



**MALARIA CONTROL IN THE
LUBOMBO SPATIAL DEVELOPMENT AREA
(Maputo Province)**



November 2007

**Produced on behalf of the Regional Malaria Control Commission
by the MRC and UCT**



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1. Background

The malaria control component of the Lubombo Spatial Development Initiative (LSDI) was put in place to address the issue of high malaria transmission in an area targeted for accelerated agricultural and economic development. The LSDI was the brainchild of the Department of Environmental Affairs and Tourism in South Africa, which formed a trilateral initiative between the governments of Mozambique, South Africa and Swaziland, to develop the area bounded by the Lubombo Mountains into a globally competitive economic Zone, ensuring sustainable employment and equity in access to economic opportunity in the region. The geographic region targeted by this initiative is broadly defined as eastern Swaziland, southern Mozambique and north-eastern KwaZulu Natal (Figure 1). However, this area also straddled the highest risk malaria areas in the three countries, and it was realised early on that no development could occur in the region if the burden of malaria was not reduced. As a result of this, the malaria component of the LSDI was conceived by the Medical Research Council and their collaborators in the three countries.

In July 1999, the Heads of State of the three countries participating in the LSDI signed the General Protocol which put in place a platform for regional cooperation and delivery. The Lubombo Malaria Protocol of understanding was signed at ministerial level between the three countries in October 1999. The malaria control component of the LSDI project is managed by the Regional Malaria Control Commission (RMCC), a core group of experts comprised of malaria control programme managers, public health specialists and scientists from the three countries.

The primary emphasis of the LSDI malaria control programme was to extend malaria control to southern Mozambique. There was increasing consensus that even if malaria control measures were optimal in South Africa and Swaziland (with effective treatment and insecticides in place), the disease burden could only be further reduced by a regional approach to control. Effective malaria control was realised to be an important precursor to development with the situation prior to malaria control in South Africa

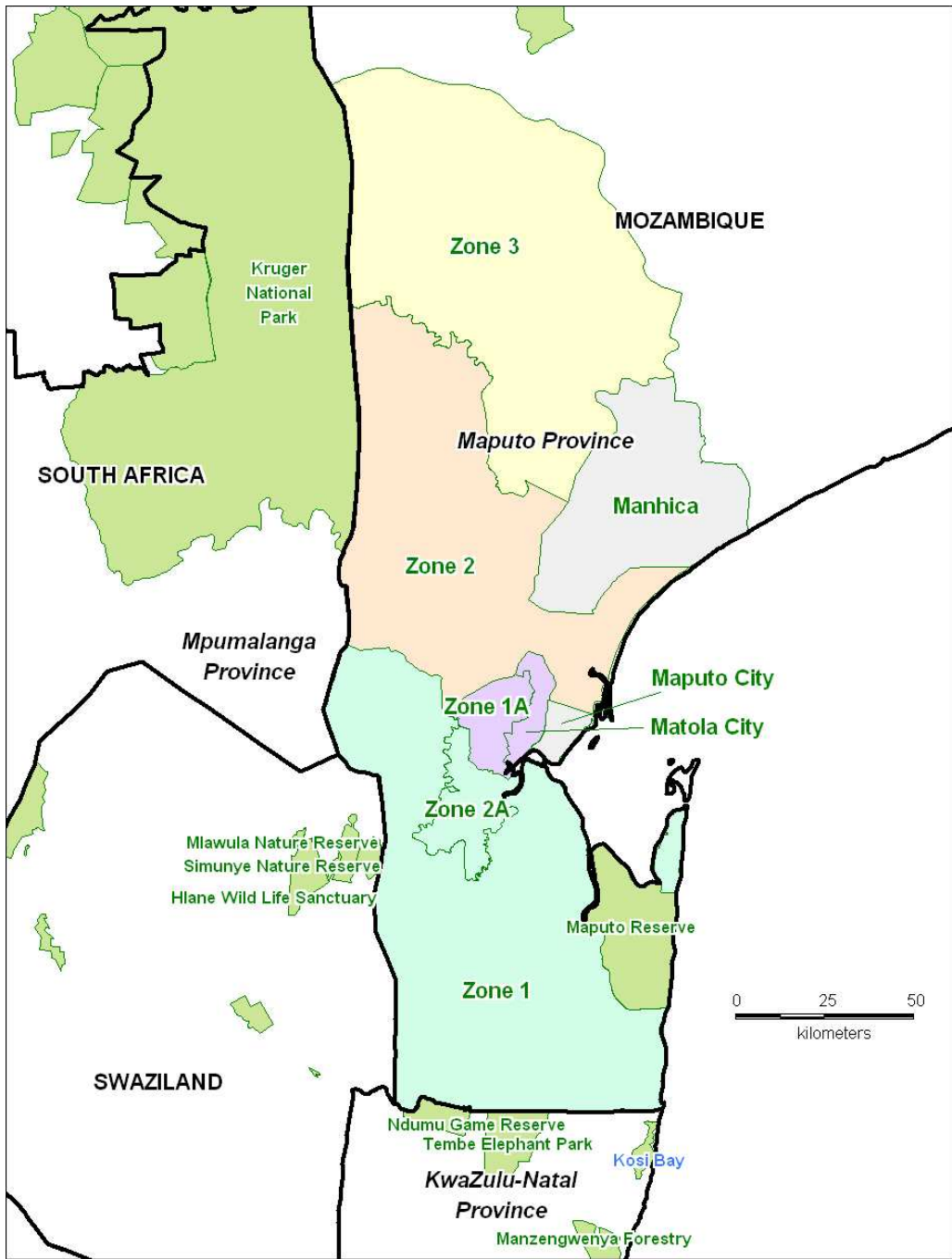


Figure 1. Map Showing the malaria control areas in the Lubombo Spatial Development Initiative

supporting this view, given the well documented negative effects of malaria on tourism and agricultural development in the 1930's. The LSDI malaria programme was targeted at creating a platform for development, the beneficiaries being communities in areas with the lowest socio-economic development in the region as well as tourism, business and governments.

