in the pre-intervention year was very low, making it difficult to demonstrate a reduction in transmission associated with EM. In contrast, in Kitebi, Kampala, where the project found considerably higher rates of transmission, there was little community support for EM activities (for reasons discussed in Chapter 6). One would therefore expect a far greater reduction in malaria transmission in areas of moderate transmission where there was significant community support for source reduction. Moreover, if targeted larviciding with biocides was also carried out, even greater success would be achieved.

5. Clinical Findings

Results from the clinical surveys are shown in Table 5.1 and Figures 5.1.a and 5.1.b. Results from both locations indicate that the environmental management interventions were associated with a substantial reduction in malaria prevalence, although circumstances differ in the two cities.

In Kampala, results from surveys performed in the first year indicate that malaria prevalence was similar in the control and intervention sites. After the interventions were implemented in Kitebi, malaria prevalence dropped substantially in that community. Thereafter, malaria prevalence increased in both Kitebi and Kikulu, but the relative improvement in Kitebi was maintained, with 36% less malaria in the intervention site than in the control site. (Relative Risk: Year 1 RR = 1.05, $X^2_{M-H} = 0.08$, n.s. Year 2 RR = 0.64, $X^2_{M-H} = 9.19$, $P = 0.002$)

In Jinja, there was consistently more malaria in the control site than in the intervention site, but the difference widened during the intervention year. The environmental management interventions in the Police Barracks were associated with an 11% reduction in relative risk of malaria. (Relative Risk: Year 1 RR = 0.56, $X^2_{M-H} = 24.30$, $P < 0.001$. Year 2 RR = 0.45, $X^2_{M-H} = 53.61$, $P < 0.001$)

Figure 5.1.a. Malaria Prevalence in Kampala Study Site

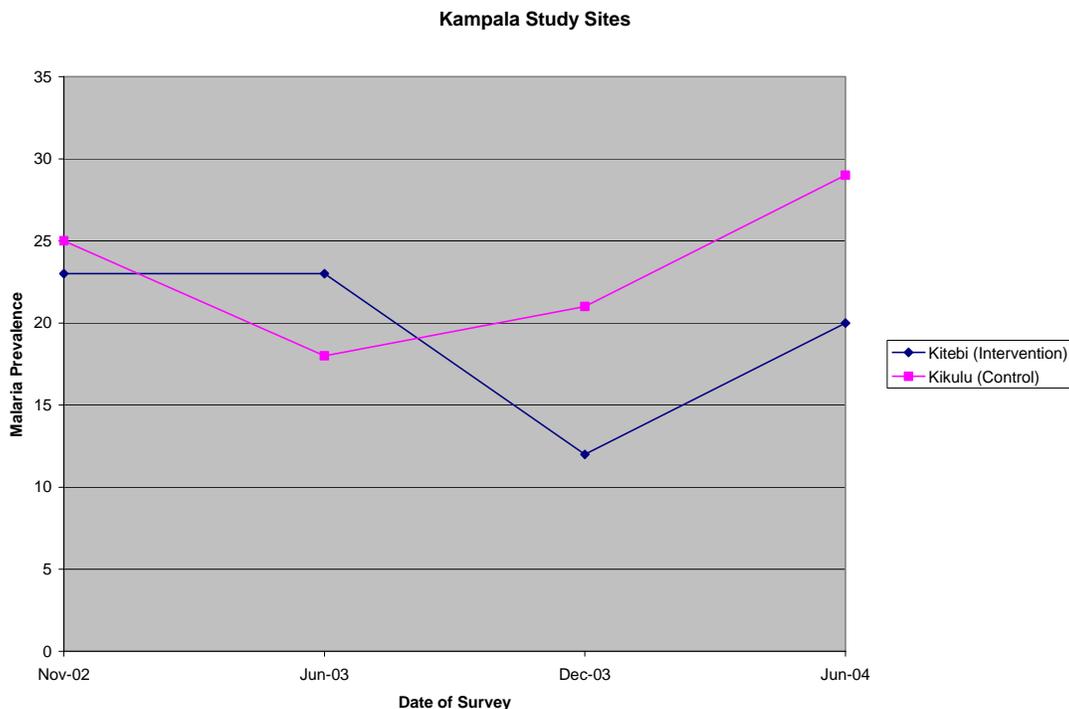


Figure 5.1.b. Malaria Prevalence in Jinja Study Site

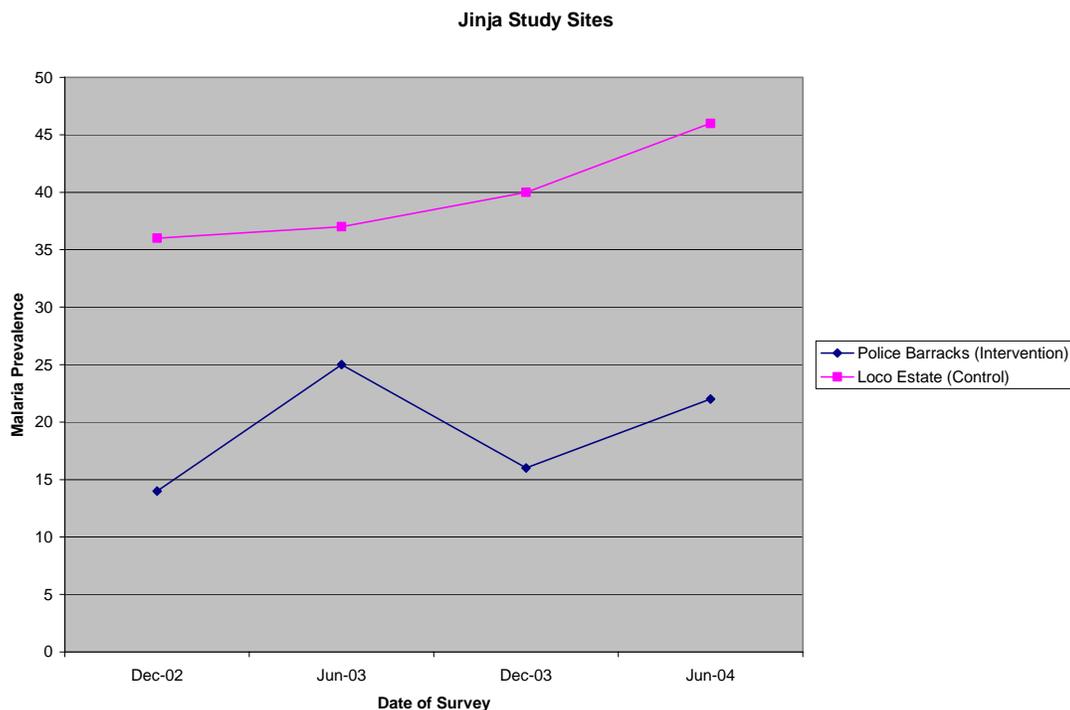


Table 5.1 Parasite infection rates in children. EM introduced into intervention sites before December 2003.

