ACTIVITY REPORT 122

First Year Summary Report

Development of a Community-based Environmental Management Program for Malaria Control in Kampala and Jinja, Uganda

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ENVIRONMENTAL HEALTH PROJECT

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Contents

Acronyms

EHP	Environmental Health Project
GPS	global positioning system
IRS	indoor residual (insecticide) spraying
ITN	insecticide-treated net
IVM	Integrated Vector Management
KCC	Kampala City Council
MOH	Ministry of Health
NGO	nongovernmental organization
NMCP	National Malaria Control Program
SSA	Sub-Saharan Africa
USAID	U.S. Agency for International Development
VBD	vector-borne disease

About the Authors

Professor Steve Lindsay is a disease ecologist with a passion for studying some of the world's most important vector-borne diseases—chiefly: malaria, lymphatic filariasis and trachoma. He has considerable experience in medical entomology, parasitology, ecology and clinical epidemiology and solves pure and applied problems in the laboratory and field using a wide range of techniques from DNA fingerprinting and mathematical modeling to methods used by social scientists, epidemiologists and biologists. His particular interest is in the design of simple tools for malaria control, and he has carried out field research in Gambia, Ethiopia, Tanzania, Thailand and Uganda over the last 17 years. He has published over 80 peer-reviewed papers, many in major international journals. Lindsay was part of one of the leading groups of researchers to demonstrate that insecticide-treated bednets protect children against malaria.

Dr. Tom Egwang is the Director General of Med Biotech Laboratories with research interests in the biology of malaria parasites and the mosquito vector. He has been collaborating with the Malaria Control Program in Uganda on a research program focusing on antimalarial drug resistance. Egwang has been conducting immuno-epidemiological studies of malaria asexual blood stage vaccine candidates in Apac District, northern Uganda.

Allen Kebba is a social scientist with an interest in local government.

Diana Oyena is a social scientist with experience in participatory research.

Gabriel Matwale is an entomologist with the Vector Control Division, Ministry of Health, in Uganda. Pests of public health importance are his area of interest, in particular, aspects that will alleviate malaria in endemic countries. Matwale has participated in vector-related control strategies for almost 15 years in his home country.

Executive Summary

We know from historical accounts that in the early 1900s malaria was controlled using environmental management for vector control in cities in Sub-Saharan Africa. What it 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 about the long-term costs and environmental impact of some of them.

This report describes the activities and findings for the first year of a two-year study designed to assess the strengths and weaknesses of a community-based environmental management program for malaria control in two Ugandan cities: Kampala and Jinja. Both cities are 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. Here, housing is confined largely to the hills, and 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.

The first year activities provided local communities and health departments with evidence and technical support to enable them to develop an action plan for the environmental management of malaria in four communities: two in Kampala (Kitebi & Kikulu) and two in Jinja (Police Barracks & Loco Estate). In the second year, environmental management for malaria control will be initiated in Kitebi, Kampala, and Police Barracks, Jinja. The study is designed to allow us to assess the impact of environmental management on the level of transmission and infection experienced in the study sites.

Routine entomological and clinical surveys were carried out in order to determine the source of vectors and the level of malaria transmission experienced in each study site. Both sites in Kampala are small valleys with extensive areas of flooded brick pits, while in Jinja, they are estates close to farmland or swamps.

The results of the entomological and clinical surveys reveal a complex picture. Generally malaria transmission is low in all sites, with anopheline mosquitoes being far less common than the abundant culicine mosquitoes. Anopheline mosquitoes are found in a wide variety of different water bodies in each study site. In Kampala, brick pits, tire ruts, and puddles are 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 Village, 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%–25%), except for Loco in Jinja where the prevalence was markedly higher (36% and 37%).

A key element of our approach has been 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. These meetings were used to develop an action plan for implementing the intervention strategies. The action plans for the control of mosquitoes are specific to the ecology and social make-up in each site. In Kampala, the interventions include the filling in of puddles, drainage of brick pits, and introduction of fish into larger bodies of water. In Jinja, options such as drainage and better disposal of water is also likely to lead to a reduction in breeding habitats. The impact of this suite of interventions will be assessed in the second year of the study.

We hope that this approach will lead to the development of an effective and sustainable intervention strategy against malaria in both cities and help guide malaria control in other African cities

1. Introduction

1.1. The growing problem of urban malaria

Over the last 40 years, the population of Sub-Saharan Africa (SSA) has almost tripled, growing by more than 15 million each year, to the present level of over 600 million people (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. 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 much morbidity and mortality and reducing productivity (e.g., Trape, 1987, Trape et al., 1993, Imbert et al., 1997, Robert et al., 2003). Following discussions with the City Council Health Authorities and study communities in both Kampala and Jinja, it is clear that malaria is a significant public health problem in these cities. This problem is likely to grow due to the increase in parasite strains resistant to chloroquine (Dorsey et al., 2000). In Kampala, malaria is presently the leading cause of morbidity and absenteeism in schools and workplaces and a sizeable portion of the health budget is spent on its control. 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 5 and 37% over 5 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. Environmental management through a process of social mobilization and community participation is being encouraged by the Ministry of Health (MOH) and includes the filling of small water collections 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 or NMCP) who was eager to develop community-led malaria control activities based on environmental management. 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, NMCP), Albert Kilian, (Malaria Technical Advisor, USAID), Ambrose Onapa (Principal Entomologist, Vector Control Division) and Michael Okia (Senior Medical Entomologist, NMCP).

1.3. Objectives

The activity had three objectives in the first year:

1. Identify areas in each city that appear to be at higher risk for malaria and confirm local transmission

2. 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

3. 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's activity produced the following results:

- the identification of two study sites

- a detailed identification and characterization of the breeding sites

- the engagement of the district health authorities and target communities

- the development of an intervention plan to reduce mosquito breeding in the two sites.

Chapters 2 and 3 describe the methodology used and the findings from Year 1.

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

1. Implement the interventions to reduce mosquito breeding in the two study sites in Kitebi, Kampala and the Police Barracks in Jinja

2. Survey the breeding sites in the two study sites to monitor the reduction of anopheline larvae

3. Assess the impact of mosquito control on malaria transmission and prevalence

4. Document improvements in strengthening linkages between the district authorities, the NMCP, and the private sector

5. Develop recommendations with the municipal authorities to institutionalize feasible and appropriate control measures.

Chapters 4 and 5 summarize the action plan for Year 2 and key recommendations for guiding the implementation of the action plan. The interventions will be implemented in September 2003 before the first rainy season.

1.4. Study plan

The study is taking 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 swamp. Agricultural land for market gardening and sometimes clay 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 square km (Jinja Municipal Council, unpublished document). The city is close to the shore of Lake Victoria, and about 33% of the area is covered in swamp. It experienced major industrial development in the 1960s, but over the last 30 years has been in decline. As a result, much of the infrastructure requires renovating, particularly in the large housing estates on the outskirts of the city.

From our preliminary observations, it is clear that many lowland areas in both cities are peppered with numerous collections of small man-made water bodies. 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 the rest of Africa. The present activity set out to establish whether larval control 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 is anticipated that a strategy developed in this manner will be both an effective and sustainable method of malaria control in urban areas.

1.5. What is environmental management for vector control?[1]

Environmental management for vector control aims to induce changes in ecosystems that 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. Such vector-borne diseases (VBD) include malaria, yellow fever, schistosomiasis (bilharzia), filariasis and plague. The vast majority of vectors are bloodsucking 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 cycle. Environmental management for vector control therefore frequently aims at introducing changes in the local hydrology or in water-use practices. Conversely, development projects of an infrastructural nature (and water resources development projects stand out in this connection) may inadvertently lead to changes in the environment that result in a deterioration of the VBD situation.

