Integrated Research Partnerships for Malaria Control through an Ecohealth Approach in East Africa: Kenya, Rwanda, Tanzania and Uganda Projects

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SYNTHESIS

This collaborative project was carried out in Kenya, Rwanda, Tanzania and Uganda and aimed to investigate the relationships between malaria, livelihoods, ecosystem and health systems so as to strengthen the capacity to carry out integrated malaria research and control in an eco-health approach. During this period a number of activities have been accomplished. The project had five objectives: (i) To determine the level and form of stakeholder engagement and involvement in national malaria control policy formulation, in order to identify priority research and policy issues; (ii) to consolidate knowledge on malaria burden and transmission intensity; (iii) to assess the strengths and weakness of the health services delivery, livelihoods and ecosystems that influence malaria control; (iv) to develop appropriate communication strategies and tools for results-sharing and utilisation; and (v) to enhance research capacity of the collaborating institutions and their boundary and strategic partners.

This project was implemented in Rusinga Island (Kenya), Nyagatare District (Rwanda), Kilosa District (Tanzania) and Kamuli District in Uganda. The focus of the study was on the linkages between malaria and livelihoods, malaria and ecosystems and malaria and health systems.

Four agro-ecosystems, namely, rice irrigation, maize and mixed farming, and savannah ecosystems were found in study countries. Rice farming was characterized by higher mosquito abundance and higher malaria prevalence. Maize/mixed farming was described in Uganda, Kenya and Tanzania while the dry savannah inhabited by pastoral communities was described in Tanzania. Malaria was described to be relatively low in savannah than in the rice irrigation agro ecosystem. The findings indicate clearly that generally, the main livelihoods of the people in East Africa are driven by water availability and resource management availability (crop farming, livestock farming and fishing).

The following activities related to water management were identified: (i) Maize farms along the lakeshore and rivers create mosquito breeding sites; (ii) Farmers dig holes to store water for irrigation. The holes remain with water most of the time hence provides suitable breeding sites for mosquitoes; (iii) Farmers dig ditches around farms to protect crops from livestock and hippopotamus. The ditches provide breeding sites for malaria mosquitoes; (iv) Flooding of rice fields leads to all year rounding breeding of malaria mosquitoes. It was also found that a considerable proportion of the population in East Africa keep livestock. Among them there are the nomadic pastoralists that shift in accordance with the availability of pastures and water. The key features identified among these communities that promote malaria transmission include poor housing structures that allow easy entry of malaria mosquitoes; and food insecurity that result in high prevalence of anaemia among children. As regards to fishing, it was found that: (i) poor housing conditions that allow easy entry of the malaria mosquitoes; (ii) extraction of earthworms (used as fish baits) from wet soil by digging creates pools of water suitable for mosquito breeding; (iii) Abandoned boats and those not in use hold water in which mosquitoes breed; (iv) use of mosquito nets for fishing, fish drying and covering fish ponds (to keep away kingfishers and other fish predators) diverts insecticide treated mosquito nets from rightful use; and (v) use of light for fishing silverfish attracts mosquitoes to fishermen.

While the health system strive to deliver preventive and medical care it is considerably handicapped in a number of ways making it difficult to achieve the set national and international goals. In terms of livelihoods, water management and culture and practices were identified to play important role in malaria transmission, acquisition and control.

The studies identified the following cultural factors and practices that promote increased mosquito biting among the communities. Farmers dress scantily when carrying out farming activities; Night outdoor family functions expose people to mosquito bites; and temporal shifting to farms expose farmers to mosquito bites.

MALARIA AND THE HEALTH SYSTEMS

The proper functioning of the health systems is known to significantly contribute to the wellbeing of the population. In this study the health systems were assessed to find out how they performed with regard to reduction of the malaria burden. The findings were categorized in relation to: (i) Governance; (ii) Resources; (iii) Health Information Management System; and (iv) Health service delivery. The findings indicate that livelihoods and ecosystem are not included in the National Malaria Control Policies. Moreover, the policy does not address intersectoral collaboration in malaria control. Other findings included frequent shortage of antimalarial drugs, lack of diagnostic services and poor case management. Although the integrated vector management approach is recommended in all the project countries, environmental management has received low attention. In all the four countries, there are no specific organized outdoor malaria interventions targeting fisherfolks and pastoralists to complement indoor malaria strategies.

In conclusion, the project has clearly shown that water is an important driver of rural community livelihood systems. This is true for fishing, pastoralism and crop production. It is therefore critical to introduce and strengthen proper water resource management strategies to prevent negative impact of water use in various livelihood practices. An inter-sectoral approach is required to address the identified problems. Health systems should be strengthened and provide livelihoods specific interventions.

RESEARCH PROBLEM

In spite of the many past and current efforts to combat malaria, the disease remains the leading public health problem in East Africa. Of the 130 million people in the region, more than 70% are at risk. Malaria has remained a major public health problem in East Africa for various reasons including human socio-cultural factors, inequity, weak health systems, limited budgets, poor governance and accountability, antimalarial drug and insecticide resistance, environmental changes and demographic factors.

Malaria represents a complex, multi-dimensional health problem with a host of interacting variables ranging from the parasite, mosquito vector, human host, local health-delivery systems to land use and climate change. A sound understanding of the nature and dynamics of certain ecosystem variables and their relationship to malaria transmission is a necessary step in identifying and addressing interventions that may reduce malaria while increasing agricultural productivity. Complex health problems such as malaria are difficult to solve without understanding socio-economic and environmental contexts. More complex and realistic approach to malaria control therefore, requires identification of certain kinds of livelihood factors, which, although are possible determinants of malaria transmission, also generate money to improve the well being of the population.

Because of the unique nature of the malaria situation in East Africa, innovative approaches to the problem are necessary. It is important that researchers, policy makers and malaria control implementers initiate new solutions appropriate for specific situations. This is because, it has been established that no single approach to malaria control will be successful across the countries; therefore multiple strategies, appropriate to socio-culturally and ecologically unique settings, must be implemented in an integrated approach.

This project focuses on providing solutions that will reduce malaria, resulting in improved health and well-being, increased productivity and poverty alleviation in East Africa. The initiative's immediate purpose is to strengthen capacity in integrated malaria research to develop and promote methods and tools for malaria control through improved livelihood, ecosystem and health systems. The main objective of this project was to investigate the relationships between malaria, livelihoods, ecosystems and health systems so as to strengthen the capacity to carry out integrated malaria research in an eco-health approach. This project specifically aimed: (i) To determine the level and form of stakeholder engagement and integration of factors related to community-based livelihoods, ecosystems, and health services in national malaria control policy formulation, in order to identify priority research and policy issues; (ii) to consolidate knowledge on malaria burden and transmission intensity in selected study areas; (iii) to assess the strengths and weakness of the health services delivery, livelihoods and ecosystems that influence malaria control; (iv) to develop appropriate communication strategies and tools for results-sharing and utilisation with target communities in improving malaria control strategies; and (v) to enhance research capacity of the collaborating institutions and their boundary and strategic partners working on malaria in the partner states and elsewhere in Sub-Saharan Africa.

RESEARCH ACTIVITIES AND FINDINGS

Regional inception workshop

At the start of the project regional inception workshop was convened to bring together key stakeholders (including strategic and boundary partners) to discuss malaria situation and control in East Africa. The workshop was conducted in Arusha, Tanzania on 21st July 2011. The workshop attracted 24 participants from Kenya, Tanzania and Uganda. The participants comprised of researchers, policy makers, district health, livestock and agricultural managers and journalists. There was no participant from Rwanda.

The workshop was chaired by Kenya. The guest of honour was the Director General of the National Institute for Medical Research, Dr. Mwelecele Malecela. In her opening speech, the Guest of Honour commended the Country Team leaders for developing such an interesting project. In her speech, she stressed that fact that in many projects, there is little trans-disciplinarity and participatory aspects, and hence widening the gaps in tackling complex problems such as malaria and the environment.

The project objectives were presented by the Project Coordinator and stressed the importance of key words from the title of the project such as 'integrated' and 'eco-health'. He said that little resources are allocated by the government on health research hence there is always little achievements regarding disease control. Each country project was given an opportunity to share with the participants the profiles of the study areas. Tanzania study targets rice farmers and pastoralists while Kenya and Uganda on crop faming and fishing. Boundary partners were described as very important actors to be involved in the project. Presentations were followed by a plenary discussion. The choice of the types of livelihood in this project was based on the fact that some of these groups are neglected; they are rarely taken on board in different health interventions. Pastoralists were said to be economically better off than crop farmers, but the current malaria interventions do not target their way of lives. Equally true is for fisherfolks, who despite a reliable source of income, they have very poor housing and the interactions between fishermen, salesmen and the community put them at higher risk of malaria.

Human factors that contribute to malaria transmission among the selected livelihoods were discussed. These included construction of watering points, road construction, constant movements among pastoralists, dressing codes among fisherfolks and pastoralists, and low knowledge on malaria transmission and impact on socio-economic status. Gender issue was seen important especially on decision making and income distribution. In the discussion, it was agreed on the need to explore on how malaria policies have been formulated in the region.

It was agreed each country to work on one of the following components of the livelihoods -crop farming (rice irrigation; non-irrigated crops), pastoralism and fishing. It was agreed that the country projects should carry out systematic reviews on the following subjects:
1. Pastoralism and malaria in Sub-Saharan Africa (Tanzania)
2. Malaria among fisherfolks in Sub-Saharan Africa (Kenya)
3. Subsistence crop farming and malaria in Sub-Saharan Africa (Uganda)
4. Rice irrigation and malaria (Rwanda)

The workshop discussed, identified and agreed on priority research areas in the context of integrated malaria research and control. The team agreed on respective specific areas on systematic review on the interaction of livelihood, ecosystem and health systems on malaria burden and control. The following activities were agreed to be implemented:

Country Project Inception Workshops

In Kenya, a project inception workshop that brought together partners including the Mbita District Public Health Office, six community based organizations (CBOs) and International Centre of Insect Physiology and Ecology (*icipe*) malaria program staff was convened on 10th August 2011. The six CBOs included *Kibisom* women group, *Kony Ngimani* self help group, *Badilisha* eco-village project, *Mabati* women group, *Lak Nyiero* self help group and the Rusinga Malaria Programme (RMP). The aims of the meeting were to (i) meet and formally introduce potential partners, (ii) inform them about proposed research and development activities, and (iii) collectively define boundary partnerships. Invited groups were asked to describe their organizational activities in order to effectively assign roles and develop a functional outcome mapping structure essential for conceptualizing the problem of malaria in a livelihoods and ecohealth context. The meeting was held at the Thomas Odhiambo Campus of *icipe* located near Mbita Point Township in western Kenya. The *icipe* being a custodian of experts actively working on various aspects of malaria was charged with the responsibility of steering the partnership. *Kibisom* women group and the Mbita-DPHO were designated to work as *icipe*'s boundary partners based on their activity profiles and strategic embedment. *Badilisha* eco-village project, *Kony Ngimani* self help group, *Lak Nyiero* self help group and *Mabati* women group were designated as boundary partners of *Kibisom* i.e. the CBO from where they originated and with whom they actively collaborate. The Rusinga Malaria Program (RMP) was designated as a boundary partner of the Mbita-DPHO by virtue of interrelated visions and activities.