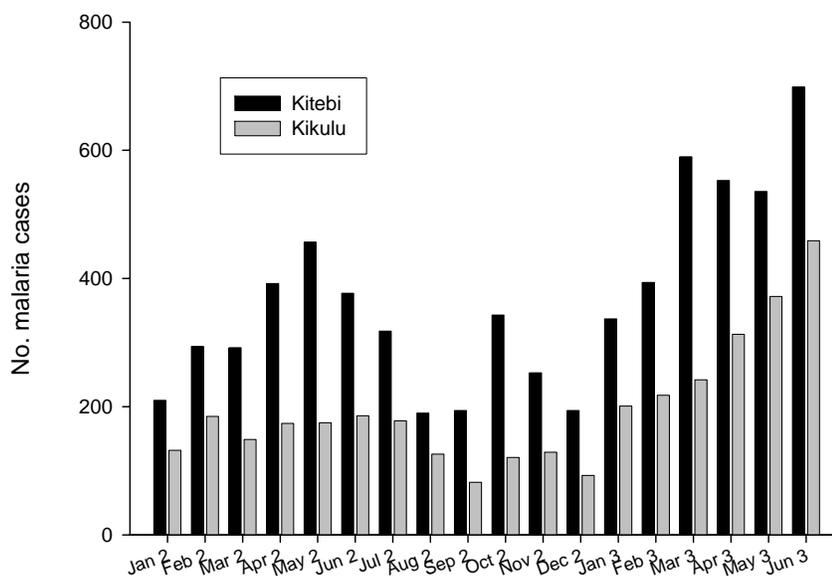
Survey date	No. bloodfilms taken	No. slides read	No. with parasites (Parasite prevalence)
Kitebi, Kampala (intervention site)			
Nov 2002	220	217	49 (23%)
June 2003	209	204	47 (23%)
Dec 2003	212	212	26 (12%)
June 2004	203	201	40 (20%)
Kikulu, Kampala (control site)			
Nov 2002	157	151	38 (25%)
June 2003	151	150	27 (18%)
Dec 2003	189	186	39 (21%)
June 2004	190	182	53 (29%)
Police Barracks, Jinja (intervention site)			
Dec 2002	237	228	32 (14%)
June 2003	232	232	59 (25%)
Dec 2003	214	210	34 (16%)
June 2004	232	229	50 (22%)

Survey date	No. bloodfilms taken	No. slides read	No. with parasites (Parasite prevalence)
Loco, Jinja (control site)			
Dec 2002	152	152	54 (36%)
June 2003	176	176	64 (37%)
Dec 2003	188	185	73 (40%)
June 2004	191	188	87 (46%)

The study team also obtained data from clinics in Kitebi and Kikulu that recorded the number of outpatients with malaria each month. Malaria cases were recorded throughout the year with peaks in June. The data appear to reflect the same general pattern seen in the prevalence surveys, with a substantial reduction of cases in Kitebi when the interventions were first implemented, followed by an increasing trend in cases in both neighborhoods.

However, the findings should be treated with caution since the diagnoses are based on febrile patients coming to the clinics, without confirmation by microscopy. Furthermore, these data show a higher number of malaria outpatients coming to the clinic for treatment in Kitebi than in Kikulu, which could reflect a higher willingness of Kitebi residents to seek treatment or that the location of the Kitebi clinic makes it more accessible to the residents of Kitebi and adjacent neighborhoods.

Figure 5.2. Clinical cases of malaria in Kampala clinics



6. Social Science Findings

In order to assess the how well people in the intervention communities understood the nature of the EHP activity, how well people participated in these activities and to identify obstacles to these activities, the team conducted a series of qualitative and quantitative surveys.

6.1. Respondent characteristics

The characteristics of people interviewed during the social science survey are shown in Table 6.1. More women were interviewed in the Police Barracks than in Kitebi. The age distribution, family size and education level were similar in both communities. However, fewer parents reported that their child had malaria in the last three months in the Police Barracks than in Kitebi.

Table 6.1. Characteristics of respondents in the intervention sites in Kitebi, Kampala, and the Police Barracks, Jinja

Characteristic	Kitebi (n = 55)	Police Barracks (n = 50)
Female	28 (58%)	40 (80%)
15-24 years	12 (23%)	18 (36%)
25-34 years	17 (32%)	23 (46%)
35-44 years	9 (18%)	5 (10%)
45 years or older	17 (32%)	2 (4%)
Married	39 (72%)	36 (73%)
Family size, 1-3 people	11 (21%)	11 (22%)
Family size, 4-6 people	25 (47%)	18 (36%)
Family size, 7-9 people	8 (16%)	14 (28%)
Family size, >9 people	3 (7%)	7 (14%)
Primary education	26 (49%)	8 (16%)
Ordinary level education	19 (36%)	19 (38%)
Tenants	11 (20%)	50 (100%)
Child reported to have had malaria in last 3 months	39 (71%)	22 (44%)
Child without malaria	16 (29%)	28 (56%)

6.2. Knowledge, attitudes and practices regarding EHP intervention activities

6.2.1. Kitebi

Knowledge

Overall, 80% of respondents knew about the project (44/55). Of these, 25% did not directly relate it to malaria control (11/44) but thought it was designed to improve the environment. Thirty-two percent of respondents learned about the project from observing the various activities that were taking place (17/55), 27% obtained information from the local council leaders or coordinators (14/55), 12% from community meetings (6/55) and others from radio and posters. Ninety-eight percent of the people said they had been affected by malaria and knew mosquitoes spread the disease (53/55).