A distinction is made between environmental modification and environmental manipulation. Modification implies permanent changes such as landscaping, drainage, land reclamation and filling. It will often entail minor or major infrastructural works 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 practice. Its costs are usually modest but recurrent. Many environmental manipulation operations require infrastructural 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 control can build on 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 those of an infrastructural nature (dams, irrigation schemes, roads and railroads, airports, flood control projects and urban development). These usually

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[1] *Extract from (Lindsay et al., in preparation). For detailed descriptions of environmental management, the reader is advised to refer to the "Manual on Environmental Management for Mosquito Control" produced by the World Health Organization (WHO, 1982).*

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.

1.6. Benefits

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

1. Reduction in anopheline breeding and malaria transmission and possibly malaria prevalence in the interventions sites. The beneficiaries of this reduction will be residents in the intervention areas, primarily young children under five and non-immune adults.

2. Demonstration of 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 other cities in Africa.

3. Creation or strengthening of cross-sectoral links between the municipal Health Department and other municipal agencies with executive duties or regulatory authority over the spaces and land type that are related to anopheline breeding sites.

4. Strengthening of connections between the municipal Health department and the private sector, including community groups, commercial enterprises, and others that may offer services to help implement the action plan.

5. Reestablishment of connections between the vector control unit of the NMCP and local officials in the two municipalities, including particularly the various levels of the local council system.

This activity is 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 Africa.

2. Methodology

2.1. Study design

This pilot study will take place in two sites in each city, over a two-year period (Fig. 2.1). In the pre-intervention year, now at an end and the subject of this report, 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 Environmental Health Project (EHP) team. In the intervention year (2^{nd} year), mosquito larvae will be controlled in one of each pair of sites, in each city.

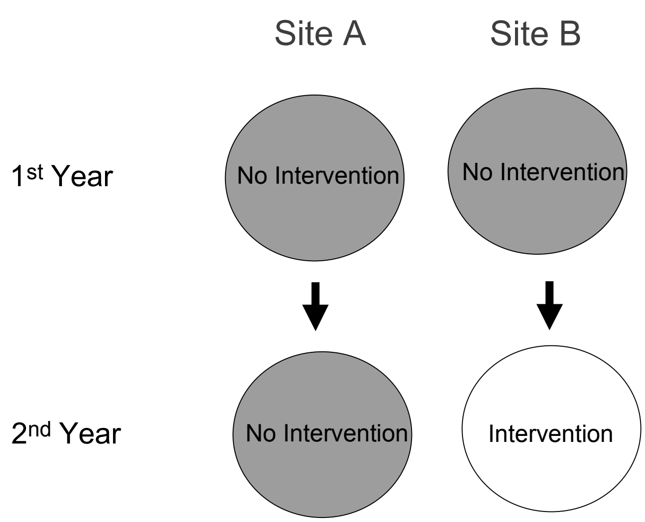


Fig. 2.1. Study design for Kampala and Jinja

2.2. Study sites

The study was carried out in Kampala, at Kitebi in Rubaga Division, and Kikulu in Kawempe Division and in Jinja at the Police Barracks and Loco Estate (Fig. 2.2). The settlements in Kampala are areas of new housing, with a mixture of lower and middle-income families. In contrast, the sites in Jinja are purposely-designed housing estates, constructed about 60–90 years ago for local industrial and public service workers.

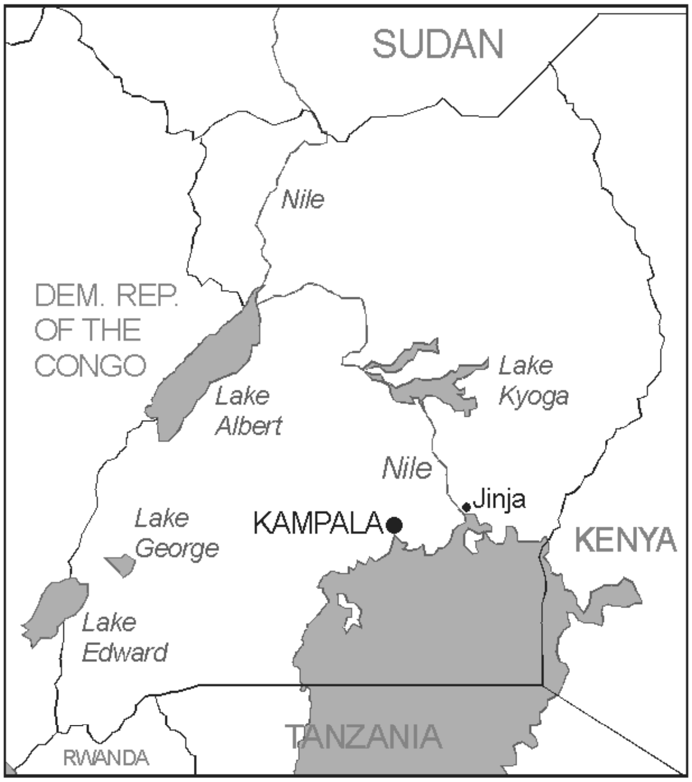


Fig. 2.2. Map of the study area showing city locations

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, we assumed that the highest peaks in malaria transmission occurred towards 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 Fig. 2.3). To assess transmission during the dry season, an additional entomological survey was carried out in February.

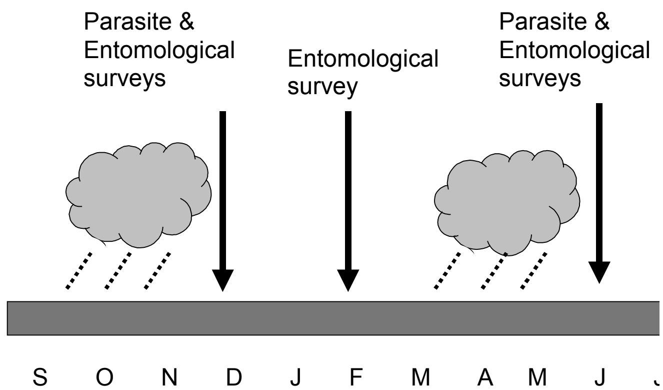


Fig. 2.3. Survey schedule

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

2.3. Entomology

2.3.1. Larval collections

During the study three larval surveys were carried out; in November 2002 and June 2003, as well as the intervening dry season in February 2003. The different types of water bodies at each site were identified and mapped using a global positioning system (GPS). During each entomological survey, the area of water occupied by each type of habitat was estimated by counting paces.

Larval collections took place between 12:00 noon and 5:00 p.m.. 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 square m 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 was recorded in each dip. At all sites, the presence of sunlight or shade, water temperature, pH, the presence of large aquatic animals and algae were recorded (Appendix A). Approximately 50 anopheline larvae or pupae were identified according to species from each type of habitat from each site during each survey.

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

6:00 a.m. and 10:00 a.m. on three separate days. Mosquitoes were identified according to species and the salivary glands of females were dissected for the detection of sporozoites. The number of children (under 10 year olds) and adults were recorded at each visit (Appendix A).

2.4. Clinical surveillance

2.4.1. Cross-sectional surveys

Cross-sectional clinical surveys were carried out in November 2002 and June 2003. A total of 220 children aged between six months and five years were examined at each study site, selected from the community living within 200 m of the edge of the settlement nearest the main breeding sites. The parents or guardian of each child was asked whether the child slept under an insecticide-treated bednet, if the walls of the house had 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 to be examined by an experienced technician for the presence of malaria parasites using microscopy (Appendix A).

2.4.2. Health facility records

Additional data was collected from local health centers serving each of the four sites in order to assess the seasonality of malaria. The numbers of patients reporting to the health facilities were 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 Fig. 2.4 was used to inform key partners about the purpose and findings from this activity and to develop the action plan for the interventions.