In Tanzania, before the workshop, the national research team members were oriented on eco-health approach in malaria research and control in a 2-day workshop in Dar es Salaam. The Project launch and inception workshop was held at Clinical Officers' Training Centre in Kilosa on 18th August 2011. The objective was to engage the district management team to the project activities. The workshop was attended by researchers from the National Institute for Medical Research (NIMR), Sokoine University of Agriculture (SUA) and Ilonga Agricultural Research Institute and representatives from Kilosa District Council departments of health, agriculture, livestock development, environment, water, irrigation, education and community development. The participants were engaged and oriented on the objectives and implementation of the project through a one day workshop. Together with research team, they identified gaps and possible solutions in malaria prevention and control in a participatory manner. Malaria was described as an important public health problem in Kilosa – based on health facility data and complaints from community members. Socio economic factors that contribute to the malaria endemicity in Kilosa were identified to include: (i) Rice irrigation systems; (ii) Brick making; (iii) Road construction; (iv) Urban farming; (v) Poor environmental sanitation. Identified gaps in malaria control included: (i) Lack of appropriate and effective Information, Education and Communication about malaria and its control; (ii) Poor policy implementation; (iii) Enforcement of laws and by-laws; and (iv) Inadequate budget.

The participants had an opportunity to highlight and agree on the current research/policy priority areas: (i) Community education and involvement in malaria control and solving other socio-economic problems; (ii) health systems especially, malaria diagnosis; and (iii) Multisectoral approach in identifying health problems. The participants identified key stakeholders in malaria control to include: Crop farmers, pastoralists and community in general; Health/ Medical personnel; Policy makers including Councillors and political leaders; Faith based (FBOs), Community based (CBO) and Non-governmental organizations (NGOs); Research and Training Institutions; and Pharmaceutical and mosquito net outlets. A number of groups were identified to be involved in malaria control in the district. These include Non-governmental organizations, various district departments and political leaders.

The inception workshop for the Rwanda project was held in Nyagatare on 13th December 2012. There were 21 participants drawn from various sectors of socioeconomic activities in Nyagatare District. The workshop objectives were: (i) To meet and formally introduce/identify potential partners in malaria control; Share malaria control experience/roles with the partners; (ii) Inform partners about the proposed research and related activities; (iii) To identify potential socio-economic factors for malaria endemicity in Nyagatare; and (iv) Identify opportunities for multi-sectoral approach in malaria control. The presentation about the project was made to the workshop participants. Clarification was made that IPMA, operates with separate teams in Rwanda, Tanzania, Kenya and Uganda that contribute to joint reporting. It was acknowledged that the project is supported by the International Development Research Centre (IDRC) of Canada which would love to see that the collaborative efforts among the different stakeholders established during the grant period would generate interest among other sources of funding to continue the activities beyond the IDRC support.

Group discussions were held to explore participant's view of malaria burden in the district, key stakeholders in malaria control; and opportunities available for multi-sectoral collaboration in malaria control. Malaria was described to be a burden in Mimuli and Rukomo Sectors in Nyagatare district whereby most malaria cases occur from May to June and November to December probably due to the swamps and other sources of water in the valleys that support mosquito breeding and other reasons.

In Uganda, Kamuli District departments of health, agriculture, environment, water, irrigation and community development were engaged and oriented on the objectives and implementation of the project through a one day workshop. Together with the research team, the participants , who included staff from the respective departments, representatives of community –based organisations, members of village health teams, medicine distributors and local council one chairpersons from Bukungu fish landing and Nabwigulu subsistence farming communities, identified gaps and possible solutions in malaria prevention and control in a participatory manner. They identified factors responsible for accelerating malaria transmission in these communities which included: farming activities which left behind water collection points which favoured mosquito breeding, old/unused boats acted as mosquito breeding grounds, poor environmental hygiene and the poor housing designs facilitated mosquito entry and increased indoor human biting mosquito densities, bed nets were used for other purposes, i.e., for various fishing activities like fish drying, covering, etc, instead of protecting humans against mosquito bites. There were no collective efforts for malaria control and prevention among these communities. These communities lacked a malaria control action plan. The project boundary partners pledged to lead by example and drew a joint malaria control action plan with assistance from the research team. The malaria action plan included improving environmental hygiene and the housing designs; establishment of a malaria control fund; advocacy and lobbying for malaria control tools and materials from the Ministry of health through the district health department; promoting proper use and disposal of mosquito bed nets and holding village malaria control meetings.

SYSTEMATIC REVIEWS

Systematic reviews on the relationship between subsistence agriculture-based livelihoods and malaria burden, association between ecosystems and malaria, and impact of health services and malaria control in Uganda/East Africa are on-going. Tanzania is finalizing its review. A summary of the review paper from Tanzania is described below:

Tanzania: Pastoralism and malaria in Sub-Saharan Africa: a review[*]
Pastoralism is a free-range livestock production system, practised in all of Africa's dry land regions. In some communities it is the main source of food security and income. The ways of life of the pastoralists make them prone to a number of communicable diseases including malaria. Moreover, most of the current malaria control strategies, rarely address this group of population. The objective of this review was to analyse and document the interaction of pastoral ecosystem and livelihoods on malaria burden and control in Sub-Saharan Africa (SSA). Internet search, library archives, desk review of publications and technical reports on pastoralism and malaria in SSA were done. Searches included peer reviewed, unpublished and grey literature on pastoralism, livelihoods and malaria. The internet search was conducted using specific search items including, livestock, pastoralism, nomads, livelihoods, malaria. Generally, pastoralism is common in arid and semi-arid areas where malaria is of seasonal and low transmission. However, pastoralist communities can move between areas of high and low malaria transmission, such that on the one hand they may bring malaria into an area where it has been reduced or on the other hand they may come from an area where transmission is low and be quite vulnerable to the serious effects of the disease upon entry into a high transmission area. In some parts of Africa malaria prevalence among pastoral communities appears to be higher than among crop farming communities. Ruminant livestock have been incriminated to create habitats for mosquito breeding. Ruminant hoof prints have been reported as important aquatic habitats for *Anopheles gambiae*. However, keeping cattle has been found to be beneficial (zooprophylaxis) in malaria prevention in some parts of the region. The introduction of cattle in areas that livestock keeping was not practised has been associated with the decline in malaria transmission indices. On the other hand, malaria epidemics have been reported in areas where large heads of cattle were moved out. Although cow dung has been implicated to support breeding of malaria mosquitoes, in some places, burning of cow dung has been reported to repel mosquitoes, and provide protection. In conclusion, malaria is a major public health problem among pastoral communities in Africa. Moreover, pastoralism may play a bidirectional role of either bringing in or out malaria from one place to another. However, little is documented of the appropriate utilisation pattern of malaria intervention tools among livestock keepers. This requires further study. Studies on malaria and pastoralism need to be undertaken to establish interactions that would allow design of appropriate malaria interventions.

Rwanda: Impact of rice cultivation on malaria epidemiology in Africa: a systematic review
The review of literature has shown that although rice growing increases the population of the mosquitoes that transmit malaria, it does not always follow that malaria increases in the population. This has been attributed to increased wealth and awareness among the rice growers thereby being able to access and utilize tools for malaria control. This has been shown in the present study that people having electricity or using candle in the houses had less likelihood of suffering from malaria fever, whereas those with wattle and daub type of houses had more likelihood of suffering from malaria. Thus, in addition to the use of available malaria control tools

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[*] To be published as: Mboera, L.E.G., Bwana, V.M., Rumisha, S.F., Malongo, M.R.S., Mangesho, P.E. (2014) Pastoral livelihoods and malaria in sub-Saharan Africa: a review. *Pastoralism* (submitted)

the household income need to be improved to overcome the vicious circle of malaria and poverty.

Uganda: Malaria and subsistence farming
The objective of this review was to analyse the relationship between subsistence farming and malaria burden and control in Sub-Saharan Africa (SSA). Internet search, library archives, desk review of publications and technical reports on subsistence farming and malaria in SSA were done. Searches included peer reviewed, unpublished and grey literature on subsistence farming and malaria. The review showed that the malaria burden is not only a threat to the people of Sub Saharan Africa, but to the world over. The link between malaria burden and subsistence agriculture has been established and discussed. In particular, subsistence agriculture changes the ecology of the disease vector and its host options; it changes the local climate and thereby affecting the spread of the disease by reducing moisture held by the vegetation and green cover and raising ground temperatures. It has many putative impacts via the role of trees in the carbon cycle and regional weather patterns. Changes in the ecology due to subsistence agriculture can play a role of anti-malarial resistance that further worsens the malaria burden.

Therefore, it is of critical concern that governments in the region have concerted efforts to help their populations out of subsistence agriculture which appears to have multi-faceted detrimental effects on the environment and the malaria spread and hence its burden.

STAKEHOLDER ENGAGEMENT AND NATIONAL MALARIA CONTROL POLICY FORMULATION

This work has been carried out to explore and document malaria control policy development process and to identify stakeholders involved in the process in East Africa. The role and operationalization of the key actors was documented and analysed to identify inter-sectoral linkages.

In Kenya several national malaria control policy documents were reviewed with the aim of identifying text on livelihoods and eco-health with respect to malaria. The key documents reviewed included (a) the National Malaria Policy 2010, (b) National Malaria Strategic Plan 2009 – 2017, and (c) the Malaria Prevention Bill 2010. The National Malaria Policy 2010 mainly focuses on implementation of malaria control interventions. These include universal access to prompt diagnosis and effective treatment, indoor residual spraying in endemic areas, intermittent preventive treatment during pregnancy and universal coverage of populations at risk using interventions such as long lasting insecticide treated nets (LLINs). The National Malaria Policy 2010 contains no statement on livelihoods and ecosystem health with respect to malaria.

The National Malaria Strategic Plan (NMSP) 2009 - 2017 is a long-term investment plan articulating the vision, goals, objectives and strategies guiding malaria control in Kenya. The document details six key strategic objectives and targets that the national malaria control programme should achieve during the implementation period. Some of the objectives include i) to have at least 80% of people living in malaria risk areas use appropriate malaria preventive interventions by 2012, ii) to have 80% of all self-managed fever cases receive prompt and effective treatment and 100% of all fever cases who present to health facilities receive parasitological diagnosis and effective treatment by 2012, among others. The NMSP contains no statement on livelihoods and ecosystem health with respect to malaria.

The principal objective of the Malaria Prevention Bill, 2010 was to repeal and re-enact the Malaria Prevention Act in order to establish the Malaria Prevention and Control Institute. Part four of the bill indicates measures to be taken by health authorities to prevent or suppress malaria. Three sections in the bill contain statements that impinge on ecosystems and livelihoods. Section 21, subsection (1) of part four, states that "*a health authority may, for the purpose of prevention or suppression of malaria construct and maintain within the area subject to its control a system of drainage for the removal of water from any land within the area*". Section 24, subsection (1), states that "*a person shall not, within an area subject to the control of a health authority, plant trees or cultivate land in such a manner as is likely, in the opinion of a health authority, to obstruct the flow of water in, into or out of a drain or culvert under the control of a health authority*". Section 26, subsection (1) states that "*Whenever it appears to a health authority that any land, pond, tank, well, spring, drain, stream, waterlogged ground, swamp, irrigation canal or other collection of water within an area under its control is or is likely to be favourable to the existence or propagation of mosquitoes, the health authority may, by notice in writing, require the owner or occupier of the land, within reasonable time to be specified in the notice, to comply with such requirements with regard to the land, pond, tank, well, spring, drain, stream, waterlogged ground, swamp, irrigation canal or other collection of water as it may specify for the purpose of preventing or suppressing the existence or propagation of mosquitoes*". In addition, the bill states that persons are not allowed to cultivate land in a manner that will obstruct flow of water into or out of a drain.

