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# 2007 ANNUAL REPORT

## PREVALANCE AND DISTRIBUTION OF MALARIA IN SOUTH AFRICA

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**Directorate: Epidemiology & Surveillance**

**Cluster: HIER**

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health

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Department:  
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## **1. BACKGROUND**

### **1.1 Malaria, the global problem**

Malaria is a major global public health problem, with an estimated 300 – 500 million cases and approximately 1 million deaths annually. Estimates show that nearly 60% of the cases of clinical malaria and over 90% of the deaths, occur in Africa South of the Sahara<sup>1 & 2</sup>. In areas of stable transmission - Angola, Malawi, Mozambique, Tanzania and Zambia, children under-five years and pregnant women are at greatest risk of severe malaria due to the low levels of acquired immunity. It is estimated that of all pregnant women, in malaria endemic areas of Sub-Saharan Africa, only 60% have access to chemoprophylaxis. In addition, for every 40 seconds a child dies of malaria, resulting in a daily loss of more than 2 000 young lives worldwide<sup>3</sup>. In the predominantly unstable transmission countries – Botswana, Namibia, South Africa, Swaziland and Zimbabwe – all age groups have a high risk of malaria due to low levels of acquired immunity.

Although malaria can be a fatal disease, severe illness and death are largely preventable when a prompt diagnosis is made and effective treatment is administered.

### **1.2 MALARIA IN SOUTH AFRICA**

#### **1.2.1 Distribution of malaria, past and present**

South Africa is not exempt from the potential ravages of malaria with its debilitating effects on communities and development. The areas affected can be seen from the continental distribution of the disease (Appendix 1).

During the first half of the 20<sup>th</sup> century, malaria was far more widely distributed in South Africa than it is now. It was a major cause of morbidity and mortality in many parts of the country, affecting areas such as Mpumalanga, northern KwaZulu-Natal, Limpopo, North-West, Northern Cape and even parts of Gauteng<sup>4</sup>. However, malaria prevention and control programmes in South Africa have achieved considerable progress for the last few decades. Resource intensive malaria control measures based on extensive indoor spraying with

Dichloro-diphenyl-trichloethane (DDT) and environmental sanitation were put into place in the late 1940's<sup>5</sup>. Anopheline densities were greatly reduced and disease transmission brought to very low numbers. Today malaria is only confined to the low altitude border areas of Limpopo province, Mpumalanga and the north-eastern parts of KwaZulu-Natal. Occasionally limited focal transmission may develop in the North West and Northern Cape Province along the Molopo and Orange rivers; these water-bodies provide favourable breeding sites for survival of vectors such as Anopheline mosquitoes. Distribution maps of malaria in South Africa in 1938 and 2006 are shown in Appendices 2a and 2b. When compared to the malaria distribution in 1938, the map of 2006 shows a significant reduction in the extent of the malaria endemic areas of South Africa.

Approximately 95% of all malaria infections in South Africa are due to the parasite *Plasmodium falciparum*. Due to conducive environmental factors certain provinces of the country experience seasonal malaria transmission and marked inter-annual fluctuations.

### **1.2.2 National malaria policy**

South Africa's National Policy goals and strategies for malaria as outlined in the box below are in line with the WHO Global Malaria Control Strategy. South Africa is also a signatory to the Abuja Declaration in committing itself to the Rollback Programme Malaria (RBM) of halving malaria mortality by 2010. In addition, South Africa is collaborating with neighbouring countries, Swaziland and Mozambique, within the framework of the Lubombo Spatial Development Initiative (LSDI), a joint development program implemented in 2000 which includes malaria control as a core component. This project has markedly reduced *P. falciparum* malaria prevalence among children in southern Mozambique and reduced the number of notified malaria cases in South Africa, particularly in those districts of KwaZulu-Natal, Mpumalanga (Table 1) which share borders with Mozambique<sup>6</sup>.

**Table 1: Notified malaria cases for Mpumalanga and KwaZulu-Natal provinces for the period July 1999 to June 2007 and the percentage change in case numbers per malaria season in comparison with the baseline year of 1999/2000.**

Malaria season	KwaZulu-Natal		Mpumalanga	
	Cases	Percent change	Cases	Percent change
1999/2000	41 077		13 856	
2000/2001	16 985	-59	12 799	-8
2001/2002	2 818	-93	9 391	-32
2002/2003	1 709	-96	4 098	-71
2003/2004	4 913	-88	4 725	-66
2004/2005	1 999	-95	2 920	-79
2005/2006	1 211	-97	4 558	-67
2006/2007	585	-99	2 154	-84

Source: Epidemiology and Surveillance Directorate and Communicable Disease Control Directorate

The timely diagnosis and notification and treatment of people with malaria is critical. In South Africa, diagnosis is conducted through malaria microscopy and rapid diagnostic tests. This is then followed by prompt treatment through the use of combination Artemisinin-based therapy (ACT).