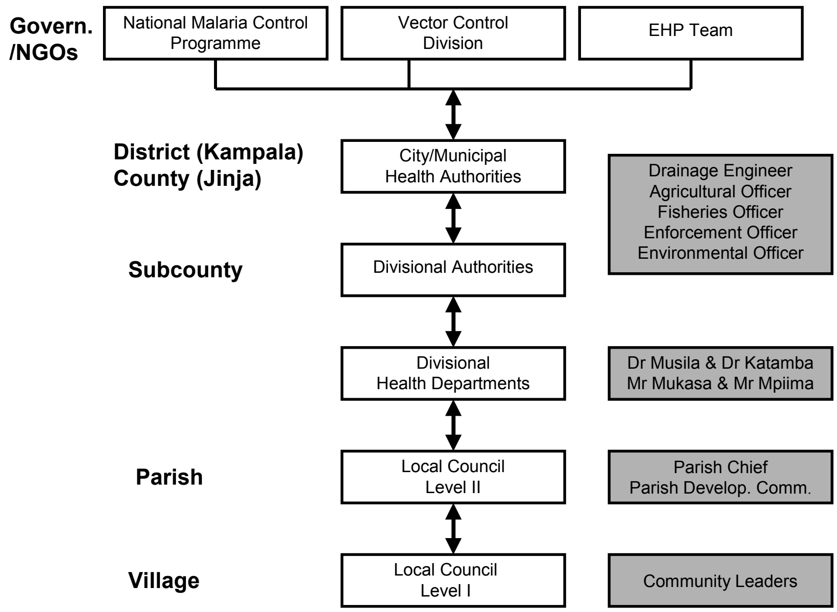


Fig. 2.4. Organizational structure used for facilitating development of intervention strategy; boxes in gray show key personnel

The role of the local health authorities was to ensure that: (1) they were actively involved in the development of the action plan, (2) that information about the project was relayed to elected and appointed officials in the councils and (3) 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. Brickmakers as well as existing youth and women groups and nongovernmental organizations (NGOs) focusing on health were also included in the sensitization.

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. At all sites the survey was carried out, after mobilization of the community.

Three major workshops were held in each city during the year to help guide the process, provide ownership of the project, and disseminate information among the key stakeholders (Fig. 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 number of measures to be used for environmental management that were tailored to the specific requirements of each study community. Both of these workshops were steered largely 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. For this reason the third series of workshops were held in the communities so that anyone who wanted to attend could do so. The number of health sector personnel was also kept to a minimum in order to allow community members to dominate the proceedings. Brickmakers as well as existing youth and women groups and NGOs focusing on health were also included in the sensitization. In this meeting research staff and health sector personnel acted as expert resources, to be called upon when needed. Study communities prioritized the types of interventions that 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. Many other smaller meetings supported this framework of major meetings during the course of the activity.

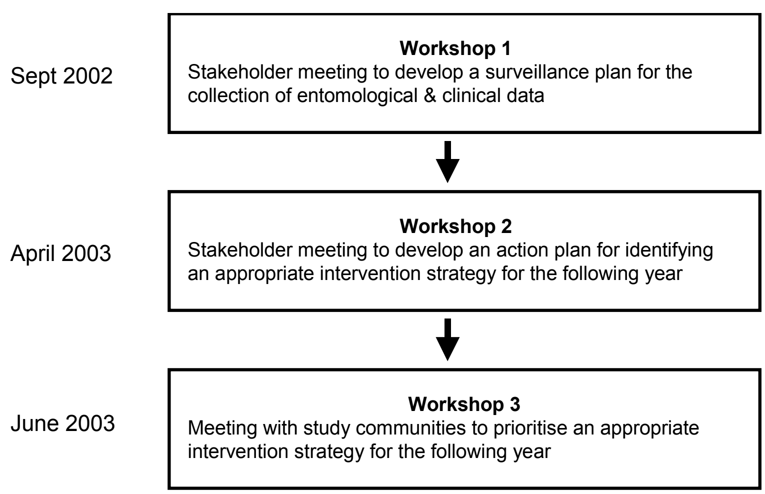


Fig. 2.5. Schedule for major meetings

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, UK.

2.6. Sample size considerations

This study is 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 is based on classical methods and the sample size is sufficient to capture some of the variation inherent in this type of sampling. We hope to be able to show that the larval intervention will reduce mosquito biting by 50%. We 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, we required 21 houses to be sprayed in each site during each survey to demonstrate a 50% reduction in mosquitoes. We assumed parasite prevalence would vary from 40% to 60%. In order to show a 33% reduction in infection associated with an intervention, we would require a sample size of between 107 and 214 children to be screened in each group, at the 95% level of significance and 80% power. We selected a total of 220 children to be screened at each site to allow for children lost from the study if they purchase an ITN during the study. The level of anopheline abundance and prevalence of parasitemia in study children were both lower than expected so that the power of the surveys to detect a decrease will be less than hoped.

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

3. Findings

3.1. Entomology findings

3.1.1. Breeding habitats

The major breeding habitats for each study site (Fig. 3.2, Appendix D) vary widely both between and within sites. Almost any small water body can support the aquatic stages of anopheline mosquitoes and this includes dirty water, as well as clean water.

In Kampala, brick and sand pits, tire ruts, and puddles are 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.