The Primary interventions

A two pronged approach to malaria control has been implemented, namely, vector control using indoor residual spraying (IRS) and effective malaria case management.

Vector Control

The malaria vector control component in Mozambique has been implemented in phases (Figure 1) starting with Zone 1, in 2000, which is the area extending from the KwaZulu-Natal border to Maputo. Zone 1A is the area surrounding the MOZAL Plant which introduced malaria control as part of their social responsibility campaign, implemented in 2001. Phase three, initiated in 2002, focussed on Zone 2A comprising part of the Boane District, and Zone 2 and 3 extending north along the Kruger National Park border, covering an area of over 20 000² Km. The contiguous malaria control area in the region now exceeds 100 000² Km.

Case Management

Since effective malaria control requires both vector control and early effective treatment, the RMCC decided to extend their objectives to ensure that the best malaria treatment was introduced across the LSDI. Widespread use of artemisinin-based combination therapy (ACT) offers the benefits of not only improving cure rates, but, unlike other malaria treatments, of also directly decreasing malaria transmission and potentially slowing drug resistance. To optimise the synergistic effects of IRS and ACTs on reducing malaria transmission and thus disease burden, while minimising programme costs, the implementation of ACTs has been timed to follow the establishment of effective vector control.

The effectiveness of the malaria control programme over the past eight years have been assessed by the prevalence of malaria over time in Mozambique as well as the incidence of the disease in the neighbouring malarious areas of South Africa and Swaziland. The success of intervention cannot only measured using process (e.g. spraying and artemisinin-based combination therapy coverage) and biological markers (e.g. parasite prevalence rates, health facility patient numbers and mosquito vector reductions), but also by the effects on tourism e.g. bed occupancy, job creation and risk perceptions, in all three countries over the course of the 7 year period (2000 – 2007).

2. Objectives of the LSDI

While the aim of the initiative was to create a platform for development through the reduction of malaria cases, the objectives required a broad approach that would reduce the burden of disease and make the results known so as to attract development.

From the baseline malaria seasons of 1999/2000 to the 2003/2004 season , the improvements in malaria control efforts have resulted in dramatic reductions in malaria incidence of over 99% in KwaZulu-Natal, over 86% in Mpumalanga and over 90% in Swaziland. Parasite prevalence in children has decreased by over 88% in Mozambique.

Objectives:

1. Reduce malaria incidence in the border areas of South Africa and Swaziland from 250 per 1000 to less than 20 per 1000.

STATUS: Achieved

2. Reduce malaria infections from 625 per 1000 to less than 200 per 1000 within three year after the start of IRS in Maputo Province.

STATUS: Achieved

3. Provide updated tourist information booklets containing definitive malaria risk maps and prophylaxis guideline.

STATUS: Achieved

4. Develop a regional malaria control programme.

STATUS: In place, covering 200 000 Km²

5. Develop a regional GIS-based Malaria Information System (MIS).

STATUS: In place in 3 countries.

6. Implement definitive diagnosis and effective treatment.

STATUS: RDTs and ACTs in place in all health facilities

The original objectives of the LSDI Malaria Control Programme are clearly being met. This has largely been achieved through the strength of the partnership between MRC, UCT, Private partners and Governments (both National and Provincial) who are equally committed to. The partners share a common vision for ensuring malaria control in the region, primarily through indoor residual spraying and ACT implementation, with ongoing monitoring and evaluation to support evidence based decision making.

2.1 Reduce Malaria Incidence in South Africa and Swaziland

2.1.1 South Africa

The South African border areas most influenced by the LSDI malaria programme are Komatipoort District in Mpumalanga and Ingwavuma District in KwaZulu-Natal. Initially parasite prevalence surveys were in conducted in KwaZulu-Natal but by 2001 these parasite prevalence rates had dropped to below 5%. Malaria incidence rates reduced from the 1999/2000 baseline year to 2006/2007 by >99%.

Incidence data for the two affected localities are given in Figures 2 and 3. Although the scale of the disease differs in the different localities, the disease trends are similar. Significant reductions were made in these border regions once malaria control interventions had been implemented in adjacent areas in Mozambique. Since 2002/2003 the number of cases decreased markedly and has remained low ever since.

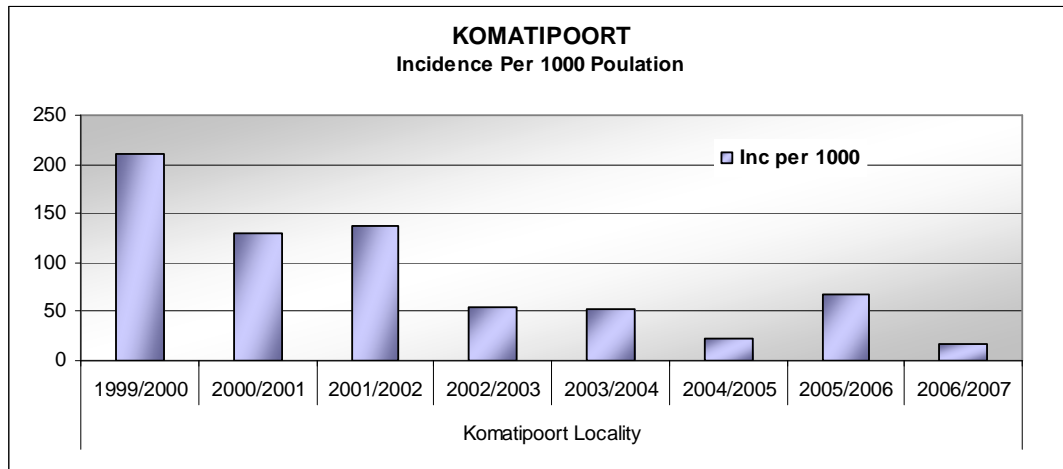


Figure 2. Incidence data for Komatipoort.