Attitudes

People welcomed the project and appreciated the activities, especially, cleaning of drainages, filling puddles with murrum, promoting health of the community and above all, controlling malaria. However, few people were actively engaged in these activities. People recognized that the project had benefited them by reducing water logging, filling up puddles and brick pits where mosquitoes breed and increasing their knowledge on how to prevent malaria. Therefore, they acknowledged that the intervention was useful although it was felt that more effort was needed to control stagnant water, sensitize and involve the entire community, remove puddles in gardens, provide more murrum and expand to other areas.

As a result of the intervention in Kitebi, 72% of respondents thought that there were some observable changes in the community's environmental health since the project started. This was evident in the cleaner environment (39/55); improved drainage; and reduced puddles or water logging. People considered these important improvements, but also felt that health should be improved by having and maintaining proper latrine facilities and improved garbage disposal (43%; 23/55, respectively). The people also emphasized the importance of having a clean home and work place and constructing buildings and latrines away from water channels.

Sixty percent of the respondents thought that the local council leaders should be the ones carrying out the EM work themselves (33/55), and only 16% said that the responsibility lay with individual households/community members (8/55). The remainder thought that the landlords and Kampala city council should be responsible for these efforts.

Practices

Only 30% of respondents reported that they had participated in the project in the last six months (17/55). Fifteen percent had participated in spreading murrum (8/55), 15% in clearing drainages (8/55) and 70% had not participated at all (39/55). Nonetheless, 85% had taken some action to help reduce malaria in their homes (46/55), mainly through sleeping under insecticide-treated bednets

(ITNs; 43%, 23/55). Thirty-four percent had used both ITNs and EM (18/55). Only 5% had relied solely on EM (2/55). Others used indoor residual spraying, mosquito coils and preventive drugs.

6.2.2. Police Barracks

Knowledge

Forty-six percent of respondents understood the objective of the project (23/50), and 33% said it sought to improve the appearance of the environment, without directly relating this to malaria control (16/50). Most people (51%) obtained information about the project from the officer-in-charge of the Barracks and from health promoters (25/50), 9% from community meetings (4/50), and others from posters and through observation. Ninety-eight percent acknowledged that there were observable changes in the community's environmental health since the project started (49/50). These changes included a cleaner environment, less mud or dust as a result of grass cover, reduced flooding because of improved drainage and construction of soak pits, fewer mosquitoes and reduced soil erosion. Community values or priorities regarding environmental health were similar to the goals of the project.

The most common sources of knowledge on malaria included the health promoters, radio, newspapers, community meetings/seminars, hospitals, clinics, posters and schools.

Attitudes

Respondents appreciated the EHP project since it aimed at mobilizing people to do something for themselves. It was felt that the objective, to reduce the incidence of malaria using EM, was particularly beneficial. One key informant said, "*Before, people were struggling to cure malaria with doses of drugs so EHP's strategy was good because it was a cheap intervention.*" In the initial stages of the project, however, most people did not relate the activities directly to controlling malaria, only to improving the cleanliness of the barracks.

People perceived the project as having become part of their routine, carrying out EM activities every Saturday morning. To keep them engaged in the EM activities, they were closely supervised. The men were usually involved in their police duty so the women did most of the work around the house. Although most people appreciated the changes that were made to the surroundings, they felt that these activities should have been extended to have covered the entire police barracks.

Responsibility for maintaining the health of the environment in their area lay mainly with the residents, community members, the officer-in-charge (OC barracks) and health promoters. Thus, in order to achieve good environmental health the community engaged in cleaning the compound every week, cleaning inside the houses, disposing of garbage, removing stagnant water, slashing tall grass, cleaning water channels, sweeping, maintaining soak pits and latrines, and planting grass.

The community observed that the responsibility for mobilizing people to participate in community activities lay with the OC Barracks/health promoters and with the people themselves. The health promoters were visible in the community, and their efforts were much appreciated.

Practices

Most community members (80%) took an active part in EHP activities, planting grass and clearing drainages during the last six months (40/50). They participated both with their families and neighbors and as a larger community.

Ninety-eight percent of people had taken action to reduce malaria (49/50) and all acknowledged that they had been affected by malaria in one way or another, in terms of hospital costs, lost hours of work or the death of loved ones. The most common methods of malaria control included sleeping under ITNs, indoor residual spraying, maintaining a clean environment, slashing grass, closing windows early in the evening, removal of stagnant water and use of antimalarial drugs.

6.3. Factors influencing the community's participation in EHP activities

Kitebi

The people who participated in the various EHP activities were motivated by:

- A desire to control malaria
- The need to improve drainage and reduce flooding especially during the rainy season
- The need to clean the filthy drains
- The fact that murrum was provided without charge

In general the level of community participation in EM activities was low in Kitebi. The reasons included:

- Lack of information
- Poor mobilization by coordinators
- Suspicion that coordinators were being paid, while the community was expected to participate without compensation
- Lack of incentives (e.g., money, gloves and gumboots)
- Insufficient time to carry out EHP activities
- Activities by coordinators were not scheduled and therefore interfered with people's work
- Tools bought by the project were held by local leaders and were rarely provided to the community
- People did not like the fact that much of the murrum intended for filling small depressions along the roads was used by community leaders for improving their own compounds
- Lack of interest in the project
- The work was too dirty for them to undertake
- Tenants expected the landlords to carry out these activities

- Reliance on alternative methods of mosquito control, such as ITNs
- Some people did not see a reduction in the number of mosquitoes
- Political interference, i.e., the local councilor at the sub-county level threatened that the tenants in Kyondo zone (where EHP and the KCC engineer had filled the brick pits with murram and the land was leveled) would be evacuated and a school constructed on their land.

The community leaders believed the low level of participation was insufficient to carry out the EM activities. Many people left their homes early in the morning and came back very late at night. In addition, many residents were young people and did not want to do the hard and dirty work required by the project. Coordinators also felt that they had limited time because they also had to earn a living. No one volunteered to clean the large drainages because they thought it was the responsibility of KCC and the LCs (local councils). One individual observed, *“The coordinators were not trained in volunteerism, and that experience had also shown that the community could not contribute money towards the maintenance of the drainages.”* Cultural beliefs also hindered participation, i.e., some men stopped their wives from taking children for assessment in the clinical surveys because they did not think it was important.