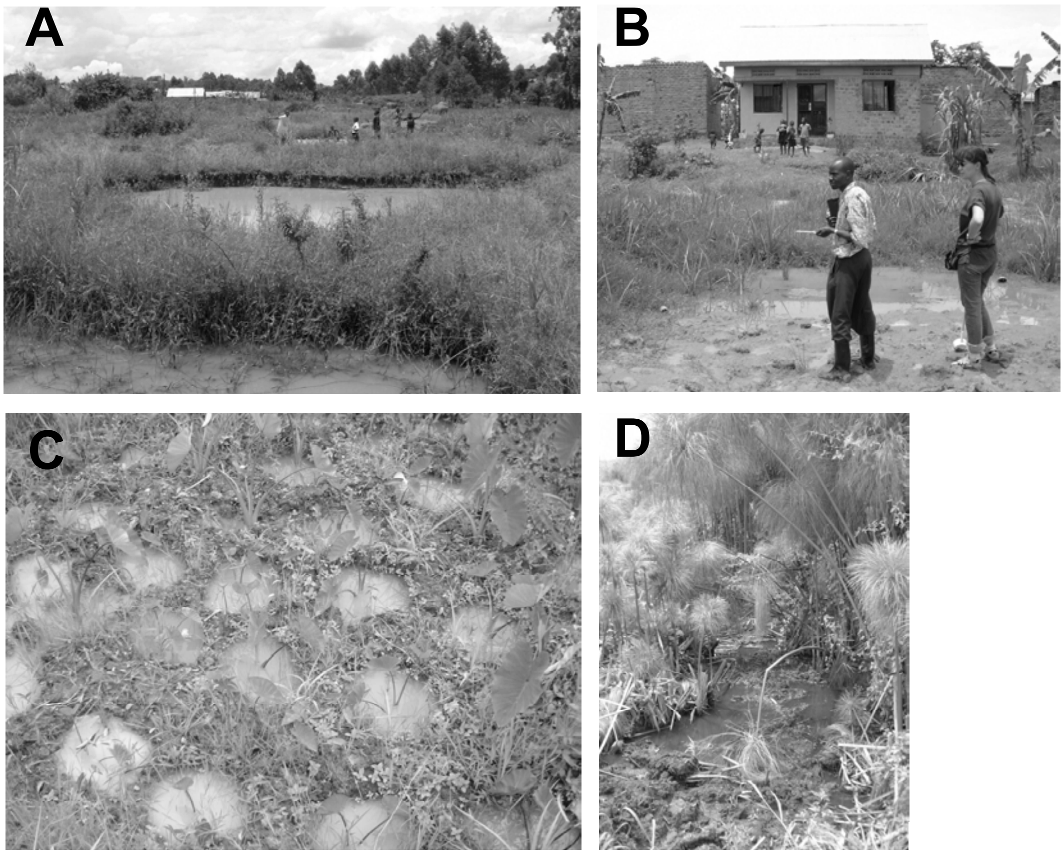
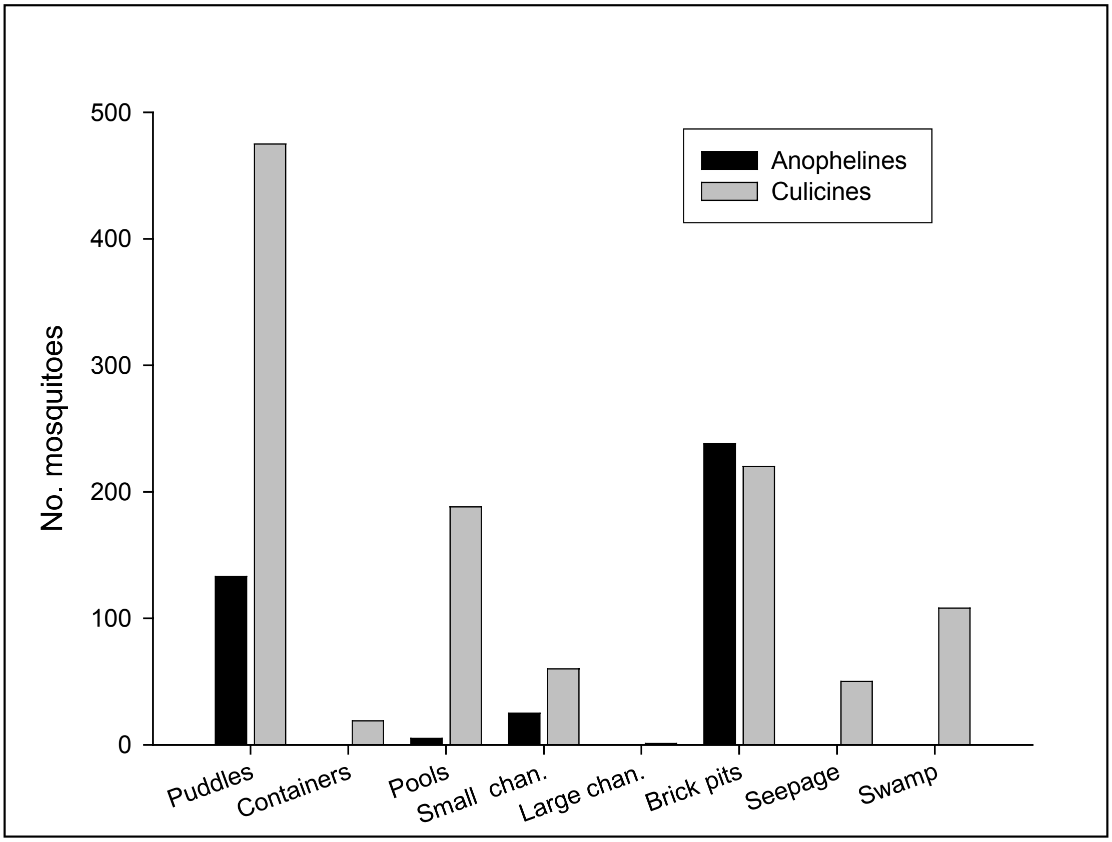


Fig. 3.1. Typical breeding habitat of An. Gambiae, where A is a flooded brick pit, B is a puddle, C is puddling at the base of coco yams and D are pools next to papyrus swamp

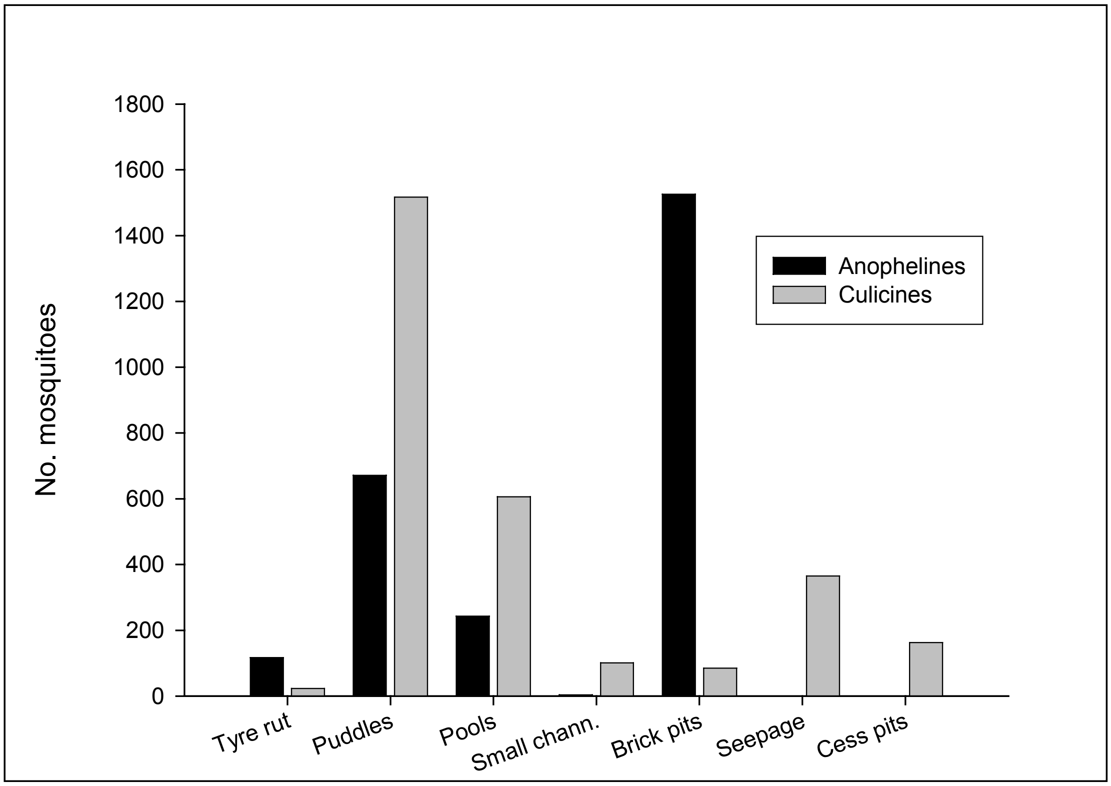
The brick pits are dug for clay to make bricks that are baked in kilns nearby. After use, the pits are left to fill with water, and in many areas they form a network of extensive and productive breeding habitats. The pits are too large to shade since vegetation nearby is cut either to cover piles of bricks waiting to be baked, in order to prevent the soft bricks from being spoiled by rain, or firewood is needed for firing the kilns. The brick pits appear to be 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. It is the newly dug brick pits that seem to be the most important source of mosquitoes, since many older pits have fish that are efficient predators of mosquito larvae.

There were considerably fewer anopheline larvae collected in the February survey compared with the November/December and June surveys, illustrating the depression of breeding that occurs during the dry season. An important point to consider here is the fact that *An. gambiae* is a pioneer species rapidly colonizing new water bodies. Often this results in individual water bodies having no larvae one week, followed by many larvae in the following week. This is important for control measures since any small water body that remains for longer than one week will provide a potential habitat for mosquitoes: it usually takes 10–14 days for the production of adult mosquitoes, depending on temperature.