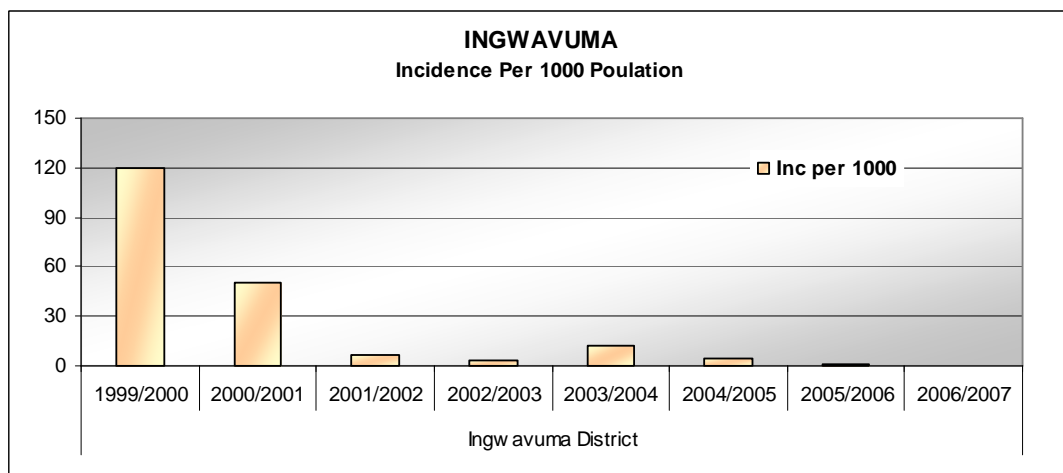


Figure 3. Incidence data for Ingwavuma.

2.1.2 Swaziland

Annual parasite prevalence surveys were conducted at four sentinel sites in Swaziland. By 2004 the average prevalence rate was 0.25%. It was no longer statistically valid to collect prevalence data and incidence rates were used since there was a well functioning Malaria Information System in place. The malaria incidence rates have been dramatically reduced by >90% (Figure 4).

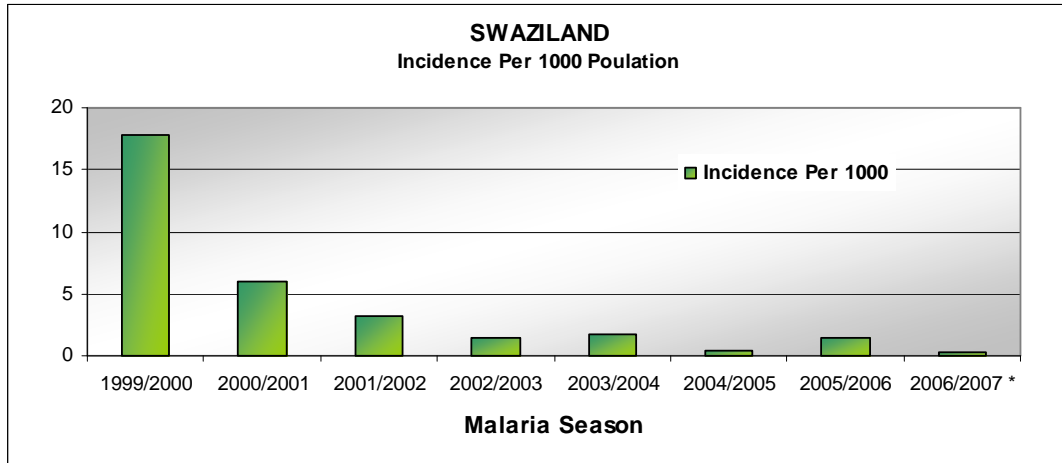


Figure 4. Incidence data for Swaziland.

2.2 Reduce Parasite Prevalence in Mozambique

Since June 2000, annual parasite prevalence surveys have been conducted at sentinel sites in in southern Mozambique. Currently, annual surveys are conducted at 28 sentinel sites in Maputo Province.

In Zone 1 baseline prevalence surveys were conducted in December 1999 and June 2000 before spraying began. Since there was no evidence of any difference in prevalence between these two surveys in children at the 7 sites ($p=0.82$), site specific data from these two years were combined into a 2 year pre-spraying baseline and compared with prevalence values obtained from post spraying surveys undertaken annually in June from 2001, to June 2007. The latest survey found that prevalence rates had decreased drastically and are among the lowest in the province (Figure 5). In Zone 1 the average infection rate from all sites at baseline was 62 %, which reduced to 1.9% in June 2007.

In Zone 1A, overall prevalence of infection at baseline in June 2000 was 86%. Currently the prevalence rate in this Zone stands at 12.6%.