The key indicators for monitoring malaria control in South Africa are malaria cases, malaria deaths, and malaria case fatality rates.

**Box1: South Africa's National Malaria Policy** (Adapted from Communicable Disease Control Directorate)

The National Malaria Policy outlines the South African national objectives for malaria control as developed by the Department of Health after consultation with the national Malaria Advisory Group (MAG) and other malaria experts within the country.

**Goals**

**The goals of the malaria control programme are:**

1. To prevent mortality and to reduce morbidity, and thus improve and maintain the social and economic status of the population that has been achieved during the past five decades.
2. To progressively improve and strengthen district, provincial, national and southern African capabilities for malaria control.

**Objectives**

**The objectives of the malaria control programme are:**

1. To maintain malaria case fatality rate below 0,5%.
2. To reduce and keep the incidence of indigenous malaria at the lowest practical level. An incidence rate, as judged by annual notifications, of less than 100 local cases per 100 000 residents per year (4 500 cases per 45 million population at risk per year) should be attained by all districts by the year 2010).

### 1.2.3 Malaria notification

Malaria is a Notifiable Medical Condition in South Africa. In the malaria-endemic provinces, malaria notification is high among health care workers providing the Department of Health with epidemiologic information essential for effective monitoring and evaluation of the impact of malaria control tools in the country. However, in the non-epidemic provinces, notification is low; there is a great deal of underreporting, delayed reporting and incompleteness of reports. Without an accurate "count", it is difficult to know how well the government is responding to the malaria public health problem locally, nationally, regionally and globally.

This report is an attempt to quantify the burden of malaria in the country between the period January and December 2007.

## **2 METHODOLOGY**

### **2.1 Data collection, management and quality assurance**

Quantifying the burden of malaria is a challenge, because the disease may be asymptomatic amongst migrant workers, reports are often inadequate and incomplete, in addition some patients (especially economic migrants from neighbouring countries) give incorrect personal particulars, e.g. names, addresses etc. or do not report to the formal health system due to the fear of being deported, all this makes the malaria estimates imprecise.

Malaria case data are reported to the Epidemiology and Surveillance Directorate through two parallel systems. Surveillance data from the three malaria high - risk provinces *viz.* Mpumalanga, KwaZulu-Natal and Limpopo are sent quarterly to the Directorate. Data from the six other provinces that have a relatively low to no risk of malaria are received through the passive notification system. This report presents data regarding cases reported through both systems.

### 3 RESULTS

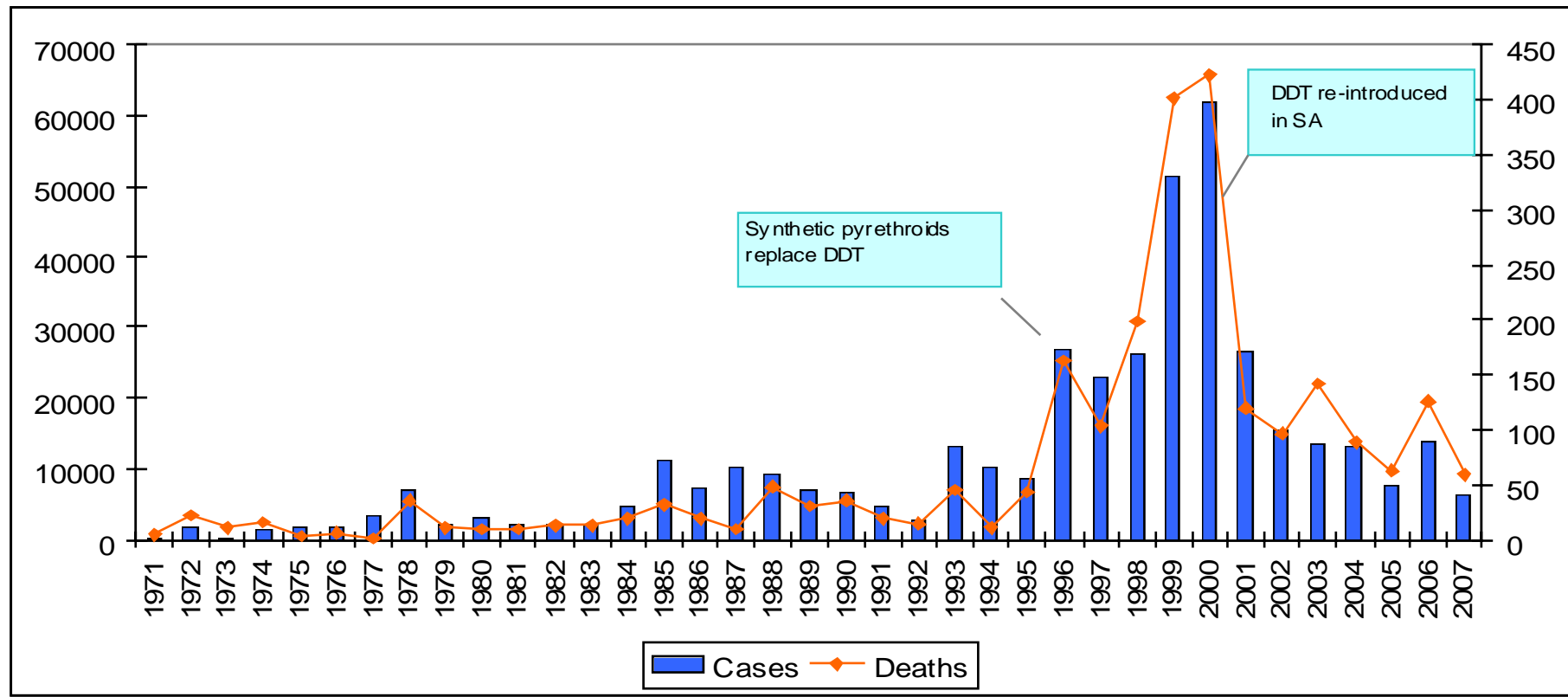
#### 3.1 Annual malaria trends in South Africa