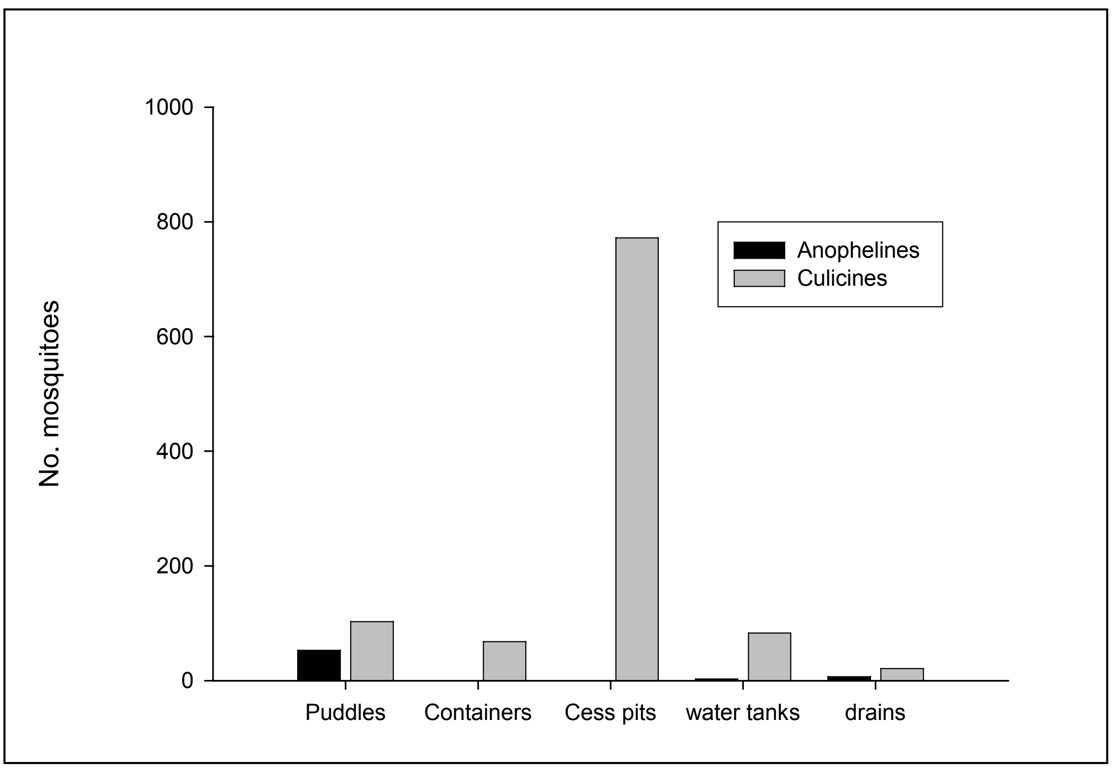
The aquatic stages of culicine mosquitoes were more common than anophelines in all surveys, apart from the Kikulu survey in November/December 2002. Many of the sites exploited by culicines were similar to those occupied by anophelines (Fig. 3.3), although there was a tendency for culicines to prefer more mature sites than did anophelines.



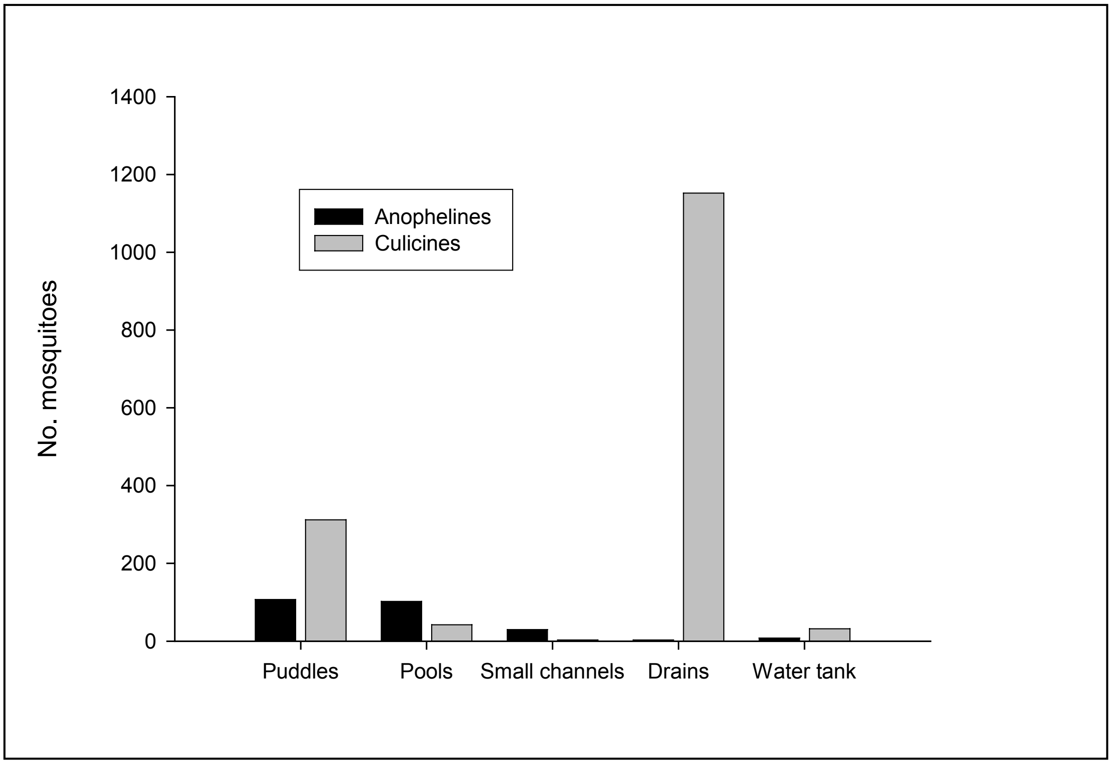
Kitebi, Kampala



Kikulu, Kampala



Police Barracks, Jinja



Loco Estate, Jinja

Fig. 3.2. Most productive breeding habitats for An. Gambiae (includes all four charts)

In attempts to control anophelines in the study sites, it will be important to control all mosquitoes, not just malaria vectors, in order to demonstrate to householders that environmental management has been successful.

3.1.2. Indoor-resting mosquitoes

The general level of exposure to malaria parasites is low in both cities (Table 3.1). In Kampala an average of 0.9 to 5.0 *An. gambiae* per house were collected during spray collections, while in Jinja this 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 10% of the *An. gambiae* collected were infective (i.e., in Kampala: 10.2% Kitebi and 9.5% Kikulu; in Jinja: 12.5% Police Barracks and 5.9% Loco), demonstrating a high rate of infection. In contrast, none of the specimens from Jinja were infective with sporozoites. Even lower numbers of *An. funestus* were collected in Kampala, indicating the presence of permanent shaded breeding sites in this area, such as slow moving grassy-edged streams. No *An. funestus* were collected in Jinja, a finding that suggests that permanent shaded breeding sites are rare here.

Culicines are clearly a major nuisance mosquito in all study sites since they form the majority of mosquitoes collected in the home.

Table 3.1. Indoor-mosquito collections

Survey date	Mean *An. gambiae*	% infected	Mean *An. funestus*	% infected	Mean *Cx. quinq.*	Mean other culicines	Mean All mosquitoes
Kitebi, Kampala							
Nov 2002	3.5	9.9 (7/71)	0.4	0 (0/8)	11.0	17.9	32.8
Feb 2003	1.1	4.3 (1/23)	0	0 (0/7)	23.5	3.7	28.3
June 2003	5.0	11.7 (12/103)	0.3	0 (0/0)	32.2	3.0	40.5
Kikulu, Kampala							
Nov 2002	1.2	12.0 (3/25)	0.2	20.0 (1/5)	3.5	0.4	5.3
Feb 2003	1.5	6.5 (2/31)	0.3	14.0 (1/7)	9.2	0.9	11.9
June 2003	0.9	11.1 (2/18)	0.4	0 (0/9)	18.0	0.3	19.6
Police Barracks, Jinja							
Nov 2002	0.3	28.6 (2/7)	0	-	18.4	0.2	18.9
Feb 2003	0	0 (0/0)	0	-	17.5	0	17.5
June 2003	0.4	0 (0/9)	0	-	13.6	0.3	14.3
Loco, Jinja							
Nov 2002	0.3	0 (0/7)	0	-	31.0	1.0	32.3
Feb 2003	0.04	0 (0/1)	0	-	17.9	0	17.9
June 2003	0.4	11.1 (1/9)	0	-	14.9	6.3	32.7

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

3.2. Clinical findings

The number of outpatients with malaria was recorded monthly at clinics in both Kitebi and Kikulu, Kampala, Uganda. Apparent malaria cases were recorded throughout the year with peaks in June. However, the findings should be treated with caution since the diagnoses are based on febrile patients coming to the clinics, without confirmation by microscopy.