In Rwanda, various policy and strategic plan documents reviewed showed that the development of the malaria control policies, strategic plan and their implementation involves a range of stakeholders and activities. There are some clear linkages and collaborative undertakings between institutions within the health sector. However, for entities outside the health sector e.g.

a number of government ministries, that collaborative endeavour for malaria control is not evident. Given that malaria control entails crossing into other sectors like agriculture, water resources, environment, education and many others, there is a need of intensifying intersectoral collaboration in planning for a holistic malaria control strategy. To be achieved, sustainable malaria control shall require the involvement of various stakeholders from the public and private institutions including those who are health and no-health oriented in their activities.

The procedure of finding out the malaria policy development process and the main participants in malaria control in Rwanda involved holding some discussion with the Malaria and Other Parasitic Diseases Division and reviewing various related documents. These include (i) Rwanda Malaria Strategic Plan (July 2012 to June 2017); (ii) Third Health Sector Strategic plan-HSSP III (July 2012- June 2018); (iii) Community Health Strategic Plan (July 2013-June 2018); (iv) National Community Health Policy (2008); (v) National Strategic Plan for Integrated Vector Management Plan (2013- 2017); (vi) Health Sector Policy, Government of Rwanda (2005); (vii) Economic Development and Poverty Reduction Strategy-EDPRS2 (2013–2018); and (viii) Ministry of Health Annual Report (October 2011).

The current five year Malaria Strategic Plan operational from July 2012 to 2017 was developed with the involvement of a number of collaborative organizations from both the public and private sectors. These include the following: Ministry of Health, District hospitals, World Health Organization (Country Office and Africa Region Office-AFRO), various non-governmental agencies working on malaria in Rwanda such as CARITAS Rwanda, Imbuto Foundation, Rwanda Development Organization, World Vision, Association of Vulnerable Widows Infected and Affected by HIV and AIDS, Deliver Rwanda, Population Service International, Society for Family Health, Clinton Health Access Initiative, Presidential Malaria Initiative, Maternal and Child Health Integrated Programme.

At central level, there are central departments of the MoH and the Rwanda Biomedical Centre. The MoH formulates health policies, undertakes strategic planning, carries out high level technical supervision, monitoring and evaluation, and national level resource coordination. The Rwanda Biomedical Centre coordinates the majority of the health Divisions/Units charged with programmatic disease control activities, a tertiary reference hospital, medical procurement and distribution, the Health Communication Centre, the Rwanda Medical Research Centre and the Medical Maintenance Workshop. The MoH is represented at district level, hospital level, Sector level, Cell level, and Village (Umudugudu) level by staff with specific roles and responsibilities including malaria control.

The various policy and strategic plan documents reviewed showed that the development of the malaria control policies, strategic plan and their implementation involves a range of stakeholders and activities. For public institutions within the health sector there is some linkage in activities because of the interaction during the planning stage and their related performance contracts could influence synergies in the output. However, for institutions that are less close linkages are not clear enough to be identified, for example between MoH and other ministries and the various NGOs. Nevertheless, the Rwanda Health Sector Policy (2005) highlights how non-public institutions could be engaged to provide related health care service by entering certain contracts.

In Tanzania, the main objective of this exercise was to map and explore key actors and stakeholder engagement in malaria control policy formulation and implementation in the country. This work was done through a desk review of various publications, reports and policy guidelines. In Tanzania, a review of documents on malaria profile and policy was carried out using current health sector policy framework, specific sector policies and health sector strategic plans.

The following government policy documents were available for critical analysis: (i) Malaria Medium Term Strategic Plan, 2008-2013; (ii) Health Sector Strategic Plan III July 2009–June 2015. In the process, policy gaps and main actors in the health sector were identified. The Strategic plan indicates that Tanzania employs two key technical components in its malaria control strategy (i) Malaria Diagnosis and Treatment; and (ii) Integrated Malaria Vector Control. In addition, there are three supportive strategies: (i) Monitoring, Evaluation and Surveillance; (ii) Community mobilisation; and (iii) Regional and district support and capacity building. From the list of those who contributed in one way or another in finalizing the National Malaria Medium Term Strategic Plan, the following institutions/organization were involved: Ministry of Health and Social Welfare, Universities, District Councils, Regional Secretariat and Non-governmental organizations. One of the Steering committees draws its members from: (i) Research Institutions; (ii) Ministry of Agriculture; (iii) Prime Minister's Office for Regional Administration and Local Government; (iv) Representatives of non-governmental organizations; (v) WHO and UNICEF Representatives. This sub-committee is composed of some members from outside the health sector.

The Ministry of Health and Social Welfare and the Prime Minister's Office Regional Administration and Local Government were the key actors in malaria control. Other included Faith-based Organisations and private and non-governmental organizations, health research and academic institutions as well as the mass media and manufacturing firms including pharmaceutical industries and textile mills. Realizing the involvement of various actors in malaria interventions, strengthening formal collaboration and linkages is crucial for a sustainable malaria control approach. Despite the fact that the National Health Policy provides a plan to promote awareness among Government employees and the community at large and that health problems can only be adequately solved through multisectoral cooperation, the linkages between sectors in malaria control is still informal and weak.

In Tanzania, factors that promote or inhibit intersectoral collaboration in relation to malaria control in Tanzania were determined. Data were collected through participatory meetings organized at district and village levels. The sectors involved were health, agriculture, environment, livestock, fisheries, education, works, irrigation, water resources, land development, forestry, and community development. At the national level, a self administered questionnaire was sent electronically to identify policy and decision makers.

At the district level, using a systematic sampling method, participants were divided into three groups: Agricultural Sector, Construction Sector and Education Sector. Participants were given three key questions to discuss and deliberate: (i) what are the sectoral activities which are likely to impact health paying specific attention to malaria?; (ii) are there inter-sectoral collaborations to control malaria in the district?; and (iii) what are the efforts, challenges and opportunities for intersectoral collaborations in malarial control? At community level, meetings were held with the community leaders of Tindiga, Malui, Mbwade, Twatwatwa and Kimamba villages. Participants were Ward Executive Officers, Village Executive Officers, Village Chairpersons, representatives of the Village Health Committees, community development officers, ward health officers and agricultural extension officers.

At the district level, the sectoral activities identified to contribute to malaria transmission included irrigation, deforestation; fishing activities, nomadic life style, water storage, road construction, house location, brick making, poor drainage systems, and farming systems. The district representatives admitted that to some extent intersectoral collaboration exist though not specifically for malaria control. Lacks of policy and budget allocation were among the major reasons for a weak intersectoral collaboration. Specific inter-sectoral strategies were proposed

to respond to gaps identified in the research findings and issues raised from the group discussions. In a participatory manner, the community, research and district representatives agreed that malaria in Kilosa District is contributed to a greater extent by human activities; hence an intersectoral approach is necessary to address the health problem. In conclusion, malaria prevention must be addressed through a multi-and inter-sectoral approach.

In Uganda, a review of documents on malaria profile and policy and interviews/discussions with key informants at the Ministry of Health were carried out using current health sector policy framework, specific sector policies and health sector strategic plans. The following government policy documents were reviewed: The National Malaria Control Strategic Plan (2005/06- 2009/10); The Health Sector Strategic and Investment plan (2010/11-2014/15); The Poverty Eradication Action Plan (2010/11-2014/15); The Health Sector Ministerial Policy Statement (2010/11) and the President's Malaria Initiative operational plan Financial year 2013. Discussions were held with Key Informants at the Ministry of health headquarters, Kampala, namely: The National Malaria Control Programme Manager, Districts Desk Officer.

In Uganda, the key actors in the development process of national malaria control policies with respect to livelihoods, eco-health and health systems in Uganda included the Ministry of Health, the line ministries (Agriculture, Animal Industry and Fisheries; Water and Environment; Trade and Industry; Works, Roads and Transport; Education; Finance, Planning and economic development), civil societies, non-governmental organisations, development partners (WHO, UNICEF, USAID, DFID, World Bank, ADB, etc) and the private sector. However, linkages between these key actors are poor, yet all these need to work in partnership in order to achieve the set objectives and targets relating to malaria control in the country.

MOSQUITO ABUNDANCE AND MALARIA TRANSMISSION INTENSITY

Study areas

In Kenya, the study was carried out in Rusinga Island in Suba district ($0°35'$–$0°44'$ S; $34°11'$–$34°22'$ E; altitude 1,100 m). The area is 42 km^2 and is the second largest island in Lake Victoria in Kenya. Rusinga Island has an estimated population of 24,078 inhabitants which form 5,425 households. Two government health centres serve Rusinga's population. The terrain is extensively deforested and generally rocky and hilly with limited vegetation cover. Two rainy seasons are typical for the area, the 'long rains' between March and June and the 'short rains' between October and November. In Rusinga Island traditional fishing and fishery activities constitute an important source of livelihood. Fishery activities practiced include (i) fishing, (ii) fish processing such as sun-drying, smoking, deep frying and filleting, (iii) buying and selling of fish, (iv) buying, selling and repair of fish nets, (v) boat construction, (vi) coxswain ship and, (vii) fish brokerage/middleman-ship.

In Rwanda, the study site was in Nyagatare District ($1°18'$ and $30°19'30E$). The area is located in the Eastern province bordering Tanzania and Uganda. The district is part of the grassy lowland plains and low hills of eastern Rwanda, with an average altitude of 1513.5m. The rainfall is weak and sporadic with an annual average of 827 mm. The average annual temperature ranges between 25.3 °C and 27.7°C. There are two main seasons of which the dry season lasts from June to October. The major economic activities are rice farming and livestock keeping. Rice farming is practiced in the large valley of river Muvumba that cuts across the district. Nyagatare is among the districts considered to have the highest burden of malaria and that were originally classified as endemic for the disease.

In Tanzania, the study was been carried out in Kilosa District ($9°127'$-$9°3339'N$ and $22°17'$-$32°49'E$) in central Tanzania. The district has a total surface area of about 14,400 km^2 and a population of 489,513 people. The area experiences a tropical savannah climate characterised by a monomodal rainfall pattern. The rains begin in October with a peak in April and continue till May. The mean annual temperature is 25°C. The district is characterised by mountains, hills, and foot slopes of mountains, undulating plains with broad valley bottoms and alluvial plains comprising the floodplains. The main land uses in the district constitute crop farming and free-range livestock production systems.

In Uganda, the study was carried out in Kamuli district ($01°05'N$ and $33°15'E$) in the eastern part of the country. Kamuli district is located 68km north of the source of River Nile, with an area of 34,44km^{2}of which 835km^2 is water; and a population of over 500,000 people in 106,922 households. The district is divided into 3 counties, 17 sub-counties, 101 town councils, 104 parishes and 1293 villages. The district has two rainy seasons, the heaviest rains in March–June and small rains in August–November. The major economic activities include crop farming (maize, rice, sweet potatoes), livestock keeping and fishing on River Nile and Lake Kyoga.