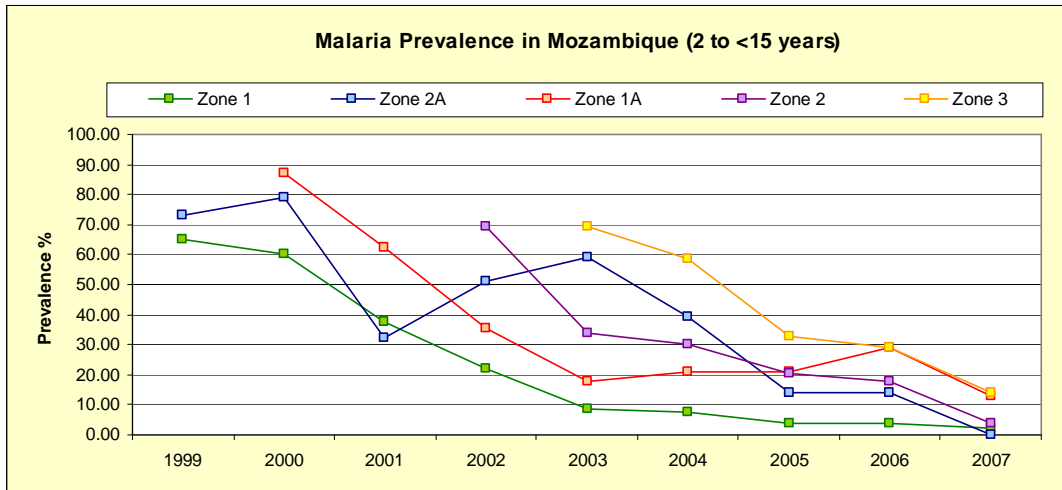


Figure 5. Malaria prevalence rates for each sentinel site.

In Zone 2, overall prevalence of infection at baseline was 70% in June 2002, reducing to 29.8% in June 2004, after spraying and dropping to 5.1% in June 2007.

In Zone 3 the prevalence was 69.6% pre spraying and after successive spray rounds, the prevalence rate as at June 2007 is 15.2%.

In Zone 2A baseline surveys in 1999 and 2000 showed a 76% prevalence, spraying was started in 2001 but due to financial constraints a permanent field officer was not assigned to the area and the spraying programme did not follow a fully structured plan as in the other areas until 2003 when funding allowed. Parasite prevalence decreased below baseline levels but not as dramatically as in other areas until 2004, when prevalence at 2 sites recorded 39% and 6% respectively. In June 2007, the lowest prevalence in the entire LSDI region in Maputo Province was 0.83%.

2.3 Provide Malaria Risk Maps and Prophylaxis Guide

The tourism component of the project was successfully completed. Surveys were also conducted in Mozambique and Swaziland. A second revision and printing of the updated malaria and prophylaxis advice booklets was undertaken and copies distributed to tourist facilities.

In the 1999/2000 malaria season, 18% of tourist facilities were in areas where 5 - 25 malaria cases per 1000 people were recorded, and 68% where in areas where the incidence was <5 per 1000 people. A major reduction in malaria cases was achieved by the 2003/2004 malaria season. None of the tourist facilities were in 5-25 malaria cases per 1000 people and 98% where in areas where < 5 malaria cases per 1000 people were recorded. The Greater St Lucia Wetland Park Authority has designated 10 development nodes within the park where local and international concerns will develop a wide range of tourist facilities from low-impact cabins to luxury hotels.

The tourism data is increasingly influencing tourism policy. SA tourism is using the “Malaria Free” campaign to enhance its international marketing strategy.

2.4 Establish a Regional Malaria Control Programme

In order to develop a regional malaria control programme, a number of different activities had to be implemented.

2.4.1 Regional management

The Regional malaria Control Commission (RMCC) is the co-ordinating and decision-making body of the LSDI programme. The RMCC is tasked with facilitating the extension of control to the Mozambique sector. The RMCC meets quarterly and the venue for meetings is rotational between countries. Decisions impacting on the project are made by consensus and supported by evidence on specific issues and the broad experience of its members, with all members having equal input. The RMCC is responsible for reviewing the progress of the project in the respective countries and finding solutions to problems that may occur. The RMCC then presents its findings and recommendations to Governments, funders and the Regional Co-ordinating Mechanism (RCM). The RCM was set up as a GFATM requirement in 2003 to ensure good governance and appropriate expenditure of the Global Fund allocation.

2.4.2 Spray programme in southern Mozambique

Malaria vector control through indoor residual spraying (IRS) of houses was introduced in Zone 1 in Mozambique with bendiocarb at 400mg per m² in November 2000. IRS was undertaken twice annually. The programme was incrementally extended, with insecticide being applied twice annually starting in Zone 1A in February 2001, Zone 2 in October 2002 and in Zone 3 in February 2004 (Table 1) The four Zones comprise an area of 20617 km² covering 7 districts.

Table 1. Stepped wedge design of Indoor residual spraying intervention in Maputo province, Mozambique, with Bendiocarb at 400 mg per m²

§ spraying with Propoxur at 200mg per m²

Baseline pre spraying cross sectional prevalence survey

Year	2000	2001	2002	2003	2004	2005	2006	2007	Area (km ²)
Zone	Cumulative Spray Rounds								
1	* 2	4 [§]	6	8	10	11	12	13	7591
1A	*	2	4	6	8	9 / 10	11	12	407
2			*2	4	6	7 / 8	9	10	5723
3				*	2	4	6	7	6893

House spraying with DDT started in Swaziland in 1981 and in the malaria-affected provinces of South Africa in 1946. The application rate was 2g per m². For a brief time in the mid-1990s, pyrethroid was used in South Africa but DDT was reintroduced to counter the effects of pyrethroid resistant *Anopheles funestus*.

All spraying was conducted throughout using Hudson expert pumps with 4001 nozzles. Spraying personnel and managers were trained in spraying techniques, safety measures and personal protection equipment appropriate to the insecticide.