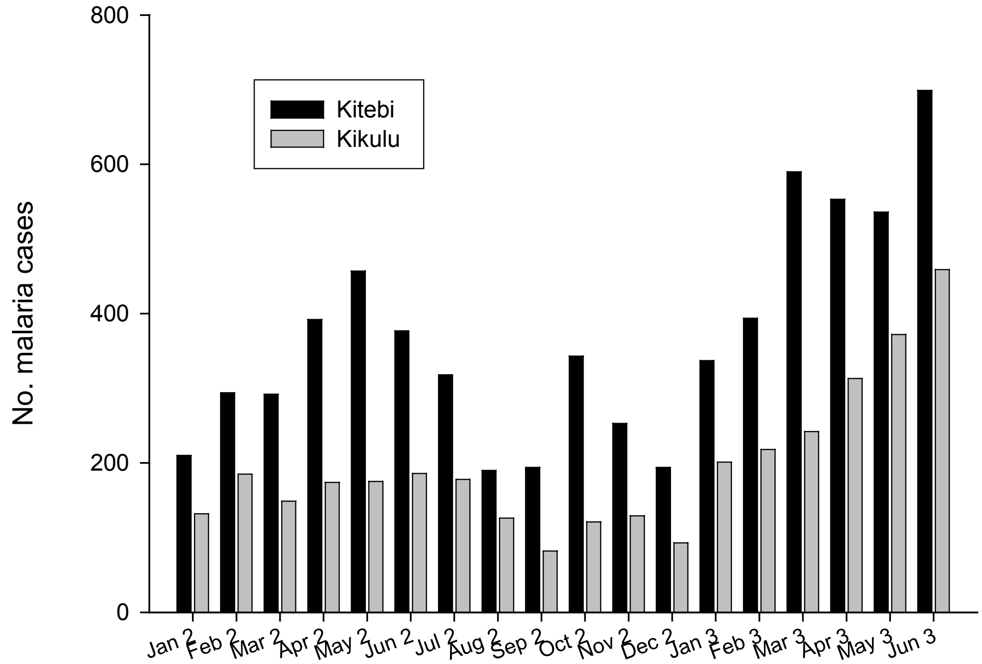


Fig. 3.3. Clinical cases of malaria in Kampala clinics

Table 3.2. Parasite infection rates in children

Survey date	No. blood films taken	No. slides read	No. with parasites (Parasite prevalence)
Kitebi, Kampala			
Nov 2002	220	217	49 (23%)
June 2003	209	204	47 (23%)
Kikulu, Kampala			
Nov 2002	157	151	38 (25%)
June 2003	151	150	27 (18%)
Police Barracks, Jinja			
Dec 2002	237	228	32 (14%)
June 2003	232	232	59 (25%)
Loco, Jinja			
Dec 2002	152	152	54 (36%)
June 2003	176	176	64 (37%)

Approximately one in four children examined in Kampala during both surveys has malaria parasites. In Jinja, there was a marked disparity between sites, with the Police

Barracks (14% and 25%) having much less malaria than Loco (36% and 37%; Table 3.2).

3.3. Control options

In the second workshop a number of different interventions were selected for consideration in a package of environmental management techniques for malaria control. Table 3.3 analyzes the strengths and weaknesses of the different options.

Table 3.3. Strengths and weaknesses of environmental management interventions

Intervention	Strengths	Weaknesses
Drainage of brick pits	• Long term solution • Effective	• May have high cost implications • Need to consider brickmakers as well as community • Requires expert technical advice • May require outsiders to complete
Filling	• Long term solution • Effective	• Requires technical advice • May require outsiders to complete
Leveling	• Long term solution • Effective	• Requires technical advice • May require outsiders to complete
Larvivorous fish	• Can be efficient predators of mosquitoes • Provide social protein • Supplements household income	• Efficacy uncertain • Knowledge required for fish farming • Difficult to maintain numbers over the long term
Growing trees and shrubs (for shading and preventing water logging)	• Environmentally friendly • Source of firewood • Long term sustainability	• High risk of denudation • Requires maintenance • Expert advice needed • Requires a number of years to be come effective
Cover water tanks	• Simple • Long term solution	• Requires external assistance
Proper disposal of plastic containers and polythene bags	• Cheap • Community involvement • Other health benefits	• Community reluctance/indifference
Control of brickmaking	• Potentially effective	• Weak enforcement • Controversial

In the third workshop the communities selected packages of interventions that they felt were appropriate to the local situation. These were refined following discussions with the local health authority, and the study sites best suited to environmental management were selected. These were Kitebi, Kampala, and the Police Barracks, Jinja. The communities were then informed whether they were an intervention or pre-intervention site and asked to come up with mechanisms for introducing the interventions into their communities. These interventions are outlined in Chapter 4.

4. Action plan

4.1. Summary of intervention

In the second year, larval control will be carried out in Kitebi, Kampala, and the Police Barracks, Jinja, with Kikulu and Loco as the respective controls. The communities themselves, supported by the Municipal Health authorities, with the technical assistance of the study team and City Engineers, will lead both packages of interventions. The communities will organize most of the interventions themselves, assisted by the local health authorities. The interventions are summarized on the next page.

Table 4.1. Summary of interventions

Problem	Solution	Mechanism for intervention
Kitebi		
Active brick pits	Larviciding with Bacillus thuringiensis var. israelensis, 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)	Desilting and clearing rubbish	Community lead supported by equipment purchased by EHP (e.g., boots, gloves, rakes, brooms, wheel barrows)
Blocked drains (major)	Desilting and clearing rubbish	Community and Kampala City Council (KCC) to carry out
Puddles in town	Filling with rubble (murram), planting grass (Paspalam spp.) or larviciding. Stop using top soil for brick-making.	EHP team to work with KCC to organize transport of murram and grass. 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		
Blocked drains	Desilting, clearing rubbish, repairing, and grass	Community lead and local builder
Puddles in town	Filling with rubble (*murram*) or larviciding	EHP team to work with the Police and local authorities to organize transport of murram and grass. Community to fill holes, supervised by engineer.
Broken cess pits	Repair	Community lead and local builder

The tasks for the intervention year are:

1. Seek and get ethical clearance for the second year of this activity
2. Implement interventions in Kitebi, Kampala, and the Police Barracks, Jinja
3. Carry out three detailed larval surveys in all four sites

4. Weekly larval surveys in Kitebi, Kampala, and the Police Barracks, Jinja

5. Undertake cross-sectional clinical surveys during the rainy seasons

6. Collect indoor resting adult mosquitoes from houses in the four study sites

7. Collect data on monthly maximum and minimum temperature and rainfall from meteorological stations at Makerere University, Kampala, and the airport at Jinja

8. Continue to sensitize the communities about environmental management for malaria control by conducting regular community meetings

9. Continue to meet regularly with the MOH and district authorities to ensure their involvement in the activity. One-day workshops will be conducted at key points in each city to review progress

10. Analyze the data from the entomological and clinical surveys

11. Assess the potential for replication and scale-up within the two cities and elsewhere in Uganda and discuss with both MOH and district authorities

12. Write the final report that includes the results of the implementation of the interventions and recommendations for replication and scale up.