Entomological surveys were carried out to determine the mosquito species, abundance and malaria transmission intensities. Mosquitoes were sampled from houses in selected villages in each study site using the battery operated CDC light traps. In each house, a room occupied by one person was used for mosquito collection. A standard miniature CDC light trap with incandescent light bulb (Model 512; John Hock Company, Gainesville, FL) was hung beside a bed net (untreated) with the shield of the trap touching the side of the net and the trap entrance in the foot end of the bed. The traps were set at 18:00hr and the owner of the room was instructed to put off the trap and tie the mosquito collecting bag at 06:00 hr in the next morning. The

human biting fraction of the mosquito population was sampled for three consecutive nights. All mosquitoes caught during each night were identified morphologically *as Anopheles gambiae sensu lato* or *Anopheles funestus*, counted and scored as unfed, blood-fed or gravid. The mosquitoes were then stored under silica gel in containers pre-labelled with place of capture and their identity and kept under cool conditions for future laboratory analyses.

The entomological surveys in Uganda and Tanzania employed a similar methodology using CDC light traps in Uganda and Tanzania. Human-landing catch and pyrethrum spray techniques were used to collect adult mosquitoes in Rwanda. In Kenya, mosquitoes were sampled inside and outside residential houses using odour baits. Caught mosquitoes were identified using morphological features and stored in silica gel pending PCR analysis. A total of ten odour baited Mosquito Magnet-X (MM-X) traps were used to sample mosquitoes indoors from a total of 16 houses per month. Other ten MM-X traps were used to sample mosquitoes outside the 16 houses for ten nights. Mosquitoes were also captured at Kaswanga fishing beach to assess the relationship between fishery activities and risk of exposure to bites of malaria transmitting mosquitoes. In Kenya, Rwanda, Tanzania and Uganda, the study also assessed the anthropogenic activities associated with malaria mosquito productivity and to investigate on the diversities of mosquito breeding sites. A larval search was done using a dipper. Mosquito larvae and pupae were collected and identified to genus level.

In Kenya, the total numbers of mosquitoes, which were trapped for a period of eight months starting from September 2012 to April 2013, were 447. Out of these 411 were females and 36 were males. The two species of female malaria mosquitoes trapped were *Anopheles gambiae s.l.* (n = 50) and *Anopheles funestus* (n = 397). Although more female mosquitoes were caught indoors (n= 266) than outdoors (n= 181), the number of *An. funestus* caught outdoors were fewer (n = 138) than those caught indoors (n = 233) and the reverse was the case for *An. gambiae s.l.* (n = 27 versus 13, respectively) (Figure 1).

The study in Kenya found no significant differences between the numbers of malaria mosquitoes (namely *An. gambiae* and *An. funestus*) with increasing distance (zero to 1,800 meters) from the Lake shore. This could be attributed to the fact that the mosquitoes were collected during the dry season when densities were very low to make statistical sense.

A total of 7,926 people were recorded at the beach conducting fishing activities of which 6,740 (85%) were male and 1,186 (15%) were female. The number of men recoded at the beach was higher than that of women throughout the study period. The data indicate a presence of two peak mosquito biting periods between 18:00 hours and 06:00 hours. The first peak is between 21:00 – 24:00 hours and the second peak is between 03:00 06:00 hours. There seems to be an increase in mosquito numbers and number of people at the beach during the two peak times. There seems to be an association between human and mosquito activities at the fishing beach. The categories of people most likely to receive infectious mosquito bites during the first peak between 20:00 hours and midnight are members of the fishing crew. Fish mongers, boat owners and the fishing crew are more likely to be bitten by infected mosquitoes during 03:00 06:00 hour peak mosquito biting period. Other individuals in the fishing industry, for instance net repairers, are not likely to receive infectious mosquito bites because they do not conduct livelihood activities at peak biting times.

In Rwanda, the results showed that there was a high malaria parasite infectivity rate at 270 *Anopheles* infective bites per person per year. However, self-reported net ownership was found to be 99.0% and it was considered to have influenced lack of malaria infected underfives year old children examined. On the other hand, lower LLIN utilization in children over 5 years of age particularly the 5-9 year old may explain the observed higher parasite density and the presence of

gametocyte in this group. There is a need of extending net availability and usage to the age group 5-9 years. Householders requested for availability of LLIN to buy perhaps that would cover the gap left by the issued nets.

In Tanzania, a total of 936 female mosquitoes were collected in 15 houses. Some 46.9% were malaria mosquitoes (*Anopheles arabiensis* = 28.6%; *Anopheles funestus* = 18.3%). *Culex quinquefasciatus* accounted for 30.3% of the total population. The largest proportion of the malaria mosquitoes (62.8%) was collected in Malui and the smallest proportion (2.3%) in Twatwatwa. Both the abundance and house density of the anopheles mosquito in this study was low. However, malaria mosquito accounted for about half of the total mosquito caught host-seeking indoors. Some 58.6% of the malaria mosquitoes were collected from the two rice-farming villages. Two-thirds of the malaria mosquitoes were collected in Malui (rice agro-ecosystem) and the lowest number Twatwatwa (dry savannah ecosystem). On average, 17.87 Anopheles mosquitoes were collected per village per day. Human biting rate per person per night for the two malaria mosquitoes was highest in Malui (46.01) and lowest in Twatwatwa (1.67). The variation in the abundance of anopheles mosquitoes was observed between villages and between different ecosystems. In the current study the parity of the anopheles mosquitoes was low. None of the anopheles mosquito in the current study was infected with malaria parasites. The low mosquito densities observed in the area are likely to be due to several factors including trapping technique and mosquito behaviours. The absence of sporozoite in the current study is likely to be attributed to the low mosquito abundance most probably a result of high mosquito coverage in the district. A more intensive longitudinal study is recommended to establish spatial and temporal malaria transmission intensity in the area.

In Uganda, a total of 1,527 female anopheline mosquitoes were caught biting humans in both the fishing and crop farming communities, of which 936 (60.6%) were *Anopheles gambiae sensu lato* and 601 (39.4%) were *An. funestus* group. A sub sample of the Anopheles mosquitoes were tested for *Plasmodium falciparum* circumsporozoite protein using sporozoite ELIZA methods. Out of 265 anopheline (in 53 five mosquito pools) tested for *P. falciparum* CSP, 50.9% (27) were CSP positive, with minimum infection rates of 0.21 and 0.09 in subsistence crop farming and fishing communities, respectively. Annual entomological inoculation rates of 292.23 and 6.75 in the respective communities were observed. In addition to indoor human biting catches of female Anopheles mosquitoes, Anopheles larval sampling in major breeding sites has also been carried out in the project sites.

In Kenya, manmade habitats represent by far the largest number of mosquito breeding sites constituting 60% of all available mosquito breeding sites on the Island as opposed to 40% natural habitats. Interesting to note is that about 70% of the manmade habitats are linked to livelihood practices. In Rwanda, the mosquito breeding habitats were dominated by stagnant water in rice paddies but this habitat was less productive of mosquitoes than back water from streams. The timing of the survey whereby rice growth had advanced could partly explain the low yield of the mosquitoes in the paddies. Nevertheless, considering the vast nature of paddies, the rice fields were the most productive of the *Anopheles mosquitoes* in Mimuli. The cattle drinking troughs were found with no malaria mosquitoes. However, they should be monitored as they constitute a potential breeding site of mosquito population. In Tanzania, man-made habitats accounted for 86.18% of all potential breeding sites. The majority (85.25%) of the man-made habitats were associated with livelihood practices. Brick making borrow pits accounted for 30% of all potential anopheles mosquito breeding sites. A total of 399 people (mean age= 39.7 years; SD=15.2) were interviewed. There was low knowledge among the community on potential mosquito breeding sites. Only 1.5% and 0.25% knew that farming systems and other human activities, respectively, were contributing to mosquito productivity in their village. In conclusion, human activities are

responsible for the majority of potential mosquito breeding sites in the study area. Inter-sectoral efforts are required to mitigate human activities that are responsible for increasing mosquito productivity in order to reduce malaria transmission. In addition, appropriate public education on environmental management is required in controlling mosquito productivity.

MALARIA PREVALENCE

In Kenya, Rwanda, Tanzania and Uganda, malariometric surveys were carried out using Rapid Diagnostic Tests. In Rwanda and Tanzania, blood samples were also collected for microscopy comparison and the study subjects were also examined for fever, haemoglobin level and spleen enlargement. In Rwanda and Tanzania, the research subjects were asked about the ownership, utilization and source of long lasting insecticide impregnated nets at their homes. In addition to malariometric surveys, in Rwanda, an analysis of the trend of malaria using Demographic Health Survey data was carried out.

In Kenya, malaria prevalence was 20.9% according to RDT. *Plasmodium falciparum* accounted for 65% of the infections, mixed parasitaemia 34% and none non-*P. falciparum* 1%. Of the total of 2,318 people diagnosed for malaria by microscopic examination 12.2% tested positive for malaria parasites. Out of the 252 people found positive with malaria parasites by microscopy, 88.5% were due to *P. falciparum*, 4% had *P. malariae*, 0.8% had *P. ovale* and 6.7% had mixed infections. Higher prevalence was observed among the young age groups.

Comparing farmers and fishermen in Kenya, a total of 362 people (farmers=114; fishermen= 248) were recruited into the study. Overall, 24 fishermen and 13 farmers tested positive for malaria infection giving a prevalence of 9.7% and 11.4% among the two groups, respectively. Of the 362 people recruited into the study, 311 people reported that they live in houses with open eaves while 51 individuals resided in houses with closed eaves. The number of malaria cases among persons living in houses with open and closed eaves were 32 (10.2%) and 5 (9.8%), respectively. A majority of the participants (319 out of 362) lived in houses that did not have a ceiling, while 43 lived in houses with a ceiling. The number of malaria cases among persons living in houses without a ceiling and with a ceiling were 32 (26.9%) and 5 (11.6%) (*P*< 0.05), respectively. Of the participants, 71, 13 and 278 lived in houses whose walls were made of permanent materials (brick, stone and cement), iron sheets and mud, respectively. Among the individuals who had malaria, 6 (8.5%) were from houses with walls made of permanent materials, 1 (7.7%) from house walls made of iron sheets and 30 (10.8%) from mud houses. Apparently malaria risk was less (13/362 or 6.7%) among individuals who dressed fully than those dressed scantily (24/362 or 14.2%) while executing outdoor activities.

The number of malaria cases among persons who used a bednet the previous night and those who did not use any malaria prevention measure were 33 (9.9%) and 4 (14.3%), respectively. Bednets were reported to be used at work by 6 people while those who did not use any malaria prevention tool were 256. Out of those who use bednets at work, only 1 person (16.7%) had malaria while 36 people (10.1%) who did not use any malaria control measure were infected with malaria.

In Rwanda, the overall malaria prevalence was 9%, being highest (16.8%) among 5-9 years children. Splenomegaly ranged between 4.2% and 8.7%; the highest was among >9 year-old children. Overall the prevalence of anaemia was 9.3%. In Uganda, malaria prevalence was 25.1%. The highest prevalence was observed among crop farming communities (46%) than fishing communities (26.3%). Malaria infection was more prevalent among children than adults.