One coordinator remarked, *“In the urban areas, people depend on hand-to-mouth living and have not been sensitized about the project and volunteerism in particular. The people do not trust their coordinators to tell the truth. The problem is on the side of both EHP and the coordinators. EHP should be sensitizing the people and not the coordinators because when the latter stand up to speak, people do not believe them.”*

The distrust between the community and their leaders seemed to be the most important factor hindering community participation in Kitebi. Six months into the intervention one leader said, *“The EHP team should be there when the coordinators are working with the community because without them the community will not respond.”*

Police Barracks

The residents clean the barracks every Saturday morning, part of the standing orders of the officer-in-charge. The EM activities were added to this established procedure. In addition, there were several factors that motivated the community to participate in the various activities.

- People understood the purpose of the project, i.e., to reduce the prevalence of malaria using EM
- They were aware of the dangers of malaria
- They were glad to have a partner in malaria prevention
- They wanted a home with grass to reduce soil erosion
- They wanted to reduce the spread and cost of malaria
- Compounds smelled from the filled soak pits
- Some saw an intrinsic value in keeping their environment clean
- A few had to be forced to do something

However, there were a number of obstacles that hindered community participation in the EHP activities, including:

- The dry season killed the young grass seedlings
- Destruction of new drainages by the children
- Destruction of grass by termites
- Poor garbage disposal
- Limited materials, e.g., gloves and rakes
- Fear of being transferred to another barracks
- Lack of ownership/tenancy
- Suspicion that health promoters were getting money
- Lack of interest in EM activities
- Lack of perceived immediate benefits
- Top to bottom planning that had long characterized the district administration
- Lack of a long-term vision stemming from a culture of hand-to-mouth living in urban areas

6.4. Contribution of coordinators to the EHP project

Kitebi

The coordinators for this project were established members of the local governing committee in Kitebi. They decided that their responsibilities were to inform the community about malaria and EHP activities, mobilize people to clean drainages and maintain a clean environment, and supervise and monitor project activities. However, the community widely believed that the coordinators should also take part in cleaning exercises.

People were generally mobilized using door-to-door messages, letters, meetings, loudspeakers. Sometimes the leaders physically took part in the activities. However, mobilization was affected because, according to one community respondent, the leaders tended to “*go where they expected money and had been weak and quite pushy, failing to explain to people the intentions of the project.*” They also failed to set days for community work and adhere to them. Even when they did the cleaning themselves, they did not usually complete the work. Some people pointed out that the project had been let down by coordinators not properly fulfilling their roles. Thirty-nine percent of the people did not even know who the coordinators were (21/55).

One coordinator agreed there were issues, “*Each coordinator has his area of responsibility, but we have been working together irrespective of the areas of jurisdiction. It is true that the coordinators did not take the responsibility of sensitizing the community. We agreed to meet every Thursday and clean the drainages, but we did not put this into practice. The relationship between the coordinators and the community has not been good.*”

The coordinators went on to explain that one major problem that emerged was the community was difficult to deal with from the outset because community members expected money for their work. Tenants did not care about the project, so the coordinators depended on the few landlords to clean the drains. Most people failed to understand that the project sought to promote — and indeed depended on — volunteerism, while also believing that the coordinators were being paid. The project team was also confused with the local council team since the project was based at the LC level and some responsibilities overlapped.

Police Barracks

Health promoters mobilized the community to participate in the various EM activities, informed them about the dangers of malaria and how they could prevent the disease. They moved from door-to-door mobilizing people to participate in general cleaning every Saturday. Sometimes they blew the whistle to attract attention, scheduled activities well in advance or used standing orders. Other methods included parades and community meetings. Overall, the health promoters engaged in and personally took part in community activities. One health promoter confirmed this, *“You see at times when the barracks administration is not there, these people do not listen to us, so we go ahead and do the work. They also think that we are benefiting financially.”* Health promoters made regular home visits during the study to help ensure that the changes in cleanliness and health of the barracks were maintained. One health promoter further observed, *“Before EHP came, Saturday was the day for cleaning, but it was not as much as it is today after the EHP intervention.”* Importantly, it should be noted that community leaders were reluctant to directly approach the engineer when problems arose and they had to go through the EHP team, who would then inform the engineer. Nevertheless, the engineer always responded positively.

The views of the community leaders and municipal authorities about the project generally were similar to those of the community. This can be attributed to the good working relationship between them. However, one key informant noted that before EHP’s intervention, none of the people in the barracks had approached the responsible municipal authorities to ask them to provide grass, something that other communities had done. They thought that they were not allowed to do anything on government property. He further noted that communities in Jinja responded to health messages more than anything else and that EHP came just in time to complement the common messages, i.e., use of mosquito nets and seeking treatment for malaria. There was still, however, the need to appeal to people’s attitudes by emphasizing that prevention, through EM, was better than having to seek treatment after being infected.

6.5. Conclusion

EM activities in the Police Barracks were a model of community participation. The activities were taken up with great enthusiasm and dedication. They were carried out routinely and successfully, with the considerable support of the district and municipal health authorities in Jinja. In marked contrast there was a general reluctance in the Kitebi community to participate in the EM activities. People expected the project to provide them with financial benefits and for all activities to be carried out by the EHP team, Kampala City Council or landlords. Although this was a community-based project, little progress was made during the intervention using volunteers to carry out the work. The EHP team therefore decided to provide token payments to key individuals in late January

2004 to try to stimulate activity over the first three months of the intervention year. This effort proved unsuccessful. There were many sites in Kitebi where water stagnated in and around people's homes, and there was little community support to improve drainage at these sites.

7. Recommendations

Figure 7.1. Unblocking drains in Kitebi, Kampala



7.1. General recommendations for environmental management

One of the main objectives of this activity was to consider the feasibility of expanding this program in Uganda if it proved to be successful. This pilot study provides evidence to suggest that EM successfully reduced the number of anopheline mosquitoes in intervention sites and may have contributed to a reduction in malaria infection in young children. This occurred both in the Police Barracks in Jinja, where there was strong community and municipal authority involvement, and in Kitebi, where there was little community participation in EM activities.

In two workshops in Kampala and two in Jinja at the end of the activity the EHP team and local stakeholders discussed the lessons learned from this activity and ideas that could be used to expand this project in the future. The recommendations are summarized on the following pages.