2.4.3 KAP in all countries

A number of Knowledge, Attitude and Perception (KAP) were conducted in Mozambique and Swaziland during 2007. During 2007, KAP surveys were carried out at community level in Maputo Province and Swaziland to identify lack of knowledge, with the intent of designing IEC strategies towards development of focussed malaria education programmes.

2.4.4 Prevalence monitoring of Antimalarial Resistance Markers

One of the major factors contributing to the continuing world wide malaria burden has been the emergence and rapid spread of resistance to both chloroquine (CQ) and sulfadoxine-pyrimethamine (SP) in the human malaria parasite, *Plasmodium falciparum*. In response to these increasing levels of antimalarial drug resistance the WHO recommended that artemisinin combination therapy (ACT) become standard antimalarial policy. Recent studies have shown that the efficacy of an ACT is compromised if the artemisinin derivative is combined with an ineffective partner drug. It is therefore imperative that the efficacy of the partner drugs are closely monitored to ensure that effective ACTs are being utilised.

In 2004 the ACT, artesunate plus SP replaced CQ as the antimalarial of choice in Mozambique. Phased ACT implementation commenced in Matutuine District, Maputo Province in 2004 and by 2006 all districts within this province had shifted to artesunate plus SP. .

Prior to ACT implementation in Maputo Province, studies conducted by the MRLP showed the prevalence of two of the five mutations essential for SP *in-vivo* resistance were at baseline levels. This finding supported the use of artesunate plus SP in Maputo Province. However, through continual surveillance for these five resistance markers, it was found that the prevalence of the *dhps* markers began increasing following ACT introduction.

By 2007 the prevalence of all five mutations was well over 30% which is an early warning sign of imminent SP therapeutic failure and potential reduced efficacy of artesunate plus SP. Based on this finding it was recommended

that the first line antimalarial treatment, particularly in Maputo Province, be changed to an ACT that did not contain SP as a partner drug. The Provincial Ministry of Health in Maputo Province heeded this recommendation and will be changing their first line antimalarial treatment to artemether plus lumefantrine in 2008.

2.4.5 Malaria Vector Species and infection rates

Baseline entomological surveys conducted identified *Anopheles funestus* and *An. arabiensis* as the main vectors of malaria in southern Mozambique. Malaria vector numbers, as monitored by daily exit trap catches from 147 traps at 28 localities, show dramatic reductions after spraying.

Numbers of *An. gambiae s.l.* decreased rapidly after the first spray round and have continued to remain low. Of the sample of mosquitoes from the post spraying collections and subject to specific species identification, *An. arabiensis* numbers decreased proportionately (36% of the total) with the other members of the complex becoming proportionately more prevalent; *An. merus* 55% and *An. quadriannulatus* 9%.

Plasmodium sporozoite rates

Molecular analysis to determine sporozoites rates was carried out on all positively identified mosquitoes. Sporozoite rates varied widely between Zones and between pre and post-spraying. The pre-spraying rate for *An. gambiae s.l.* ranged from 0,84% to 10,9% (n=784) and post-spraying rates ranged from 0-1,22% (n=471)

The pre-spray sporozoite rate for *An. funestus s.s.* ranged between 4.69% and 5.28% (n=763). Post-spray rates ranged between 0 and 2.7%. (n=339) No other *A. funestus* member species was found to be infected.

2.4.6 Mosquito Resistance

Insecticide resistance monitoring is an ongoing component of the monitoring and evaluation of the IRS programme.

2.4.7 Capacity development

The foundation of a successful, efficient and effective spraying programme is optimally trained staff at every level. Experience in this regard was lacking in Mozambique, and training was therefore a key priority before a spraying programme could be introduced. It was also conducted on an ongoing process once spraying started.

Training of field staff, whether spray operators or supervisors, followed a similar pattern i.e. 85% practical and 15% theory. However, supervisors received more in-depth training on environmental hazards, toxicity, first aid and safe handling/disposal of insecticides. Training of supervisors and spray persons has taken place each year. The Mozambican programme managers assisted Mpumalanga in training their spray operators in 2002.

Training was extended to include intervention assessment and in this regard, window-trap caught mosquitoes were morphologically identified in Mozambique, and residual efficacy bio-assays carried out. The latter required the maintenance of an insectary and the ability to undertake both susceptibility and biochemical resistance testing which are increasingly being done in the country and will lead to a postgraduate degree. Training has been undertaken to equip field entomologists with the necessary research techniques, field staff to use global positioning system (GPS) receiver hand-held units, office staff in the use of the MIS and insectary staff in Maputo. Intervention assessment with regard to development has been assessed through various studies investigating perceptions of tourists and tourist facility operators to malaria and its impact on this sector.

Human resource capacity has been built in both the implementation of ACTs and RDTs and in monitoring and evaluation of these interventions. Effective ACT and RDT deployment required strengthening of the healthcare infrastructure including in service training of all healthcare providers, including community healthcare workers. Introductory training includes drug and RDT management, malaria diagnosis using RDTs (and microscopy), assessment of disease severity, treatment guidelines, indications for referral, record

keeping and pharmacovigilance. This training is supported by regular on-site supervisory visits and the provision of malaria treatment guidelines, drug management manual, pharmacovigilance handbook and adverse drug reaction reporting forms. To date, at least 468 healthcare workers have participated in this training programme, well in excess of the target of 300.

Academic training of core contributors to the LSDI is provided when the RMCC identifies a specific gap in knowledge or skill that is needed to meet the objectives of the LSDI. There are currently 15 professionals receiving such academic training at Diploma, Masters or PhD level, with 7 from Mozambique and 8 from South Africa. Fields of further training include public health, tourism, drug and insecticide resistance, and drug safety.