In Tanzania, a total of 1,318 school children aged 9 years (range=4–16 years) were screened for malaria infection. The overall malaria prevalence by RDT and microscopy was 8.5% and 3.5%, respectively.

Prevalence of malaria infection, splenomegaly and anaemia by livelihoods and village in Kilosa district

Type of livelihood	Village	No. screened	mRDT N (%)	Microscopy N (%)	Spleen N (%)	Anaemia (%)
Rice farming	Tindiga	250	35 (14.0)	22 (8.80)	4 (1.6)	24.4
	Malui	258	58 (22.5)	20 (7.75)	2 (0.79)	19.4
Pastoralism	Twatwatwa	269	6 (2.23)	2 (0.74)	0 (0)	38.7
	Mbwade	239	9 (3.77)	2 (0.84)	0 (0)	15.1
Mixed livelihoods	Kimamba	302	4 (1.32)	0 (0)	0 (0)	13.6
	Total	1318	112 (8.5)	46 (3.5)	6 (0.47)	22.2

No significant difference in malaria prevalence was observed between sex, age or mosquito net. However a reduction on the odd of acquiring malaria infection was observed for those who were using mosquito nets. Children over 8 years old were observed to be at higher risks of acquiring malaria infection as compared to the younger children. A significant high risk of malaria was observed among children from the rice farming communities. Those living in areas with health care facilities had low odd of malaria infection by 45% (OR: 0.55; 95% CI. 0.35, 0.86).

In Uganda, malariometric surveys covered 519 people (224 adults and 295 children) living in 70 households at Bukungu fish landing site, Nabwigulu crop farming and Kyanshama game park communities. Malaria rapid diagnostic tests were employed in determining the community malaria point prevalence. Parasite prevalence was expressed as the number of infected people per the total number of people screened in the population cluster in that period of time. Overall, 25.1% (130 out of 519) of the people screened in the three sites combined had malaria. Malaria burden was found to be highest (46%) among the subsistence farming communities (Nabwigulu) compared to Bukungu fishing community (26.3%) and Kyanshama subsistence farming communities neighbouring the game park (7.7%). Both crop farming and fishing played a big role in malaria transmission, however, crop farming contributed more malaria than fishing activities. However, statistically, there was no significant difference in the malaria burden among the three livelihoods (*P* = 0.692). Generally, males had the same risk of malaria infection as females among the fishing and game park communities, while in the subsistence farming communities in Nabwigulu, Kamuli, males (26.7%) had higher malaria prevalence than females (18.3%). The prevalence (58.3%) of malaria among school-going children (6 to 11 years) in the subsistence farming community in Nabwigulu was similar to that of <5 years old (53.8%). Malaria prevalence was lowest among children 12 to 17 years (17.6%). Children under five years apparently had the highest malaria prevalence in both the Bukungu fishing community (43.3%) and Kyanshama game park community (10.4%). Overall, adults (>18 years) had a malaria prevalence of 47.4%.
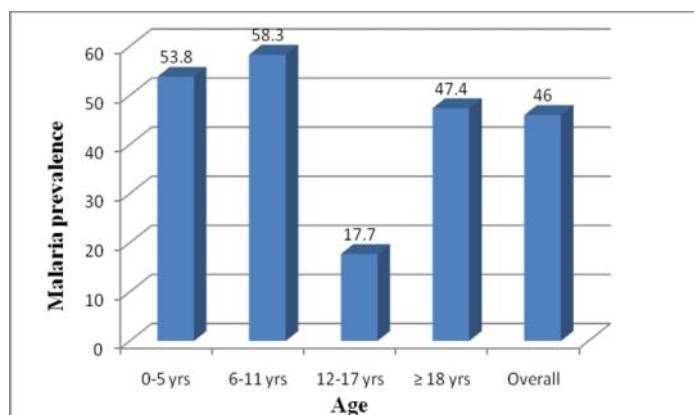
Malaria prevalence in all age groups in Nabwigulu crop farming community in Uganda

In Rwanda, based on Demographic Survey (2009-2012), malaria in Nyagatare was reported to be the highest among the districts considered to have more malaria burden than the rest in the country. In Rukomo sector, the school selected for the study was Group Scholaire Rukomo while in Mimuli Sector Group Scholaire Cyabayaga with primary as well as secondary school classes was chosen.

Prevalence of *P. falciparum* by RDT, microscopy, splenomegaly, and fever rate in Rwanda

Age (years)	N	Prevalence by RDT (%)	Prevalence by microscopy (%)	Fever (≥37.5°C) (%)	Splenomegaly (%)	GMPD	*P. falciparum* Gametocyte prevalence (%)
0-4	23	4.3	0.0	0.0	4.3	0.0	0
5-9	95	16.8	8.4	21.1	4.2	724.4 (313.3-1678.8)	1.05
Over 9	92	17.4	12.0	9.8	8.7	274.6 (127.1-593.3)	0
Overall	210	15.7	9.0	13.8	6.2	413.5 (235.5-726.10	0.48

Key: GMPD= Geometric mean asexual *P. falciparum* parasite density

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KNOWLEDGE AND PRACTICES AS REGARDS TO MALARIA AND LIVELIHOODS FACTORS

Household surveys using a structured questionnaire were conducted in Kenya, Uganda and Tanzania to establish factors affecting risk to malaria, accessibility, availability and utilisation of malaria interventions; key informant in-depth interviews and focus group discussion were conducted. Qualitative data was collected on demographics, malaria perceptions, and knowledge, malaria history, prevention and treatment, and livelihoods, housing quality, household food security and socio-economic indicators.

In Kenya, the majority of small scale farmers (94.3%) interviewed admitted seeing adult mosquitoes in their houses. In comparison 78.3% of the farmers admitted seeing mosquito larvae on their farms while the rest were not sure if this was the case (20.0%) or knew nothing about this (1.7%). The respondents cited utilization of bed nets (78%; n=234), drainage of stagnant waters (65.7%, n=197), cleaning of environment (47.3%, n=142), spraying of insecticides (41.7%, n=125) and clearing of bushes (30.7%, n=92) as possible methods of reducing densities of malaria vectors on Rusinga Island.

Most fisher folk (87.2%) said that they were at a high risk of contracting malaria while carrying out fishing related activities (88.2%). Reasons given about being at a high risk of contracting malaria included working for long hours along the Lake shore and beach areas (32.9%), carrying out fishing activities at night (19.6%), carrying out fishing/working around swampy areas (7.5%), carrying out fishing activities at dawn (4.3%), working without protective clothing (4.2%), staying around stagnant waters (4.7%), sleeping along the Lake shore (4.0%), staying around bushy areas (5.1%), carrying out fishing activities at dusk (0.8%), living along the lake shore (1.2%), working in the cold (2.8%) and sleeping in *Abila* unprotected (0.5%). Capture fishery activities on Rusinga Island are carried out both in shallow (41.78%) and deep waters (47.18%). Fishery activities are also carried out at fish docking sites (0.23%), *Abila* (0.23%) and beaches (2.82%). From calculations 41.78% of respondents thought that those who fish in shallow waters were more exposed to infection with malaria parasites.

Majority of the respondents (81.33%) farmed along the lake shores, with most farms (77.67%) located within a distance of less than 1km away from the shoreline. To overcome over reliance on rain fed agriculture, some farms were irrigated using hand-held buckets (52.7%) while water pumps were used in others (38%). However, some farmers (24.6%) preserved irrigation water in open tanks, un-cemented holes and abandoned fish ponds. These forms of storage presented suitable breeding sites for malaria mosquitoes, so increasing risk of exposure to infectious mosquito bites. Water-filled ditches, which were used to protect crops from damage by night grazing hippopotami were a commonly cited mosquito breeding habitat type (also see section 3.3).

Most respondents (63.3%) reported preparing land at dawn, dusk and night. Planting was done at dawn (27.7%), dusk (8.3%) or both (18.0%). Weeding was mainly done specifically during daytime (40.3%), dawn (30.7%), dawn/dusk (14.7%) and day/dawn (6.3%). Harvesting was mainly at daytime (52%), dawn (25%), dawn/dusk (11.3%) or day/dawn (4.0%). These findings indicate that a consideration proportion of farming activities coincide with peak biting times of local malaria vectors (belonging to *Anopheles gambiae* and *An. funestus* complexes) i.e. at dusk, night and dawn. The on-farm dressing code encompasses old sweaty clothes, mainly short trousers and short-sleeved shirts (94%). Smelliness plus scanty cloth cover exposes farmers to mosquito bites and high malaria transmission risk.

Makeshift structures (*Abila*) existed on 19.7% (n=59) of the respondents' farms. The door of *Abila* typically faced the Lake, enabling occupants to see invaders (especially Hippopotami). The structures were mostly used at night, but also during daytime, dawn and dusk. *Abila* are used all year round for shelter against sun/rain by occupants guarding crops, to store farm produce and for resting. A bigger percentage of farmers reported that most *Abila* (83%) were not mosquito proof and belonged to farm owners (84.4%) who shared their use with household members, neighbours and customers. Bed nets were the main (18.6%) mosquito control measure inside *Abila*.

Children under 5 years (63.3%) followed by children above 5 years (22.0%) were thought to be most affected by malaria. The elderly (6.3%) and pregnant women (4.3%) were also reported as being prone to contract malaria. The main occupations cited as predisposing Rusinga residents the most to malaria were fishing (76.7%) and farming (71.7%). Others included keeping watch at night (41.0%), schooling (7.7%) and prostitution (5.7%).

Use of bed nets was reported as the most effective method of preventing malaria indoors (80.3%). Ironically, many farmers (83.3%) reported that all members of their households did not use a bed net while others reported children (12.3%) and homestead heads (2.7%) as other categories of persons not using bed nets. Indeed, the effective use of bed nets by children is questionable. This is due to the fact that most children sleep on the floor and bed nets are secured up on the roof or loose pole in the sitting room areas. Bed nets tend to unfasten under these circumstances thus exposing children to mosquito bites. It further emerged that children are exposed to mosquito bites because they use bed nets in turns.

Activities conducted by the fisherfolks of Rusinga Island included fishing, fishing net related activities e.g. mending and repairs, fish trade, preservation of fish, transportation and crew management. These activities were actively practiced during the day and at dusk, night and dawn. The respondents indicated that (a) fish bait mines were located in swampy areas along the lake shore where mosquitoes breed (65.82%), (b) that fish bait mining was done along the lakeshore where mosquitoes breed (4.74%), and that (c) places where fish baits were extracted became mosquito breeding sites (26.27%). The fish baits were sold during the day (9.00am to 6.00pm) and at night (1.00am to 6.00am). This study established that most of the fishermen (80.73%) on Rusinga Island are scantily dressed when carrying out their activities and hence becoming more exposed to bites of malaria mosquitoes.

Fishermen reported that they use bed nets (85.5%), spray insecticides (7.0%), clear bushes (3.2%), take anti-malarial drugs (2.3%) and drain stagnant water (1.8%) as means of preventing malaria. However, although 85.5% of the fishermen cited use of bed nets as the most effective method of malaria control, they did not sleep in them. This is because they spend most of their time fishing in the lake (mainly at night) hence never making use of the bed nets.