7.1.1. Identify good leadership

EM activities can only be successful if the leaders and community members think it is a good idea. In this study, one of the two intervention sites suffered from weak leadership, which became one of the prime reasons for the lack of community involvement. In the future greater efforts must be made at the beginning of the activity to identify good local leadership that has strong community support. One approach might be to identify NGOs already working with urban communities to seek their help in identifying active communities. If this is not possible, the LC1 leaders could be asked to arrange a community meeting to discuss the problem of malaria in the community. The number of people who attend this meeting would provide a good indication of local interest. Once a community is identified, it is important to gain the support of the appropriate LC2 or LC3 leaders who could help support the project and encourage the community throughout the life of the activity.

7.1.2. Community participation

For EM to be successful it is important to engage the community in the decision-making processes at every opportunity. This is particularly difficult in urban settings where social structures are weak since the community is diverse and family connections are limited. Although the current project sought to engage the community, the process was a slow and lengthy one that could not be rushed. In retrospect it would have been better to have a social scientist engage the communities from the outset. EHP did retain a social scientist midway through the first year, but the study sites had already been selected.

Considerable time should be spent with the local community, building support and explaining the nature of the activity. Three different social scientists worked in this study during the course of the two-year activity. Although these individuals were extremely competent, the change of personnel may have presented a disjointed picture of EHP activities. A better approach would have involved spending more time with the communities at the start of the project to help establish a stronger relationship between the EHP team and the community.

7.1.3. Study support

EM activities should be based on current structures within the community and in local government efforts. Parallel systems are unlikely to be sustainable in the long-term and will complicate relationships among key parties.

7.1.4. 'Volunteerism' versus monetary rewards

There was considerable discussion among the EHP team and during the workshops about whether EM could be sustained on a voluntary basis or whether people need to be paid for this activity. The communities with which the project worked are extremely poor and have little time for anything other than the daily grind of finding a means to survive. The study team believed that the best way to make EM sustainable is to provide an incentive for individuals to participate. The alternative view was that EM, like many community services, should be based on voluntary work. While this approach is favored by many, there are few success stories that result from it, particularly in urban areas where communities are often weak and fragmented. In these situations the logic of "why

should I do the work for my neighbor if my neighbor doesn't do the work for me?" can prevent or destroy the possibilities of "volunteerism." Yet there are situations where volunteerism can work. For example, in Jinja, EM was successfully conducted in the Police Barracks where there was an established framework for cleaning.

If any future program bases its approach on a voluntary system, it must define the precise nature of this approach to everyone involved from the beginning of an intervention. Otherwise, people may perceive it differently and some may expect to be paid for their services. The study team assumed that voluntarism would be understood and practiced, but that was not the case in Kitebi.

7.1.5. Income generation

Even if EM is based on "volunteerism," there will remain a need to generate a small amount of money to pay for repairs and purchase new equipment, e.g., rakes, spades and wheelbarrows. If additional money can be generated beyond those requirements, small payments could be made to those individuals most active in EM.

One model for implementing EM is through established youth groups within the community. In this case, youth groups are identified and sensitized to inform them about the importance of improving the local environment for their own health. These young people could be encouraged to carry out cleaning and repairing drains for a small payment. Payment would be made by local village committees, directly from residents, from proceeds gained by manufacturing cooking fuel briquettes from collected waste or some combination of all these. If these groups develop and expand they may eventually be funded either directly from the LC3 budget for waste removal or sub-contracted to private companies who carry out waste clearing paid by the local municipal authorities. In essence the youth groups would collect rubbish and clear drains, while the private companies would use their trucks to collect the waste from the community. Using youth groups has been the goal of Uganda Living Earth, which has been operating in Kampala for the past five years (see www.livingearth.org.uk). If this approach is considered viable Uganda Living Earth, or similar NGOs, should be brought into discussions at an early stage before any future activities are undertaken to learn from their experiences.

7.1.6. Activating by-laws

Many old by-laws exist that are designed to prevent people from obstructing drainage channels or creating potential mosquito breeding sites, but these are rarely, if ever, enforced. Local politicians and environmental health officers should be encouraged to review and possibly implement these powers.

7.1.7. Development of community-led action plan

In order to help build consensus and develop an action plan, the project conducted three workshops with key players during the first year of the study including representatives from the Ministry of Health, municipal authorities and local communities. While these were essential activities, the social structure that exists in Uganda limited a free interchange of ideas among participants. In particular, community members did not speak freely in front of senior leaders. Therefore the third

workshop was conducted in the communities themselves with two EHP team members acting as facilitators. In order to develop an action plan the options for control should be presented at a community meeting, while giving the community members sufficient time to consider these options. For example, a community may decide to have a follow-up meeting among themselves, before reporting back to the EHP team with their detailed plan. The important point is to allow communities sufficient time to discuss issues in depth before developing a plan of action.

7.1.8. Malaria engineer

It is strongly recommended that the role of a “malaria engineer” be created in Kampala for vector control. This position would recommend approaches to reduce the breeding of mosquitoes in all major engineering projects planned for Kampala City. Anyone in this position would require training in public health entomology and should also train engineers at the divisional level to reduce malaria transmission through source reduction. Such a post would offer significantly new opportunities for malaria control in Kampala and other cities in malaria-endemic countries.

7.1.9. Larval control

EM in communities like those in Kampala and Jinja is unlikely to be sufficient to reduce anopheline breeding to levels that would make a substantial contribution to a reduction in malaria transmission. Therefore, it is recommended that larval control using biocides, such as *Bacillus thuringiensis var. israelensis* and *B. sphaericus*, be considered for inclusion in urban control programs. These are effective and safe larvicides that will help reduce mosquito breeding to very low levels. The mechanism for such larval control programs may be from NMCP, health inspectors or local communities.

7.1.10. Culicine control

Despite attempts to reduce surface water in Kitebi and the Police Barracks, Jinja, large numbers of culicine mosquitoes were still found in people’s houses after the interventions. One important source of culicines probably overlooked by this project were those being produced in pit latrines, which are well known sources of culicines. Therefore, in future projects these latrines should be targeted for control. It is vitally important to control all mosquitoes in a community to reduce the biting nuisance, since many people will not understand the concept that only some types of mosquitoes actually transmit malaria. If they continue to be bitten by mosquitoes, they will consider that the EM controls failed.