2.5 Development of a GIS-Based Malaria Information System

Malaria Information Systems (MIS) were developed and implemented for each of the three countries participating in the LSDI. This computerised system allows the input, management and output of malaria case data which is used for both management and research purposes. It includes a spatial component using a geographic information system (GIS) which is being customised to minimise end-user skill requirements and optimise access to the different data sets. The data collected during routine operations and entered into the MIS consists of both in- and out-patient data of confirmed and clinically diagnosed malaria cases. The input screens mirror the data collection forms and the automatic-linking and drop-down list minimising data entry errors. Information collected during routine spray activities are collated and entered into the MIS and plays a key role in monitoring as well as planning of spray activities

Pre-designed outputs are provided in the form of maps, graphs or tables. This allows problems to be identified and addressed on an ongoing basis.

The MIS provide for the management of two types of malaria-related data:

1. Health facility diagnosed malaria cases, and
2. Information relating to the malaria control activities, namely indoor residual spraying.

Ensuring the effective and efficient functioning and use of the MIS not only requires technical expertise relating to the data in the system, but necessitates managing the information flow process both before it reached the MIS and afterwards. This requires the local ongoing technical expertise of information officers (IO) with the skills to operate and develop the MIS.

Spatial data has been collected for the region and includes administrative boundaries, population, health facility locations, towns and other relevant information. New sources are continually sought to ensure that current data at appropriate scales are provided.

2.6 Implement effective Malaria Diagnosis and Treatment.

Improvements in malaria case management have well exceeded targets set for the LSDI (Table 2).

Table 2: Summary of progress against target indicators by Year 4 of the LSDI

Indicator	Targets	Actual Result
Number of public healthcare facilities using ACT's as first line treatment of uncomplicated malaria	50	119
% of target public healthcare facilities with no reported stock-outs of either ACT's or RDT's	90%	99.5%
Number of public healthcare facilities routinely using RDT's to confirm malaria diagnosis	53	157
Proportion of definitively diagnosed cases appropriately treated with ACT	90%	150.2%
Drug efficacy monitoring	2	3
Number of districts with an established pharmocovigilance system	4	7
ACT drug efficacy level	90%	97.7%
Clinical personnel receiving in-service training	300	468

Achieving these indicators showing effective case management, including large scale deployment of artemisinin-based combination therapy and rapid diagnostic malaria tests at more healthcare facilities than initially planned within the defined budget, has been made possible by the following:

- 1) the marked reduction in malaria case load following the effective community based indoor residual spraying and widespread use of ACTs,
- 2) limiting treatment to only definitively diagnosed malaria cases and
- 3) adhering to the Ministry of Health directive to also distribute RDTs and ACTs to community health centres.

Efficient management and use of drug and RDT supplies through extensive training and supervision has minimised stock-outs and wastage.

2.6.1 Ensuring effective malaria diagnosis and treatment

Accurate case reporting has necessitated the implementation of appropriate diagnostic measure through the use of Rapid Diagnostic Tests (RDT's) to reduce the number of people being unnecessarily treated through diagnosis based on clinical signs and symptoms.

This objective is being achieved through wide-spread use of artemisinin-based combination therapy (ACT) as first line treatment. The artemisinin derivatives, such as artesunate and artemether, have been selected specifically for their ability to reduce gametocyte carriage (Figure 6).

Gametocyte carriage is being monitored in the *in vivo* studies of therapeutic efficacy, all of which have shown significant reduction in gametocyte carriage in the ACT arm when compared with the SP monotherapy arm. The number of malaria cases has decreased markedly following the implementation of ACTs as first line treatments, in districts where IRS was already well established.

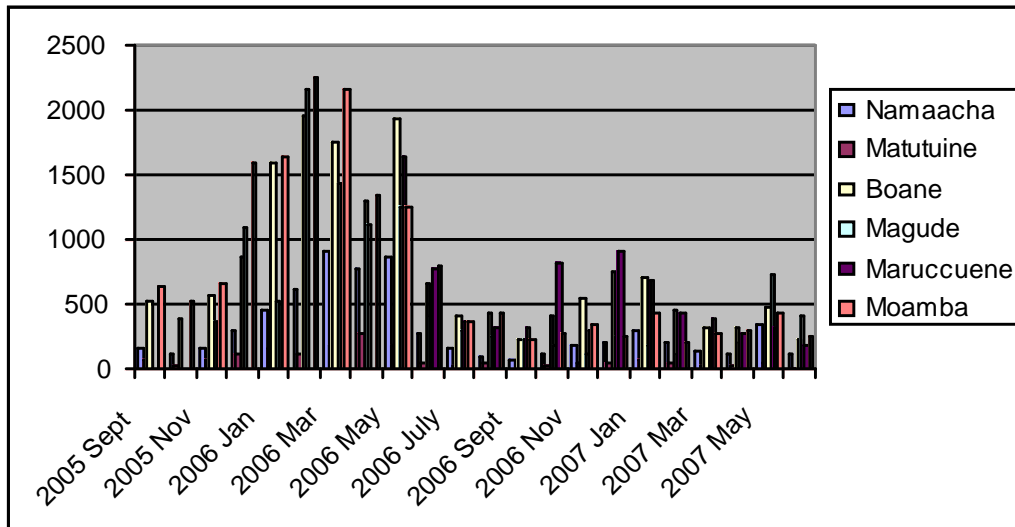


Figure 6: Number of patients treated with ACTs by district, between September 2005 and June 2007, demonstrating seasonal pattern of malaria transmission and decreasing malaria morbidity.