In Rwanda, the main occupation of the residents of Mimuli and Rokomo is farming undertaken by 84.2% of all residents involved in study. Main crops reported are maize, cassava, beans, banana, rice and a few more. Livestock were said to be kept by 58.4% of the respondents. Knowledge of the causes of malaria/transmission, preventive measures and diagnosis is high in the study area and in both sectors but in varying extents in different sexes and education levels. The females who turned out to be less educated appeared to have less knowledge on malaria issues than men.

Apart from fever, other symptoms of malaria were not well known by over 50% of the population. Given that only 43.4% of respondents indicated having someone treated of malaria within 24

hours suggest that more efforts are needed to increase their knowledge of the various symptoms which may manifest variously in different individuals to ensure early seeking for treatment. Rice farming involves irrigation by flooding the parcels, whereby the floods are kept on by the dikes for a long period which turns out to be long enough for adult mosquitoes to emerge. Comparison to relate malaria episode in the last month with householders' various agricultural and livestock farming activities including growing different crops, irrigation, livestock keeping, and food security status showed no statistically significant association. Socioeconomic status of having measured in terms of having a good house with electricity or using a candle was associated with reduced likelihood of suffering from a malaria episode. It is recommended that in addition to increasing LLIN ownership and utilization, awareness creation on malaria symptoms be undertaken, improved rice cultivation methods be explored, and along the lines of EDPRS2 household poverty be reduced to enable people have better living conditions and overcome the malaria burden.

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In Tanzania, a total of 475 households (with 2639 members) were interviewed. About 90% of respondents knew that mosquitoes were responsible for malaria transmission. Fever was reported from three quarters of the household (N=346) households. About 26.9% of the individuals were reported to have had fever in the previous 3 months. Among those with fever 56.5% were females. Some 79% of the respondents believed that the fever was due to malaria. Fever was associated with malaria more frequently among pastoral than crop farming communities

Crop farming communities claimed to experience longer periods of fever illness than the pastoral communities. Women experienced significantly more episodes of fever than men (p-value<0.001). Crop farmers experienced few number of fever episodes than pastoralists (p-value<0.01). Most of the diagnoses of fever were done at health facilities (96.2%). Women took significantly longer time before starting medication than men (p-value=0.016). Use of insecticide treated mosquito nets was the most frequently (89.2%) reported means of protection against malaria. Majority (84%) of the women received at least one dose of SP for IPTp during their most recent pregnancies. However, only 38% had received two doses of SP for IPTp.

Slightly over half (56%) could not associate farming practices and mosquito productivity or malaria transmission. Respondents in Tindiga and Malui associated crop irrigation and mosquito productivity than those in Mbwade and Twatwatwa (Figure 2.7). Most (86.2%) of the mosquito breeding sites were man-made and 85.3% of the man-made habitats were linked to livelihood practices such as farming, business and house construction. Bricks making was contributing 30% of all potential mosquito breeding sites.

Awareness of the existence of malaria among the respondents was high. About three quarters (73%) reported that most people get sick from malaria during the rainy season. Half of the respondents felt malaria has decreased in their village in the last 10 years, presumably leaving the other half unimpressed by malaria reduction. Reported mosquito net usage among the farming households was very high (98.9%), with an average of at least 2 nets per household.

Standing water was mentioned by 57.9% of the respondents as the most important factor affecting mosquito abundance in their homes. Climatic parameters that influence mosquito abundance were rainfall (35.8%), temperature (11.28%) and relative humidity (2.0%). A number of responsibilities that associated with farming lifestyles increased the risk of exposure to mosquitoes for many respondents. Over one-third had responsibilities outdoor before 5am, when the malaria mosquitoes are biting.

In Kenya, as fishing and small scale farming constitute the main socio-economic activities on Rusinga Island. Several factors associated with livelihoods were identified promote breeding of malaria mosquitoes or increase exposure to infectious mosquito bites on the Island. These included *rudimentary irrigation, crepuscular and nocturnal activities and ditch fencing.* Fishery-related activities aggravating the problem of malaria on Rusinga Island included fish bait mines, housing and settlements, finger ponds, night life, boats not in (active) use and misuse of mosquito nets.

STRENGTHS AND WEAKNESS OF THE HEALTH SERVICES DELIVERY

In Kenya an informal discussion was conducted with staff based at four health facilities. Information was sought on i) the delivery system of LLINs in the region, ii) delivery of case management strategies, iii) delivery of Intermittent Preventive Treatment in Pregnant women (IPTp), iv) malaria diagnosis, v) referrals, and vi) various actors and stakeholders in delivery of malaria health services. The discussions involved one member of the research and the head of each of the four health facilities.

In Rwanda, the Malaria and Other Parasitic Diseases Division (MOPDD) receives malaria data from some sentinel health centres on a weekly basis, while other health centres report every month to the Ministry of Health Management Information System (HMIS) and with feedback to the source of the data. This ensures that the malaria control authorities in the district and at national level are kept informed of the trends for action. Despite that the data processing work is done fairly smoothly, there are challenges associated with it. These include incomplete data, use of different register books, short time interval between reports, high number of patients and internet connectivity issues. More effort is needed in improving the completeness of the data and internet connectivity.

In Uganda, household surveys using a structured questionnaire have been conducted in 225 households to establish factors affecting risk to malaria, accessibility, availability and utilisation of malaria interventions; key-informant in-depth interviews and focus group discussions have been conducted –still under analysis. Qualitative data collected on demographics, malaria perceptions and knowledge, malaria history, prevention and treatment, and livelihoods, housing quality, household food security & socio-economic indicators still under analysis. Focus group discussions, Interviews with key informants at facility, district and national Levels (Ministry of health) relating to the status of the health delivery system with respect to malaria control were conducted.

In Uganda, information gathered indicates that Uganda struggles to provide high quality health services at all levels. However, only 56% of established posts are filled in health facilities and the distribution of the health workforce are inequitably distributed, especially in the hard-to-reach and rural areas. There exist systemic challenges in recruitment, retention and effective and efficient human resource management at all service delivery levels arising from the flat line wage bill ceilings. A strong public private sector partnership with regard to various malaria control activities exists in Uganda. The private sector plays an important role in the delivery of health services in the country, with more than half of the population seeking care from the private sector as their first point of entry into the health system, particularly in many rural and hard-to-reach areas

Technical competence in the National Malaria Control Programme (NMCP) is still weak in Uganda. While all facilities offer malaria treatment services, availability of functional laboratory diagnostic capacity is limited to only 50% of health facilities. The NMCP has in place a health management information system (HMIS) run from the lowest health service delivery level to the national level. However, the human resource component as well as proper coordination is still lacking.

In Tanzania, an assessment of malaria Information system at facility and district levels was done to identify key barriers, constraints, priority actions for surveillance strengthening. An in-depth interview was conducted to identify key barriers, challenges and priority actions for malaria surveillance in the district. A total of 17 health workers from all levels of health facilities were interviewed: two from hospitals, four from health centres and 11 from dispensaries. Out of 17

informants, 15 were familiar with disease surveillance. Eight (8/17) received training from 2010-2012. Different means were used for reporting, public transport and motorcycle taking the lead. Most of the health facilities (14/15) faced difficulties in submitting reports because of inadequate financial and human resources. A good number of health facilities (9/17) were reported to perform minimal data analysis. This was done by age group- under and above five years and by sex. Analysis was also done on outpatient and inpatient data (including morbidity and mortality for under-fives and pregnant mothers). Analysis specific for malaria focused on monthly malaria incidence. Analysis was also done showing complicated and uncomplicated cases.

In Tanzania, the study also explored the use of evidence in facility and district health planning and formulation of by-laws in relation to malaria control. A review of the Council four Comprehensive Health Plans (CCHPs) was done to document the evidence for 2007/08, 2008/09, 2010/11 and 2011/12. Sections reviewed include i) summary of health problems, ii) Key problems identified, iii) specific objectives, iv) plans to implement the intervention, v) budget summary, vi) malaria statistics (outpatient and inpatients, vii) malaria indicators, viii) important HMIS indicators, achievement, ix) objectives versus planed activities in relation to malaria. Analysis of the collected information focused on whether there are any indications of follow-up on pervious malaria situation to plan for the upcoming interventions and any temporal trend on items like budget allocated and planned activities.

The strength and weaknesses of the health system in Kenya were identified to include the following: Free access of insecticide treated nets by pregnant women visiting ANC; Majority of people received ITNs during the campaigns resulting into effective net coverage, ITNs are available to everyone regardless of age. However, ITNs are given to pregnant women and not to everyone. Those who do not visit the clinics are not provided with net. During mass net campaigns in 2011, there was bias during distribution of nets by a few administrative officials. Quality assurance was lacking- with some individual picked for others. In addition, some people were registered twice on the recipient list. Moreover, the price of long-lasting insecticidal nets is high. There are few net selling points in Mbita. In terms of antimalarials, the medicines are provided free for children under 5 years only. At chemists, antimalarials are available to everyone regardless of age. IPTp can be accessed for free by pregnant women visiting the ANC. However, IPTp is only provided to pregnant women who visit clinics. On the other hand, expired drugs are common because shelf life of drugs is not keenly observed. There is lack of adherence to national guidelines – such that, quinine is given to individuals who have uncomplicated malaria. As regards to the referral system, it is effective for patients who are referred to nearby health facilities. For those living far, there is lack of transport and money to move a critically ill patient from a lower facility to a higher level one. In terms of actors and stakeholders, there lack of proper coordination of malaria activities. Each partner conducts his own activities depending on his organizational objectives

In Tanzania, the findings indicate that structural and management issues such as shortage of skilled staff, shortage of essential equipment and insufficient community network were mentioned consistently in all plans. In all consecutive years, high mobility and mortality due to malaria was identified as a major problem to be taken into account during planning, which was also mentioned as the primary health problem. Data analysis is on-going. At the district level, malaria information system is fragmented and not coordinated. Malaria information is collected separately in Health Management Information System (HMIS), Integrated Disease Surveillance and Response and malaria specific system.

In Rwanda, Surveillance, Monitoring and Evaluation in malaria was carried out with the aim: (i) To ensure routine case reporting from all the Health Facilities (HF) through existing Health

Management Information System (HMIS) on key indicators throughout the district (including from the community level); (ii) Developing a malaria data analytic tool linked to the national HMIS database in order to make best use of the HMIS for regular monitoring of progress and impact of interventions on malaria morbidity and mortality; (iii) To ensure that all district hospital supervisors regularly monitor the decline of key indicators on a quarterly basis, monitor and support poorly performing health facilities; (iv) To strengthen monitoring epidemics based on weekly surveillance data at HF level; and (v) To strengthen the sentinel surveillance sites: geographically representative data on malaria cases, death, therapeutics efficacy of medicines, insecticide resistance status and pharmacovigilance.

Information gathered indicated that Uganda struggles to provide high quality health services at all levels. However, only 56% of established posts are filled in health facilities and the distribution of the health workforce are inequitably distributed, especially in hard to reach and rural areas. There exist systemic challenges in recruitment, retention and effective and efficient human resource management at all service delivery levels arising from the flat line wage bill ceiling. Technical competence in the National Malaria Control Programme is still weak in Uganda. While all facilities offer malaria treatment services, availability of functional laboratory diagnostic capacity is limited to only 50% of health facilities.

A strong public private partnership with regard to various malaria control activities exists in Uganda. The private sector plays an important role in the delivery of health services in the country, with more than half of the population seeking care from the private sector as their first point of entry into the health system, particularly in many rural and hard to reach areas.   The NMCP has in place a health management information systems (HMIS) run from the lowest health service delivery level to the national level. However, the human resource component as well as proper coordination is still lacking.