7.1.11. EM should be a part of a broader health agenda

One way to increase the chance of EM’s long-term sustainability is to integrate these activities with efforts already associated with improving living conditions and a healthier life, such as the provision of clean drinking water and improved sanitation. EM can then be seen as part of a larger solution encompassing the provision of a healthier and cleaner environment in which to live. Opportunities should be explored to link the mosquito abatement activities of EM with water and sanitation projects in Uganda. Efforts should also be made to investigate whether government or NGOs are conducting such activities in any potential future study site.

7.1.12. 'Healthy homes' for schools

To help ensure the success of EM for malaria control in urban settings, the younger generation needs to be educated about the benefits of a healthier lifestyle. School children should learn about healthy living through a curriculum and specific activities that drive home key health messages. One specific technique might be the use of a model healthy home. This miniature home would be built by school children on the school grounds, constructed in the style of a local house but with added features that would help ensure that it is a healthier home, such as piped water, a VIP latrine, closed eaves, screened doors and windows, a separate kitchen, etc. This building could be built as part of a school project and, when completed, used as a clubhouse by the children or for other school activities.

7.1.13. Memorandum of understanding

In order to ensure from the start of the activity that everyone clearly understands their roles, a memorandum of understanding should be produced, not just for each EHP team member, but also all key players, including representatives from the MOH, local councils and communities. This may help increase the prospects for sustainability of the EM activities at the end of the EHP activity.

7.2. Recommendations for future EM activities in Uganda

The team recommends that expansion of EM should be targeted at malaria control in Jinja. Malaria is a major public health problem in this city and local people are interested in controlling this disease using EM. Importantly, the local health authorities and district and municipal councils are also committed to helping reduce malaria in the city. Identifying suitable sites for EM in Jinja and ways of paying for EM should be explored carefully over a 12-month period. Working in cities is a complex undertaking, and it is important that all stakeholders be informed about this activity and that their views on the best ways to proceed are solicited. A series of workshops, similar to the one described in this report, were successful in Jinja and a similar approach should be adopted for all future work.

Care must be taken to identify active communities and groups within the city. EM is a difficult initiative and will work only where groups of people are committed to implementing these services. The team also strongly advises that assistance for this intervention should be sought from NGOs, like Living Earth Uganda, who work closely with communities by providing health services for local people. Such organizations may prove to be ideal for launching EM activities, since they have many years of experience in developing health services at the local community level. This work needs to be tied closely to the efforts and plans of the city health department and city engineer in Jinja. Both are essential players in this activity, are professional and are interested in developing EM in their city.

If possible, the city engineer should provide technical assistance for any large-scale drainage, or filling. Grass planting may be necessary to prevent silt from being washed into drains, and the local agricultural officer could provide assistance with this effort. The practicalities of using youth groups

to clear small drains, fill small puddles and plant grass should also be explored. The best mechanism for spraying *Bacillus thuringiensis* on larval breeding habitats that are difficult to control by EM also must be considered, with actions implemented by community groups or by the local vector control officers of the health department.

Most of all, it is critical that any planned intervention be developed by the community members themselves, guided by the local health authorities and relevant experts. It is important to provide local communities with ownership of these activities to help them create a healthier city.

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Appendix A

Standard Operating Procedures (SOP)

Blood slide collection and staining

Two slides will be made for each child. On each of the slides a thick and a thin blood film will be prepared for parasitological examination.

Preparation of thick films

- Clean finger with cotton swab soaked in antiseptic (methylated spirit) and dry with dry cotton wool
- Puncture ball of finger with sterile lancet
- Apply gentle pressure and collect 3 drops (about 1.5 ml) adjacent to each other
- Using the corner of another slide quickly spread drops of blood to form an evenly spread film of \cong 1 cm in diameter
- Make two identical films
- Dry in air or using a hair dryer
- Label on the frosted end using a lead pencil or a diamond pencil for slides that are not frosted
- Protect slide from flies and dust
- Good thick films should be thin enough to allow a print to be read through
- Stain promptly to avoid autofixation

Staining thick films

- All slides will be stained with Giemsa
- Staining will be done using vertical staining jars
- One of the slides will be stained by the rapid Giemsa method (10 minutes with 10% Giemsa). This will be done the same day and the results given to the child and the clinician so that appropriate treatment is given.
- The other slide will be stained using the standard method (30-45 min by 3% Giemsa) and this will be done after 24 hours. Once the slides are dry, pack them in the slide boxes.

NB: Slides must not exceed 72 hours without staining to avoid auto fixation.

Washing slides

After staining, all slides will be washed by gently flooding the slides with clean water. Ensure that the stains are not washed off. Washing of slides by dipping them in clean water is not recommended.

Making 10% Giemsa solution

To make 100 ml of 10% Giemsa, pipette 10 ml of stock Giemsa solution provided, add 90 ml of buffered de-ionized distilled water. Stock buffer is provided and will have to be diluted 1 in 20. To make 90 ml of diluted buffer, pipette $90/20 = 4.5$ ml of stock buffer and top up with distilled de-ionized water to make 90 ml. Add 90 ml of the dilute solution to 10 ml of stock Giemsa.

To make 500 ml of 10% Giemsa, pipette 50 ml of stock solution and add 450 ml of buffered water. The stock buffer volume to measure is calculated as follows $450/20 = 22.5$ ml, then top up to 450 using de-ionized distilled water.

You can make these calculations for any volume required. Some common volumes used are given in the table below

A:Volume of stain of 10 % to make(ml)	B:Volume of stock Giemsa required (ml)	C:Volume of buffered water to add (ml)	D:Volume of stock buffer to use(column C/20) (ml)
100	10	90	4.5
200	20	180	9.0
300	30	270	13.5
400	40	360	18.0
500	50	450	22.5
600	60	540	27.0
700	70	630	31.5
800	80	720	36.0
900	90	810	40.5
1000	100	900	45.0

Making 3% Giemsa solution

To make 100 ml 3% Giemsa, pipette 3 ml of stock Giemsa, and add 97 ml of buffered de-ionized distilled water. The volume of stock buffer to use is calculated as follows $97/20 = 4.85$ ml of stock buffer and top up to make 97 ml with distilled water.