Decreasing gametocyte carriage is as important for reducing the spread of drug resistance as it is for reducing malaria transmission. The data from Mpumalanga shows that increased post-treatment gametocyte carriage was the earliest indicator of increasing sulfadoxine-pyrimethamine resistance, preceding a significant increase in treatment failure rates. This relatively higher gametocyte carriage in primary infections with resistant genotypes (Figure 7) following SP monotherapy treatment fuels the spread of resistance even before failure rates rise significantly.

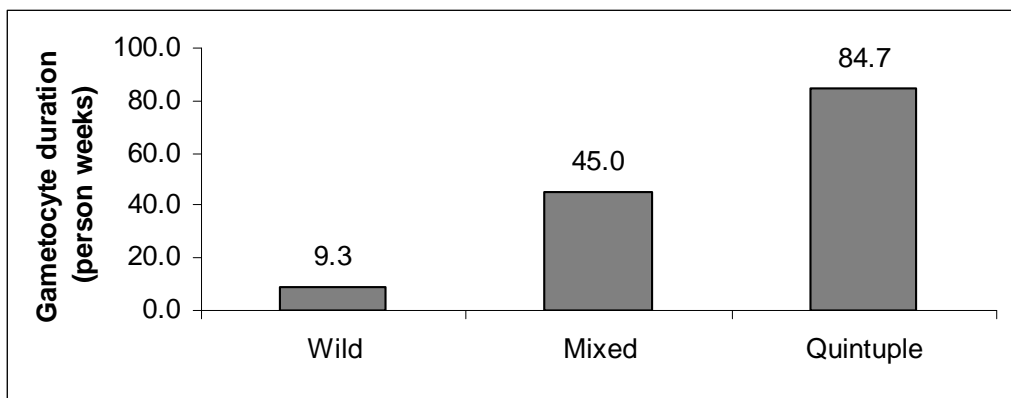


Figure 7: Geometric mean duration of gametocyte carriage per 1000 person weeks of follow-up among patients with wild (n=139), mixed (i.e 1-4 mutations; n=76) and quintuple dhfr / dhps genotypes (n=17) enrolled in sulfadoxine-pyrimethamine in vivo therapeutic efficacy studies in Mpumalanga Province, South Africa in 2000 and 2002.

KwaZulu-Natal implemented an ACT malaria treatment policy when it introduced Coartem in January 2001 and ACTs were introduced in Mpumalanga in 2003. In southern Mozambique, the phased district level implementation of artesunate plus SP has been supported financially by the Global Fund to fight AIDS, tuberculosis and malaria. This has been achieved in all public sector health posts and health centres in Namaacha (March 2004), Matutuine (July 2004), Boane (January 2005), Marracuene (July 2005) Magude (November 2005) and Moamba (April 2006) districts. During 2006, the Ministry of Health in Mozambique implemented artesunate plus SP as first line treatment nationally, which ensured that health facilities in Manhica and Matola districts which fell outside the LSDI areas were also supplied with ACTs. The LSDI contributed to optimal use of ACTs in these non-LSDI districts by providing training, supervisions and RDTs to limit use of ACTs to only parasitaemic patients.

During 2006 – 2007, the LSDI has been active in providing training, RDTs and ACTs to community health workers, in addition to the formal public sector health workers. This has led to the LSDI exceeding its target of 50 and 53 healthcare facilities routinely using ACTs and RDTs respectively, and is instead achieving this goal in 119 and 157 facilities, respectively. This successful model of additionality bodes well for the sustainability of effective case management in the future.

The drug and RDT management systems implemented by the LSDI have reduced stock-outs to a minimum. In the past year (September 2006 – August 2007) there have been no RDT stockouts and only 5 facilities stocking ACTs recorded any stockouts. All stockouts were of short duration (<5 days), so 100% of facilities achieved the stockout target.

The number of RDT used and the proportion of clinically suspected malaria cases that are RDT positive varies by age category and by district (Figure 8). This tool allows targeting of ACTs for patients who carry malaria parasites. Patients in whom the malaria test is negative should also benefit from more prompt management of the actual cause of their illness.

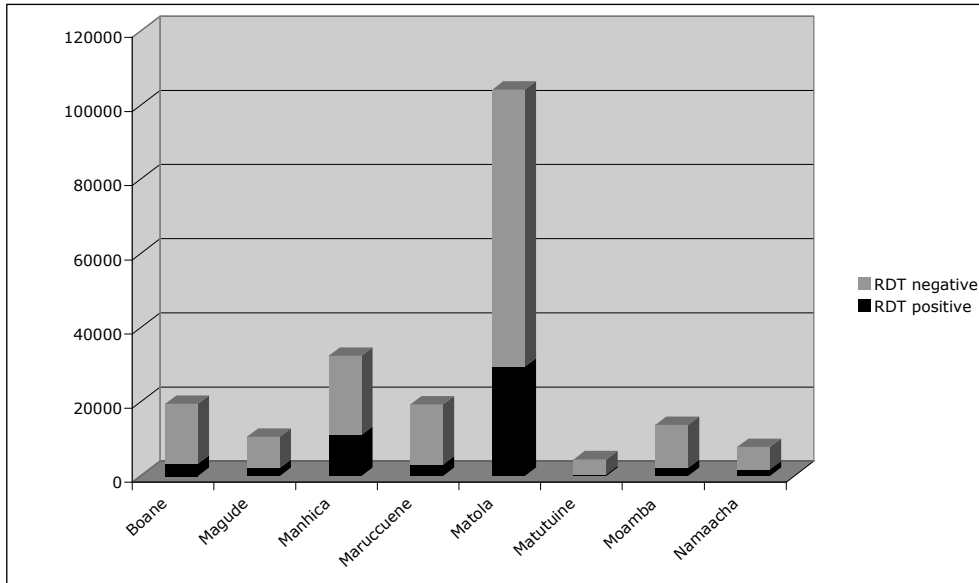


Figure 8: Number of RDTs used and Proportion of clinically suspected malaria cases that are rapid test positive, by district (September 06 – January 07).