STRATEGIC COMMUNICATION

Information, Education and Communication
In Kenya, a three month education programme to improve the fishing and farming community's Knowledge, attitudes and perceptions and mosquito control using participatory approaches was developed. An outcome mapping approach was used to mitigate malaria risk among fishermen and farmers of Rusinga Island. A 2014 wall calendar was developed and distributed to beneficiaries namely fish farmers, fishermen and subsistence farmers after attending malaria educational sessions. The coloured calendar, A3 in size, containing 4 pages, carried information about malaria transmission, causes, fishing and farming activities related to malaria, and prevention/control strategies. Malaria training workshops were conducted to educate Boundary and Strategic partners about malaria risk in relation to livelihoods and ecosystem health. The Outcome mapping tool was used to measure behaviour change in fisherfolks and farming groups. Outcome Journals were used to document progress marker achievement among Boundary Partners. The Journals were filled in during joint monthly feedback meetings conducted by IPMA project members and Boundary Partners.

A knowledge, attitudes and practices (KAP) survey carried out before and after the malaria educational intervention geared towards determining the effect of malaria control knowledge and skills on community adoption of disease prevention measures. The survey was only conducted among fishermen. Two fishing beaches on Rusinga Island namely Luanda Rombo and Uta beaches were randomly chosen for this. Fifty fishermen were randomly chosen to participate in the survey from each site.

In Tanzania, calendars carrying out messages on "Livelihoods and Malaria in Kilosa Districts" were developed, printed and distributed to study villages and district departments in Kilosa and primary schools in study villages. The calendars were serving both as a series of pages showing the days, weeks and months of 2013 and a series of pages carrying advocacy messages towards malaria impact and its control methods. On the other hand, in Kenya, two IEC materials were developed namely one project brochure and a training guide. The two tools were shared among boundary partners during workshops. Community sessions were conducted by boundary partners using the training guide. Brochures were handed out during the sessions to community members. The brochure was A4 in size, coloured and contained information about i) farming and fishing activities that promote mosquito breeding, ii) common malaria risk factors, and, iii) malaria prevention and control measures. The training guide was used by members of boundary partners to conduct community sessions. The guide is A3 in size and contained content similar to but more enhanced than what is in the brochure.

In Uganda, the following communication tools and strategies were identified for sustainable and equitable knowledge-sharing and transfer at all levels: Workshops, Mass media (Radio, newspapers, TV), wall calendars, Flyers and Policy briefs. Two hundred calendars (in English and Luganda) were produced and distributed to communities and other project stakeholders in the study areas. The calendars contain such messages as:

- The IPMA project goal and objectives
- Malaria as the leading killer disease in Kamuli and Buyende districts, the study sites
- Children, pregnant women and people living with HIV/AIDS are most vulnerable to malaria infection: the need for their protection with insecticide-treated bed nets
- IPMA East Africa Country teams meeting with IDRC staff in Nairobi
- Nabigaaga swamp and old boats in Bukungu fishing community as some of the main *Anopheles* mosquito breeding grounds. The need for improved environmental hygiene
- Fishermen are at very high risk of being bitten by mosquitoes as they carry out their all-night-fishing activities
- Protective methods against mosquito bites: ITMs, long sleeved clothing
- Improved house designs

In Rwanda, research communication and translation workshops were conducted and involved various groups. Wall calendars carrying messages on malaria control were developed and will be printed and distributed to health centres, schools, offices and other places where people meet.

Conferences/Workshops/ Meetings

In both Kenya and Tanzania, abstracts were developed and submitted for presentation at international conferences. Two abstracts (one from Kenya and one from Tanzania) were presented at the 4th East African Health and Scientific Conference, Kigali, Rwanda held on March 26-29, 2013. Four more abstracts from Tanzania were submitted and accepted for presentation during the 27th Annual Joint Scientific Conference and 2nd One Health Conference held in Arusha from April 16-19, 2013.

Meetings were held in Kenya and Tanzania to share the preliminary research findings with a number of stakeholders. In Tanzania, the meetings involved community leaders from the study villages. Participants of the meeting were Ward Executive Officers, Village Executive Officers, Village Chairpersons, representative of the Village Health Committees, community development officers, health officers and agricultural extension officers. Facilitation was provided by the researchers and the District Malaria Focal person. The objective of the meetings was to share preliminary findings from the studies carried out in the five study villages. The meetings also aimed at getting community's views on the findings presented, factors contributing to malaria burden in their respective communities and what could be done to improve the situation.

In Kenya and Tanzania, preliminary findings of the project were shared with a number of boundary partners. The main objective was to share experiences on malaria control activities between researchers and boundary partners. In Kenya, a workshop was conducted in October 2013 aimed at disseminating findings. Strategic partners, Boundary partners and beneficiaries were determined. Progress markers were developed for each Boundary Partner. Focus Group Discussions (FGDs) were conducted in October 2013 to determine the structure and activities of all Boundary partners. During the stakeholder workshop carried out in October 2013, a new Outcome mapping model was developed. Three Boundary Partners namely Kibisom Women Group, Uta/Luanda Rombo Beach Management Units (BMUs) and Kakrigu Fish Farming Group were identified. Two strategic partners were identified namely Department of Fisheries under the Ministry of Agriculture, Livestock and Fisheries and District Public Health Office under the

Ministry of Health. In Tanzania, A knowledge translation workshop was held on October 8, 2012 at Kilosa Clinical Officers' Training Centre in Kilosa. The workshop was attended by representatives of the District departments responsible for health, agriculture, environment, livestock, fisheries, education, works, irrigation, water, land development, forestry, and community development. The workshop was facilitated by researchers from the National Institute for Medical Research and Sokoine University of Agriculture.

The workshop objective was to share research findings with key district stakeholders and identify strategic inter-sectoral interventions. During the district workshop, the researchers presented findings of their study on "Malaria and Livelihoods in Kilosa District," while the District Medical Officer made a presentation on "Malaria Situation in Kilosa District".

In Rwanda, the collaboration with the partner including the Malaria and Other Vector-borne Diseases Division, Nyagatare District health team and their community level staff were engaged in the IPMA project more frequently and indeed they have contributed quite significantly towards the activities and results.

In Tanzania, a number of youth groups were involved in the identification of potential breeding sites and contributed a lot in sensitising the community in draining standing water in their vicinities. Following feedback dissemination of the preliminary results to the district authority and community local government, leaders were using the findings to sensitive heads of household to send their children to receive antihelmintics during the National Schistosomiasis and Intestinal Worms control campaigns. The village leaders were also using posters developed by the project to communicate with their respective community of the burden of malaria and anaemia.

In Tanzania, the IPMA identified and worked with a Community Change Agent (CCA) in Kilosa district in October 2012. The main objective was to share experiences on malaria control activities. The IPMA team presented the salient findings of the Kilosa study using a poster that was developed and distributed to different villages involved the study. The CCA also had an opportunity to share about its objectives and activities carried out in Kilosa District. It was realized that the Community Change Agents are found in different Wards of the Kilosa district. The objective of CCAs is to sensitize community on behavioural change pertaining to malaria control. Specifically they target primary schoolchildren, adults from the community, and pre-school children. For schoolchildren, CCAs usually visit schools and offer health education pertaining to malaria. The schoolchildren are also taught in essay writing, drama groups, songs, poem to advocate for malaria control. The CCAs organized school essay competitions. Pupils have produced different messages on malaria that are used as greetings or opening a session in class etc. CCAs collaborate with village and ward leadership in implementing their activities. Through the Change Agents, community members have been sensitized and this has resulted into increased use of mosquito nets. Posters developed by the IPMA project were given to the Change Agents for wider use.

CAPACITY STRENGTHENING

One of the objectives of the project was to support post-graduate students in providing opportunities and mentorship to carry our research for their dissertations and theses on priority malaria problems. In Tanzania, the project supported four candidates who completed their studies and submitted their report to the Project and their respective Institutions.

In Kenya, staff of the USA Army Medical Research Unit in Kenya (USAMRU-K or the Walter Reed Project (WRP)) situated in Kisumu, Kenya trained 10 project team on malaria microscopy techniques in August 2012. The ten field assistants were trained on, i) collecting a blood sample, ii) making a thin and thick blood smear, iii) packaging, transporting and storing stained microscopic slides, iv) conduct slide readings. Two staff members from the Ifakara Health Institute in Tanzania also attended the training. Staff from the USA Centres for Disease Control and Prevention (CDC), situated in Kisumu, Kenya trained field assistants on malaria diagnosis and treatment.

In Uganda, two MSc students were recruited and registered for research training and engaged in the project research activities.

Capacity strengthening within IPMA Project in East Africa

Country	Student (Programme)	Title
Kenya	Jacqueline E. Oduke (MA Sociology) E.A. Olanga (PhD)	Occupational exposure of fishermen to malaria on Rusinga Island, western Kenya
Rwanda	Cyubahiro Beatus Asingizwe Domina Iribagiza Marie Claire	"The Effect of rice growing on transmission intensity of malaria in Nyagatare District" Community Participation and Involvement Towards Malaria Elimination in Bugesera District Assessment of risk factors influencing achievement of malaria elimination in Mageragere Sector in Nyarugenge District, in Kigali.
Tanzania	1. Phillips Paul (MSc University of Dar es Salaam) 2. Mary Zinga (MSc Tropical Diseases, Muhimbili University of Health and Allied Sciences) 3. Carrie A. Fahey (BSc Global Health, Washington University) 4. Dee Dee Wei ((BSc Global Health,	1. Impact of agricultural practices on vector ecology and malaria transmission in Kilosa District, Tanzania 2. Factors influencing the uptake of malaria preventive services among pregnant women in Kilosa District, Tanzania 3. Livelihoods, climate change, and access to malaria prevention methods for pregnant women in maize-farming communities of Kilosa, Tanzania 4. Knowledge, attitudes, and practices on malaria prevention among

	Washington University)		pregnant women in the Kilosa District of Central Tanzania
Uganda	1)Samuel Waiswa (MPH), International Health Sciences University) 2)Margaret Suubi (MPH), International Health Sciences University)	1) 2)	Malaria burden and transmission intensity in Bukungu fishing community A review of the relationship between malaria and subsistence farming in Uganda/East Africa

PROJECT OUTPUTS, OUTCOMES AND IMPACTS

In general, the project has achieved most of the set objectives: (i) It has consolidated knowledge on malaria burden and transmission intensity in different ecosystems and livelihood practices; (ii) it has identified key actors in malaria control and documented the form of stakeholder engagement in national malaria control policy formulation; (iii) It has identified strengths and weakness of the health services delivery that influence malaria control, both in terms of malaria surveillance and readiness of facilities in malaria services; (iv) A number of communication strategies have been developed including wall calendars and other information, education and communication materials and were effectively used for results-sharing and utilisation with bounder partners; and (v) The project has enhanced research capacity strengthening of two graduate and nine post-graduate students in East Africa.