Table 4.2. Overall timeline

Activity	J	F	M	A	M	J	J	A	S	O	N	D
2003												
Interventions								x	x	x	x	x
Estimates for interventions							x					
Community sensitization							x	x	x	x	x	x
Entomological survey											x	
Clinical survey											x	
Data analysis										x	x	
Visit by team leader									x			
2004												
Interventions	x	x	x	x	x	x						
Community sensitization	x	x	x	x	x	x						
Entomological survey		x			x							
Clinical survey						x						
Data analysis	x				x	x	x					
Visit by team leader				x		x						
Report writing & dissemination							x	x				

Table 4.3. End-of-study analysis plan

Research hypotheses	Data required for testing hypotheses	Statistical methods to be used
EM will reduce the number of anopheline larvae in intervention sites.	Comparison between pre-intervention and intervention larval surveys	Parametric or non-parametric univariate analysis
EM will reduce the number of culicine larvae in intervention sites.	Comparison between pre-intervention and intervention larval surveys	Parametric or non-parametric univariate analysis
EM will lower the number of indoor-resting anophelines by 50%.	Comparison between pre-intervention and intervention spray collections	t-tests and ANOVA
EM will decrease the number of indoor-resting culicines by 50%.	Comparison between pre-intervention and intervention spray collections	t-tests and ANOVA
EM will reduce the prevalence of malaria parasites in children by 33%.	Comparison between pre-intervention and intervention clinical surveys	Chi-square test
EM can be carried out by local communities with the assistance of the municipal authorities	Records of workshops, meetings and description of interventions	General description

Thus, this study sets out to assess the efficacy of environmental management with community participation to reduce malaria transmission and infection in two urban areas in Uganda. The findings from this study will help inform the city health authorities in Kampala and Jinja about the strengths and weaknesses of environmental management for malaria control.

5. Recommendations

The activity has made good progress and remains on track, and we would advocate continuation of funding for a second year.

1. In Kampala the intervention should be conducted in Kitebi and include the package of interventions outlined in Table 4.1. These will be carried out by the community with assistance from the local municipal authorities in Rubaga District, Kampala.

2. In Jinja the intervention should be carried out in the Police Barracks and consist of those interventions described in Table 4.1. Again these interventions will be carried out by the study communities, assisted by workers from Jinja municipal council.

3. The central role of the community is critical for the successful operation of this activity. Regular meetings between the EHP team and the study communities need to take place in order to help facilitate the interventions. Gabriel Matwale (GM) has been the most influential figure in his contacts with the local communities. He is not only an EHP team member, but is also an employee from the Vector Control Division, MOH Kampala. This means that the EHP activity is building capacity for environmental management within the Ministry.

4. The EHP team needs to continue to act as expert advisers, helping the communities to help themselves. GM will help educate the communities about the nature of the different types of mosquito breeding habitat and how these can be most effectively dealt with. Individuals selected by the study communities will carry out weekly surveys of larval breeding sites and help guide the community to problem areas. This activity will be overseen by GM.

5. Environmental management should focus on reducing culicine as well as anopheline mosquitoes. Without the control of <u>all</u> nuisance mosquitoes, people living in the study sites may lose the motivation for source reduction in their communities.

6. The municipal health authorities will play a critical role in the interventions. There is a real need for cross-sectoral collaboration here between the health department and city engineers. Drainage and filling of breeding habitats is essentially a problem of water management, and civil engineers are well placed for advising how best to achieve this. It is thus essential that an engineer work in both intervention communities to facilitate source reduction. Specifically they

should advise about appropriate methods of drainage and filling and, where possible, get assistance from the city to carry out these activities.

7. Discussions should continue with the Health Authority to build a partnership with the study communities and the EHP team.

8. In Kitebi, community leaders should hold a community meeting including brickmakers, their landlords, and local leaders of industry to discuss the environmental management plan. The role of the brickmakers and their landlords in inadvertently promoting mosquito breeding, subsequently leading to high rates of malaria infection, and this needs to be explained clearly. Residents, together with the brickmakers and their landlords should then discuss alternative ways of brickmaking that does not lead to water stagnation. The arbitration of KCC and local leaders is important in this process. The community and brickmakers should exhaustively discuss appropriate land use in residential areas, and the control of brickmaking should be proposed and enforced. In Kitebi, where brickmakers operate on government organization land (Electricity and Railways), representatives should also be invited to attend such discussions.

9. The process of community mobilization needed for the interventions should be recorded in order to learn how best to implement environmental management.

10. Other interested parties should also be invited to attend workshops to review study progress, such as representatives from Kampala Urban Sanitation Project, Urban Agriculture Office of KCC, and the Ministry of Water, Lands and Environment.

11. Timely disbursement of funds is essential for this activity to move forward on schedule.

12. The EHP team leader will continue to make regular visits to the study sites to help facilitate operations.

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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 ≅ 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 autofixation.

Washing of 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 of 10% Giemsa solution

To make 100 ml of 10% Giemsa, pipette 10 ml of stock Giemsa solution provided, add 90 ml of buffered deionized 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, deionized 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 deionized, 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 of 3% Giemsa Solution

To make 100 ml 3% Giemsa, pipette 3 ml of stock Giemsa, and add 97 ml of buffered deionized, distilled water. The volume of stock buffer to use is calculated as follows: 97/20 = 4.85 mls 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 deionized, 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 (study site and date).

Labeling of slides

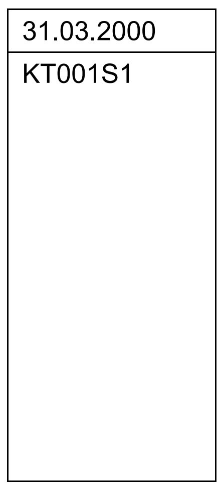
- Date.

- 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 (001 to 220 or more) and the last two digits will be the survey number (S1 to S3). This has to be filled on to the survey form. Do not forget to include the date. This is to help identify the month and the year when the sample was collected. If a number is wrongly written 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:



Storage of Blood Slides

Blood slides should be stored in an organized manner so that they can be easily retrieved and reexamined 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.
- 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.
- And 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 specimen, ethanol to kill specimen 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 which 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, where 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. Small pans, soup ladles, and photographic dishes can be utilized.
- The dipper should be light in 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 and any larvae that might be present flow in.
- Take care not to disturb the water too much and make the larvae swim downwards. If this happens, wait three minutes before continuing.
- When lifting the water, take care not to spill the water containing the larvae and pupae.

- Hold dipper steadily until larvae and pupae rise to the water surface in the dipper. This can take several minutes, especially with older instars.

- Collect larvae and pupae by means of a pipette and transfer them to a bottle or vials.

- Alternatively, count (genera, instars) for density measures.

- Do not throw the water back to the breeding place so as 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 and they disappear. Additionally, they are even more clustered at one spot than larvae, and therefore the number of pupae per dip might be underestimated.

Where there is dense, floating vegetation:

- Disturb the 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 can not spill out.

- Make sure air is in the container; they need to breath.

- Do not allow 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 Polymerase Chain Reaction (PCR) is to be carried out, place alive immediately in absolute ethanol.

- Label clearly.

- Close tubes tightly.

Processing mosquito larvae

- Collect the mosquito using a pipette from a preservative to a watch glass containing 70% alcohol for 5 minutes.

- Using a pipette, decant the alcohol and add 90% alcohol for 5 minutes.

- Remove alcohol and pour 100% alcohol for 5 minutes.

- Remove alcohol from the watch glass and add xylene for 5 minutes.