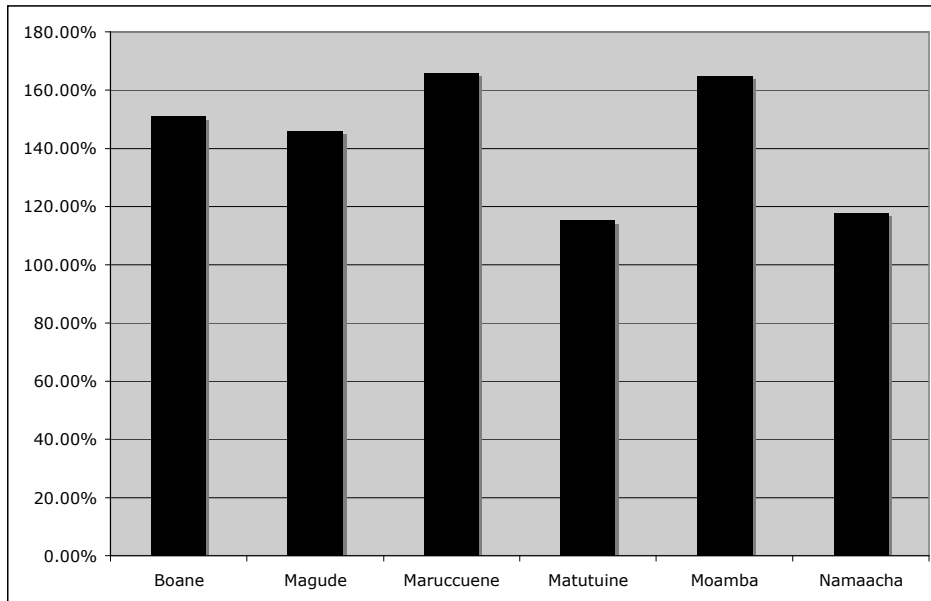


Figure 9: Proportion of RDT positive patients treated with ACTs, by district between September 2006 and August 2007.

The higher than expected proportion of RDT positive patients treated with ACTs, at some facilities (Figure 9) has been investigated. The healthcare facilities with the highest percentages are those with microscopy, so much of this apparent ACT “overuse” is actually appropriate ACT use in confirmed

malaria cases. Nonetheless, healthcare worker training is reinforcing the importance of limiting ACT use to confirmed malaria cases, although allows initial use of ACTs in severely ill patients.

The efficacy of ACTs within the LSDI has been closely monitored through *in vivo* therapeutic efficacy studies with 6-week follow up. These have shown the ACTs to be highly effective across all study sites (97.7% Adequate Clinical and Parasitological Response to artesunate plus SP), and to be significantly more effective than monotherapy. However, it has been noted with concern that despite patients receiving directly observed treatment with the internationally recommended dose of SP, drug levels achieved in pre-school children are approximately half those in adults. Younger children treated with sulfadoxine-pyrimethamine are therefore doubly disadvantaged by lack of immunity and lower drug concentrations. This late recognition of the critical impact that age has on SP drug levels, despite widespread use for decades, has raised the question of whether other vulnerable populations are similarly at risk of being under-dosed. The LSDI has thus initiated two studies on antimalarial drug levels achieved in pregnant women in Mozambique in 2006. The first on treatment of malaria in pregnancy had to be stopped as only 3 pregnant women with malaria were enrolled throughout the study season, reflecting the marked improvements in malaria control in Maputo Province, Mozambique. The second study on drug levels achieved in pregnant women given SP as intermittent preventive treatment (IPTp) is ongoing.

Studies of the therapeutic efficacy of artemether-lumefantrine were conducted in Limpopo and Mpumalanga, South Africa in 2007. Due to effective malaria control, this study was unable to achieve its target sample size. Of 62 patients studied, there was one early treatment failure, giving an Adequate Clinical and Parasitological Response rate of 98.5%. There were no serious adverse drug events in this study. Lumefantrine drug concentrations from this study are currently being analysed.

3 Monitoring and evaluation

Each component of the LSDI is comprehensively monitored, as summarised in Table 3 below. This monitoring and evidence based policy is supported by the Geographic and Malaria Information Systems.

Table 3: LSDI Monitoring and Evaluation of Malaria Case Management

Activity	Progress
ACT In vivo therapeutic efficacy	Artemether-lumefantrine studied in KZN (2002), Mpumalanga and Limpopo (2007). Artesunate plus SP studied in Namaacha (2003), Catuane (2003), Boane (2004-2005), Magude (2004-5) and Matola (2006). STATUS: Completed
Drug safety	Integrated into MOH STATUS Completed:
Economic evaluation	Maputo Province policy change: analysis starting Mpumalanga policychange: analysis completed STATUS Completed:
Drug Use Review	Data collection completed; data analysis ongoing
School-based IEC RCT	STATUS : Ongoing
SP IPT pregnancy	STATUS : Ongoing

4. Concluding Remarks

Entering the final semester of the grant, the PR and relevant stakeholders are looking towards securing a rolling Continuation Channel grant in order to ensure the sustainability of the programme.

5. Scientific manuscripts published to date

2007

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