To make 500 ml of 3%, pipette 15 ml of stock Giemsa, and add 485 ml of buffered water. To compute the volume of the stock buffer divide 485 by 20, and then top up with de-ionized distilled

water. You can make these calculations for any volume required. Some common volumes used are given in the table below:

A:Volume of stain of 3% to make(ml)	B:Volume of stock Giemsa required (ml)	C:Volume of buffered water to add (ml)	D:Volume of stock buffer to use(column C/20) (ml)
100	3	97	4.85
200	6	194	9.70
300	9	291	14.55
400	12	388	19.40
500	15	485	24.25
600	18	582	29.10
700	21	679	33.95
800	24	776	38.80
900	27	873	43.65
1000	30	970	48.50

Fixing of thin films

All thin films will be fixed with methanol on the same day that they are made.

NB: Remember that thick films are not supposed to be fixed and you should avoid this mistake.

Storage of slides

- Clean off oil using lens tissue soaked in Xylene
- Pack in special slide boxes or
- Wrap with smooth tissue paper and pack in original pack
- Label boxes clearly (with study site and date)

Labeling slides

- Date
- Survey subject number/ code

Numbering System

Each child's information has to be unique and easily identified. The principal investigator will give each child a unique 7-digit identification number. The first 2 digits will be the letter code for each site (Kitebi=KT, Kikulu=KK, Police Barracks=PB, Loco=LC), the next 3 digits will be the number of the child (1 to 220 or more) and the last two digits will be the survey number (S1 to S3). This has to be filled in on the survey form. Do not forget to include the date. This will help identify the

month and the year when the sample was collected. If a number is written incorrectly or a number is written twice, these records cannot be used and will be wasted. Try to avoid such mistakes.

For example: Slide recording for the first season (S1) for the first child (001) at Kitebi (KT), done on the 31.03.2000 is recorded as follows:

31.03.2000
KT001S1

Storage of Blood Slides

Blood slides should be stored in an organized manner so that they can be easily retrieved and re-examined for quality control. Blood slides should be stored in slide boxes. You will be provided with slide boxes.

Collecting larvae and pupae from breeding sites

Reasons for larval sampling

We collect larvae to:

- get presence-absence data for identification of a habitat as breeding site;
- determine the preferred breeding sites of each vector species;
- assess biodiversity;
- describe changes in mosquito densities;
- assess the impact of control activities; and
- determine the population size of vector mosquitoes.

Problems:

- Great diversity and complexity of larval habitats
- Variable size of habitats
- Large number of habitats

- Fast changes in habitats in short periods
- Especially because of the behavior of larvae: aggregation and distribution in habitat, high photosensitivity

Anopheles larvae and especially pupae are usually concentrated in certain parts of large breeding sites, which makes larval collection and estimates of population size difficult. Edges of sites and patches of vegetation are often places where larvae can be found; sun exposure and wind can also play a role.

Essential Equipment

The equipment required for collecting larvae consists of a dipper, a large tray, a pipette, vials to collect specimens, ethanol to kill specimens and preserve them immediately, bigger bottles or suitable containers to transport larvae alive, a pencil and a notebook.

Identify preferred-breeding sites

To identify preferred breeding sites it is essential to be systematic and check all possible breeding places, even those that are hard to reach, this enables determination of the types of sites most likely to harbor the larvae of anopheles mosquitoes

Potential breeding sites include:

- Small pools, tin cans, hoof-prints, drains, ditches where the entire surface of water should be examined
- Streams that should be searched at edges, where there is vegetation and the water moves slowly
- Ponds and lakes where the larvae can occur in vegetation around the edges, but also can sometimes be found far from the shore among floating vegetation
- Swamps and marshes: here the larvae are also normally associated with vegetation or edges
- Special sites like wells and cemented water pits, where the entire surface should be considered

Use of a dipper

- The most common and easiest technique is dipping
- A dipper can vary in shape and size. Sall pans, soup ladles and photographic dishes can be utilized
- Should be a light color inside to see the larvae easily
- The amount of water you dip should be known if you want to measure densities per volume

Methods of use

- Lower the dipper gently in an angle of 45° just below the surface so that water flows in any larvae that might be present
- Take care not to disturb too much and make larvae swim downwards; if so, wait three minutes before continuing
- When lifting the water, take care not to spill the water containing the larvae and pupae
- Hold dipper steady until larvae and pupae rise to the water surface in the dipper (can take several minutes, especially older instars)
- Collect larvae and pupae by means of a pipette and transfer them to a bottle or vials
- Or count (genera, instars) for density measures
- Do not throw the water back to the breeding place in order not to disturb larvae and pupae for further sampling

Remember that anopheles densities are often quite low compared with other genera, and you have to extend your time and efforts to detect them. Furthermore, dipping pupae is extremely difficult because they are extremely sensitive and fast; with the slightest disturbance they disappear. Additionally, they are even more clustered at one spot than larvae. Therefore the number of pupae per dip might be underestimated

Where there is dense, floating vegetation:

- Disturb water, causing immature to sink below the surface
- Clear away vegetation with the dipper and wait a few minutes for larvae and pupae to return to surface
- In clumps of vegetation such as grass, press dipper into it, so that water flows in

Transporting live larvae and pupae

- Make sure the bottles are closed well so that water cannot spill out
- Make sure air is in the container; they need to breath
- But not too much air; otherwise they shake too much and are damaged

Killing and preserving larvae and pupae

- Kill by placing them in warm water (60°C)
- Remove from water and place in vials with 70% ethanol or MacGregor's solution
- If PCR is to be carried out, place alive immediately in absolute ethanol
- Label clearly

- Close tubes tightly

Processing mosquito larvae

- Collect the mosquito from a preservative using a pipette to a watch glass containing 70% alcohol for 5 minutes
- Using a pipette, remove alcohol and pour 90% alcohol for 5 minutes
- Then remove alcohol and pour 100% alcohol for 5 minutes
- Remove alcohol and pour xylene for 5 minutes
- Place a drop of mountant (Depex, Caedax, or Canada balsam) on the slide
 1. If anopheles
 - Lift larvae from the last fluid onto a slide using a fine brush and a mounted needle
 - Cover it with a cover slip tail first and examine
 2. For culicine
 - Similar to above (Put the specimen on the slide using needles; do not place in mountant yet)
 - Place the specimen dorsal side upwards with the head towards you and the tail away from you, i.e., across the slide
 - Cut off the last two segments
 - When in the mountant on the slide, arrange alongside the body of the larva
 - Place the cover glass onto the specimen starting from the tail rather than from the side; this holds the larvae in position
 - Examine

Appendix B

Data collection sheets

Clinical Surveys (ugclin02)

Child's name.....