- Remove the mosquito to a slide and immediately cover with a drop of mountant (Depex, Caedax, or Canada balsam)

  — 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.

  — If Culex:

    – As above (put the specimen on the slide using needles), but 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 of the abdomen.

    – Carefully add a drop of mountant to the slide to cover 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 travelled outside their neighbourhood 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 [[ml?]] 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 (^{o}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. Philosophy of community participation

Mobilization and Participation

The proposed design for community mobilization adopts the following approach:

1. Awareness-raising
2. Development of community action plans
3. Monitoring implementation of the plans
4. Community assessment of plan implementation
5. Institutionalizing plan process in local government systems

Awareness-raising

It is imperative that communities possess or gain a level of knowledge and appreciation of the background of malaria and the effects on productivity and health of affected individuals. It is therefore important that design for community participation start with sensitization on issues of malaria. The target group here will be household heads and mothers who are usually confronted with malaria outbreaks in families. Responsibility for this activity will rest with the Community development Assistants, Malaria control officers, Health Centre Educators, The Chairpersons LC1 (Local Committee) and Secretaries for Health at LC1.

Development of Community Action Plans

It is essential that the communities collectively and collaboratively develop action plans that will capture agreed actions necessary for control or reduction of malaria in their areas. These plans will contain information with regard to the following:

- Activities or description of intended activities
- Suggested time frame for the activities
- Persons responsible for implementing the work plan
- The required level of effort in person days

Monitoring of implementation of the plans

It is essential that the communities experience first hand the effects that control efforts will have on malaria levels in their communities. Of course attribution may not necessarily rest with community participation since there will be other interventions targeting the same objective. Monitoring therefore will be important in establishing whether in fact intended actions have been carried out as agreed. It will be necessary for the communities to establish in advance indicators that will guide monitoring of the activities as well as a simple reporting format that will channel information from monitoring to other members of the communities. Key activities therefore will include:

- Establishment of a baseline or starting point
- Development of simple indicators against which progress will be measured
- Development of a reporting format
- Establishing channels of communications

Evaluation or assessment of implementation

It is important that communities collectively participate in measuring the impact of their activities and that they appreciate first hand successes and failures arising from implementation. This can best be done by comparing levels of malaria incidences progressively or with the situation before the intervention.

Institutionalization of the activity

It is essential that the community appreciates that this is not a one-time activity but part of a continuous process that is vital for healthy and malaria free lives. It is therefore necessary that activities link with ongoing processes and systems since this is essential for sustainability purposes.

Appendix D. Results of larval surveys

Table 1. Findings from first larval survey in November and December 2002.

Habitat type	No. of dips	Total no. anophelines	Mean no. anophelines /dip	Total no. culicines	Mean no. culicines /dip
Kitebi, Kampala					
Tire rut	14	3	0.2	8	0.6
Pools	37	0	0	86	2.3
Small water channels	22	0	0	46	2.1
Puddles	19	0	0	8	0.4
Brick pits	16	0	0	5	0.3
Man-made containers	6	0	0	2	0.2
Large water channels	24	0	0	1	0.04
Car tires	2	0	0	0	0
Total	**140**	**3**	**0.02**	**156**	**1.11**
Kikulu, Kampala					
Brick pits	17	1016	59.8	11	0.7
Foot prints	1	52	52	10	10
Soil pits	5	153	30.6	0	0
Puddles	19	252	13.3	92	4.8
Pools	20	221	11.1	56	2.8
Tire ruts	6	117	19.5	54	9
Sand pits	13	97	7.5	37	2.9
Small water channels	10	4	0.4	3	0.3
Seepage	6	0	0	0	0
Wells	4	0	0	0	0
Total	**101**	**1912**	**18.9**	**263**	**2.6**
Police Barracks, Jinja					
Puddles	15	12	0.8	0	0
Water tanks	17	3	0.2	22	1.3
Discarded jerry cans	5	0	0	75	15
Discarded Basins	3	0	0	6	2
Drains	18	0	0	11	0.6
Plant axils	3	0	0	0	0

Total	**61**	**15**	**0.3**	**114**	**1.9**
Loco, Jinja					
Pools	13	41	3.2	8	0.6
Puddles	16	9	0.6	69	4.9
Hoof prints	6	3	0.5	8	1.3
Drains	18	3	0.17	35	2.9
Discarded jerry cans	3	0	0	0	0
Water tank	5	8	1.6	32	8.0
Total	**48**	**56**	**1.2**	**120**	**2.5**

Table 2. Findings from second larval survey in February 2003.

Habitat type	No. of dips	Total no. anophelines	Mean no. anophelines /dip	Total no. culicines	Mean no. culicines /dip
Kitebi, Kampala					
Brick pits	12	23	1	6	0.5
Clay/Brick pits	16	8	0.5	11	0.6
Puddles	26	7	0.3	220	8.5
Seepage	2	0	0	50	25
Small water channels	23	0	0	14	0.6
Discarded tires	2	0	0	9	4.5
Discarded basins	2	0	0	8	4
Pools	49	0	0	0	0
Drains	3	0	0	0	0
Total	**135**	**38**	**0.28**	**318**	**2.36**
Kikulu, Kampala					
Puddles	31	149	4.8	883	28.5
Sand pits	5	144	28.8	0	0
Brick pits	7	33	4.7	4	0.6
Ponds	9	2	0.2	1	0.1
Soakpit	3	0	0	365	121.7
Cess pits	3	0	0	114	38
Pools	7	0	0	101	14.4
Drains	4	0	0	49	12.3
Small water channels	10	0	0	49	4.9
Discarded jerry cans	3	0	0	0	0
Confluence small/large Channels	8	0	0	0	0
Tree trunks	1	0	0	0	0
Total	**91**	**328**	**3.6**	**1566**	**17.2**
Police Barracks, Jinja					
Cesspits	7	0	0	772	110.3
Drains	19	0	0	0	0
Seepage	3	0	0	0	0
Total	**29**	**0**	**0**	**772**	**26.6**
Loco, Jinja					
Drains	8	0	0	60	7.5
Discarded jerry cans	5	0	0	0	0
Puddles	17	0	0	0	0
Water Tank	11	0	0	0	0
Total	**41**	**0**	**0**	**60**	**1.5**

Table 3. Findings from third larval survey in June 2003.

Habitat type	No. of dips	Total no. anophelines	Mean no. anophelines /dip	Total no. culicines	Mean no. culicines /dip
Kitebi, Kampala					
Puddles	65	126	1.9	247	3.8
Clay/Brick pits	113	207	1.8	198	1.8
Pools	60	5	0.08	102	1.7
Drains	0	0	0	0	0
Small water channels	45	25	0.6	0	0
Swamp	30	0	0	108	3.6
Tire rut	1	0	0	64	64
Well	23	0	0	0	0
Total	**337**	**363**	**1.1**	**719**	**2.1**
Kikulu, Kampala					
Clay/Brick pits	113	183	0.6	33	0.3
Puddles	65	218	3.4	532	8.2
Small water channels	45	0	0	49	1.1
Swamp	30	0	0	0	0
Pools	60	20	0.3	448	7.5
Tire ruts	1	0	0	23	23
Well	23	0	0	0	0
Total	**337**	**421**	**1.2**	**1085**	**3.2**
Police Barracks, Jinja					
Puddles	48	41	0.9	0	0
Cesspits	5	0	0	0	0
Drains	56	7	0.1	10	0.2
Water tank	57	0	0	83	1.5
Tires	5	0	0	68	13.6
Total	**171**	**48**	**0.3**	**161**	**0.94**
Loco, Jinja					
Pools	95	61	0.6	34	0.4
Small water channels	50	30	0.6	3	0.1
Puddles	50	95	1.9	235	4.7
Drain	65	0	0	1057	16.3
Total	**260**	**186**	**0.72**	**1329**	**5.1**

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