Outputs

In Kenya, the following have been achieved: Increased consultations between the project team and Rusinga Malaria Project (RMP). There has been an increased respect of RMP leaders within the Rusinga community. Currently, the RPM leaders are exploiting alternative ways of controlling malaria on their own. The cooperation with the National Malaria Control Programme (NMCP) has increased. The NMCP donated 5,100 doses of Coartem to the project for free. As a result of participating in IPMA project activities the Rusinga Malaria Project participated in the 2013 World Malaria day celebrations where they showed cased self-nurtured mosquito prepared plants and distributed copies of their brochure to sensitise the community on their activities. As a result of close working ties with the Tom Mboya Health Centre, Humanist Dispensary, Kolunga Dispensary and Waware Dispensary the number of genuine referrals to the Mbita sub-district hospital have been regulated due improved diagnostic skill among the laboratory staff in these health facilities.

In Kenya, four research outputs have been achieved to date. These include: A project poster based on the currently funded IPMA project was prepared and presented during *icipe*'s 40th anniversary celebration in Nairobi. The occasion was held on 16th November 2011; Prof. Richard Mukabana attended the Kenya National Malaria Forum with the theme "*moving from evidence to action*". The occasion was held on 10-11 October 2011 at the Crowne Plaza Hotel in Nairobi, Kenya. Prof Mukabana gave a presentation titled "*Bridging between ecosystem and public health with respect to malaria*". The presentation was based on data from IPMA project activities in Kenya. The following have been achieved: Evelyn Olanga's PhD proposal accepted and submitted to University of Nairobi. She has received her admission letter to University of Nairobi and will be supervised by Deputy Vice chancellor (DVC) in charge of Research, Production and Extension. Jacqueline Oduke completed a draft manuscript on farming and malaria. She has also completed a draft thesis titled 'Use of outcome mapping to conceptualize the problem of malaria in a livelihoods and ecohealth context on Rusinga Island'. Training guide and brochure for boundary partners was developed during the reporting period. In Kenya, a paper presentation was prepared and made at the 4th Annual East African Health and Scientific Conference and International Health Exhibition and Trade Fair held at 27th to 29th March 2013 Serena Hotel, Kigali, Rwanda.

In addition, Kenya recorded the following outputs:
– Developed and printed the 23-page, A3 size training guide for Boundary Partners.
– Developed and printed A4 size brochures on "Malaria Prevention and Control among Fishermen and Farmers Of Rusinga".
– Developed and printed A3 size coloured, wire-bound, 4-page calendar.

In Rwanda, the outcome of IPMA project has increased collaboration with various stakeholders namely the Malaria and Other Parasitic Diseases Division of the Rwanda Biomedical Centre, Nyagatare District health team, the School of Public Health, Nyagatare District Directorate of Health, Rice and Maize cooperatives in Mimuli and Rukomo and the communities in these two Sectors. Others included the NGOs involved in strategic communication in Nyagatare and other parts of the country, and the Centre for Health Communication. The various levels and communities in which the work was done have become more familiar with the concept of malaria as it relates to livelihoods and the boundary partners including the teachers, community health workers as well as the rice growers cooperative members are finding it quite clear that they need sensitize more those in their sphere of influence to engage in malaria control endeavours. Increased collaboration between East African malaria researchers through the regular contacts that we have made during the time of the project. Established linkages with IDRC and got more aware of the opportunities available. Got transformation into systems thinking when it comes to malaria control.

In Tanzania, findings were interpreted and shared with a number of stakeholders through public meetings, workshops and conferences. A number of stakeholders workshops/meetings were conducted, these included:
1) East African Community Regional Inception workshop: This initial workshop was held in Arusha and brought together researchers and policy makers from Kenya, Tanzania and Uganda aiming to set research priorities.
2) District Inception Workshop held in Kilosa. The workshop included district officials from various sectors to foster multisectoral involvement. Fourteen representatives participated in the workshop. They were drawn from departments responsible for Agriculture, Water, Works, Natural Resources, Planning, Fisheries, Livestock Development, Education, Environment, Community Development and Health.
3) National Knowledge Translation workshop: A workshop at National level involved national representatives from various government sectors, non-governmental organization, research and academic institutions. During the workshop, research results were shared and discussed to develop strategies for multisectoral involvement
4) District and Regional Translation Workshop: The workshop held in Morogoro and opened by the Regional Commissioner brought together researchers and district and regional officials from various sectors to share and discuss final results. During this workshop, the consultant had opportunities to interact with both the research team and project boundary partners.
5) Community meetings: Five meetings were done at community level in all study villages to share the research findings. The meetings involved local and community leaders including Ward Executive Officers, Village Executive Officers, Village Chairpersons, representative of the Village Health Committees, community development officers, health officers and agricultural extension officers. The meetings also aimed at getting community's views on the findings presented, factors contributing to malaria burden in their respective communities and what could be done to improve the situation.

In Rwanda, the following outputs have been recorded:
• A paper presentation was prepared and made at the 4th Annual East African Health and Scientific Conference and International Health Exhibition and Trade Fair held at 27th to 29th March 2013 Serena Hotel, Kigali, Rwanda
• A manuscript on Impact of rice cultivation on malaria epidemiology in Africa: a systematic review was written and is about to be submitted for publication
• A manuscript on malaria and livelihoods in Rwanda in under preparation

- A dissertation of Mr Beatus Cyubahiro was successfully defended and the candidate has since graduated in MPH Epidemiology.
- Two more candidates will be graduating in 2014 with MPH degrees.
- Calendars with strategic communication messages on malaria control and elimination are in preparation.

In Uganda, some of the project outputs include the following: (i) Two Masters of Science students have been recruited for support in training in research related to eco-health and malaria; and (ii) Malaria (and other pests) controls Action Plans that were produced by the project boundary partners are being implemented with little support from well-wishers. Further support is being sought from Government and Non Governmental Organizations.

In Tanzania, four manuscripts have been developed and submitted for publication:

1) Malongo R.S. Mlozi, M.R.S., Rumisha, S.F., Mlacha, T., Bwana, V.M., Shayo, E.H., Mayala, B.K., Malima, R.C., Mashoto, K.M. & Mboera, L.E.G. (2014) Policy and decision makers' perspectives on intersectoral approach in malaria control in Tanzania. *Global Public Health.* MS ID: RGPH-2013-0324.
2) Shayo, E.H., Rumisha, S.F., Mlozi, M.R.S., Bwana, V.M., Mayala, B.K., Malima, R.C., Mlacha, T. & Mboera, L.E.G. (2014) Social determinants of malaria and health care seeking patterns among rice farming and pastoral communities in Kilosa District of Central Tanzania. *Malaria Journal* MS ID 8314402661158799
3) Rumisha, S.F., Zinga, M.M., Fahey, C.A., Wei, D., Bwana, V.M., Mlozi, M.R.S., Shayo, E.H., Malima, R.C., Mayala, B.K., Stanley, G., Mlacha, T. & Mboera, L.E.G. (2013) Accessibility, availability and utilisation of malaria interventions among pregnant women in Kilosa District in Central Tanzania. *BMC Health Services Research.* MS: 1254349437112678.
4) Mboera, L.E.G., Bwana, V.M., Rumisha, S.F., Mlozi, M.R.S. (2013) Pastoral livelihoods and malaria in sub-Saharan Africa: a review. *Pastoralism*

Outcomes

In all the four countries, the outcome of the project has been increased collaboration with various stakeholders namely National Malaria Control Programme, Research and Development Institutions, District Councils, Farmers cooperatives, Faith-based Organizations, Non-governmental Organizations, schools and the communities. The various levels and communities in which the work was done have become more familiar with the concept of malaria as it relates to livelihoods and ecosystems. For instance, in Tanzania,
The involvement of district and regional key departments provided an opportunity for planning malaria control strategies for Kilosa district. There was increased collaboration between East African malaria researchers through the regular contacts that we have made during the time of the project. At all levels, the interaction between the knowledge user and the researcher resulted in mutual learning and the process was described to be beneficial to both. The final project report has been published and shared with a wide range of stakeholders and is available at: http://www.nimr.or.tz.

Impacts

In Tanzania, a number of youths were involved in the identification of potential breeding sites and contributed a lot in sensitising the community in draining standing water in their vicinities. Following feedback dissemination of the preliminary results to the district authority and community local government, leaders were using the findings to sensitive heads of household to

send their children to receive antihelmintics during the National Schistosomiasis and Intestinal Worms control campaigns. The village leaders were also using posters developed by the project to communicate with their respective community of the burden of malaria and anaemia.

In Rwanda, the collaboration with the partner including the Malaria and Other Vector-borne Diseases Division, Nyagatare District health team and their community level staff are engaged in the IPMA project more frequently and indeed they have contributed quite significantly towards the activities and results attained so far. The communities in which the work is done have become more familiar with the project and the boundary partners including the teachers, community health workers as well as the rice growers cooperative members are finding it quite clear that they need sensitize more those in their sphere of influence to engage in malaria control endeavours.

In Uganda, a number of Impacts have been realized: (i) Malaria control Action plans have been developed and are being implemented by the boundary partners in the respective study sites; (ii) Healthier and economically active communities are envisaged as a result of reception and use of the knowledge produced by the project; and through integrated multi-sectoral collaboration and partnerships in malaria control strategies.

PROJECT IMPLEMENTATION AND MANAGEMENT

The Regional project was coordinated by Dr. Leonard Mboera, the Project Coordinator through Country Team Leaders.

In Kenya, the project has two core staff members including the country Principal Investigator (Professor Wolfgang Richard Mukabana) and a technician (Ms. Dolly Orlando). In addition boundary partner employees actively participate on the project. These include two from Kibisom (Ms. Esther Odhiambo and Ms Margaret Ayugi), three from the Mbita District Public Health Office (Mr. Mathew Ajwala, Mr. Zachary Bosire and Apollo Kennedy) and one from the Rusinga Malaria Project i.e. Mr. Ibrahim Kiche. In Rwanda, the project was run from Kigali Health Institute (KHI) led By Prof Kato J. Njunwa. In Rwanda, the staffs that have been involved in the project come from 4 main institutions but the major ones in terms of staff and operational issues are the Malaria and Other Parasitic Diseases Division (MOPDD) and Kigali Health Institute (KHI). In Kenya, separate funds were acquired and used to supplement the IPMA budget. The funds have been received from the COmON Foundation, Netherlands. These funds were used to support malariometric and entomological surveys.

In Rwanda, there were changes in the status of Kigali Health Institute into being a College of Medicine and Health Sciences of the new University of Rwanda run by the Government of Rwanda. Management of the project did not change. Prof. Kato Njunwa was the Country Project Coordinator.

In Tanzania, Dr Leonard Mboera, the Project Coordinator is the Country Team leader. He was assisted by Ms. Tabitha Mlacha as Project Administrator. At the district level, the District Medical Officer, Dr. John Lindi and the District Malaria Focal person (Ms. Rosemary Nguruwe) were the boundary partners. The National Institute for Medical Research provided office space for the Project Administrator. Financial matters are handled by the Institute Directorate of Finance and Administration, which also provides for project vehicle, secretarial services and other logistic needs.

In Uganda, the project was technically managed by Kamuli District Local Government in conjunction with Makerere University (Zoology Department) under the leadership of Frederick Kabbale. The grant was being administered by Makerere University as per the Memorandum of Grant Conditions. Kamuli facilitated the implementation of project activities including provision of office space, conference halls, laboratory, some equipment, and contributions in cash and in kind towards the implementation of the project.

Acknowledgements