Mother's name

Father's name

Child's date of birth (dd/mm/yy)..... |__|__|__|__|__|__|

Sex (male =1, female =0).....|__|

Date

Site (Kitebi=KT, Kikulu=KK, Police Barracks=PB, Loco=LC)|__|__|

Child number (1-220).....|__|__|__|

Survey number (S1 to S4).....|__|__|

Slide number (Site, Survey, Child No).....|__|__|__|__|__|__|

Has the child had fever in the last week? (Yes=1, No=0).....|__|

Did the child receive treatment for this fever? (Yes=1, No=0).....|__|

If yes, what treatment did you receive?

Chloroquine (Yes=1, No=0).....|__|

Fansidar (Yes=1, No=0).....|__|

Paracetamol (Yes=1, No=0).....|__|

Others (Yes=1, No=0).....|__|

If other, specify.....

Has the child traveled outside their neighborhood in the last month?
(Yes=1, No=0).....|__|

If yes, where.....

Is the spleen enlarged? (Yes=1, No=0).....|__|

Did you take a blood slide? (Yes=1, No=0).....|__|

Malaria parasites present (Yes=1, No=0).....|__|

Number of parasites per ul of blood.....|__|__|__|__|__|

Larval Surveys (uglarvae02)

To include:

- Site
- Date
- Time of day
- Habitat type
- GPS coordinates
- Dip number (1-60)
- No. Anophelines
- No. Culicines

- Temperature (°C)
- pH
- Sunlit (Y=1, N=0)
- Presence of large animals (Y=1, N=0)
- Type of animal
- Presence of algae (Y=1, N=0)
- Remarks

Mosquito Spray Catches (ugspray02)

House number.....|__|__|

Household head.....

Date (dd/mm/yy).....|__|__|__|__|__|__|

Site (Kitebi=KT, Kikulu=KK, Police Barracks=PB, Loco=LC)
.....|__|__|

Number of adults sleeping in room.....|__|__|

Number of children (under 10 yrs old) sleeping in room.....|__|__|

Has the house been sprayed with insecticide in the last 3 months?
(Yes=1, No=0).....|__|

Was an insecticidal aerosol spray used last night? (Yes=1, No=0)|__|

Was a mosquito coil burnt last night? (Yes=1, No=0).....|__|

Bedroom with closed eaves (Yes=1, No=0).....|__|

Bedroom with ceilings (Yes=1, No=0).....|__|

Treated bednet (Yes=1, No=0).....|__|

Mosquito collections:

Number of adult female *Anopheles gambiae*.....|__|__|

Number of adult female *Anopheles gambiae* dissected.....|__|__|

Number with sporozoites.....|__|__|

Number of adult female *Anopheles funestus*.....|__|__|

Number of adult female *Anopheles funestus* dissected.....|__|__|

Number with sporozoites.....|__|__|

Number of other adult female anophelines.....|__|__|

If other female anophelines present, specify.....

Number of adult female *Cx. quinquefasciatus*.....|__|__|

Number of other adult female culicines.....|__|__|

If other female culicines present, specify.....

Appendix C

Specific recommendations for sustaining EM in Kitebi and the Police Barracks in Jinja

Community members in the two intervention sites suggested a number of actions to assist the sustainability of community strategies for malaria control. These are summarized below.

Kitebi

1. The community should seek more information, participate in decision making/meetings, contribute money to maintain the large drainage channels, condemn unhealthy behavior and the brick makers should stop digging up clay.
2. Coordinators should mobilize more inclusively to maintain the benefits and resources, promote communalism, target the tenants and youth, make a timetable of the 10 zones and agree on when to meet each zone; link the community meetings to specific activities so that people understand what the project is about; include other active members of the community on the project team; use radio announcements; be more friendly and persuasive instead of using force; make more regular community/ house visits; inform people about the activities well in advance; every coordinator should take a record of all the people in their zone and in the process tell people about the project; coordinators should recommit themselves; activities should be scheduled on weekends; tools should be properly kept and distributed; and community activities should be made compulsory.
3. EHP should increase people's awareness of the dangers of malaria through intensifying community sensitization meetings, conducting seminars on voluntarism and carrying out house outreaches as well as radio programs. In addition, EHP should carry out regular monitoring, increase incentives to the community and work closely with local leaders/resource persons; there should be coordination between the EHP team and community resource persons.

Police Barracks

1. The rules should be made clear about the activities to be carried out and the particular days of community work, taking into account the transient nature of police officers.
2. The community, including its leaders, should be further sensitized about the importance of the project. Once sensitized, the Police Barracks leadership should be able to replace broken tools, for instance, and approach the political leaders and other well wishers for help.
3. The respective municipal authorities should supervise the grass planting and maintenance of drainages, in addition to the usual garbage collection. They should also link with the relevant partners in Mpumudde division to supply more grass if required.
4. Radio programs should be used to sensitize people about the importance of environmental management, in addition to using posters and other methods.

5. Sensitization of communities should emphasize that EM is a preventive, cost-saving measure.
6. EHP should work with the community leaders so that some of the messages are turned into bylaws and enforced at village level.
7. EHP should increase incentives given to the project committees, strengthen the capacities of project change agents and evaluate their performance.
8. EHP should work with other partners in an integrated effort, e.g., NGOs and the health department at the municipality, sharing with them work plans and spelling out the roles for each stakeholder.
9. The municipality should continue with the supervision and also include EM in their financial budgets.
10. Health promoters should supervise work regularly.
11. Animals should be removed from the barracks since they destroy the grass; walking on newly-transplanted grass should be controlled.
12. EHP should intervene on a wider scale because breeding places of mosquitoes are still beyond control, given the low level of development. The mosquitoes are flying insects and therefore control efforts need to be integrated, e.g., sanitary facilities need to be maintained as well.