The annual malaria trends from 1971 to December 2007 are shown in figure 1. The prevalence of malaria had been escalating at alarming rates since the mid 90's. The highest number of cases (61 934) was reported in 2000, the worst levels of malaria recorded since the epidemics of the 1930's.

Many factors may have contributed to this. First, change from DDT as the insecticide of choice to synthetic pyrethroids resulted in the emergence of resistant Anopheline mosquitoes. There was evidence of the presence of detectable numbers of *Anopheles funestus* mosquitoes inside houses sprayed with pyrethroids in the Ndumu area of northern KwaZulu-Natal <sup>7</sup>. Secondly, there was evidence of parasites resistance to anti-malarial drugs especially chloroquine <sup>8&9</sup>. Third, the country experienced unusually heavy rains following several years of drought; this increased the number of breeding habitats for mosquito vectors. Lastly, the large influx of economic migrants from Mozambique, Zimbabwe many of whom carry malaria parasites, also resulted in a large number of imported cases and unexplained local upsurges and lack of finding index cases during sporadic outbreaks.

The reduction in malaria cases and deaths since the year 2000 can be attributed to a number of interventions such as:

- the change of first-line treatment to co-artemether,
- the re-introduction of DDT spraying,
- as well as the regional approach to malaria control in the Lubombo Spatial Development Initiative.



**Figure 1: Annual notified malaria cases and deaths in South Africa, 1971- 2007**

Source: Epidemiology and Surveillance Directorate and Communicable Disease Control Directorate

### 3.2 Prevalence and mortality of malaria between January and December 2007 in South Africa

A total of 6 615 malaria cases and 60 deaths were reported to the National Department of Health, Epidemiology and Surveillance Directorate, a decrease of almost 50% compared to the 13 901 cases reported for the same period in 2006 (Table 2). One of the most important indicators for evaluating the overall impact of malaria control is malaria case fatality rates (CFR). The objective for malaria control programmes in South Africa is to maintain this rate below 0.5%. The case fatality rates as shown in Table 1 are however higher than the set target.

**Table 2: Malaria cases reported by province, South Africa, Jan 2006 - Dec 2007**

Province	2006			2007		
	Cases	Deaths	CFR %	Cases	Deaths	CFR %
Eastern Cape	6	0	0	0	0	0
Free State	57	1	1.7	41	0	0
Gauteng	1 882	40	2.1	910	3	0.3
KwaZulu-Natal	1 211	11	0.9	585	5	0.9
Limpopo	6 144	53	0.8	2 898	34	1.1
Mpumalanga	4 558	21	0.4	2 154	17	0.7
North West	43	0	0	27	1	3.7
Northern Cape	0	0	0	0	0	0
Western Cape	0	0	0	0	0	0
<b>TOTAL</b>	<b>13 901</b>	<b>126</b>	<b>0.9</b>	<b>6 615</b>	<b>60</b>	<b>0.9</b>

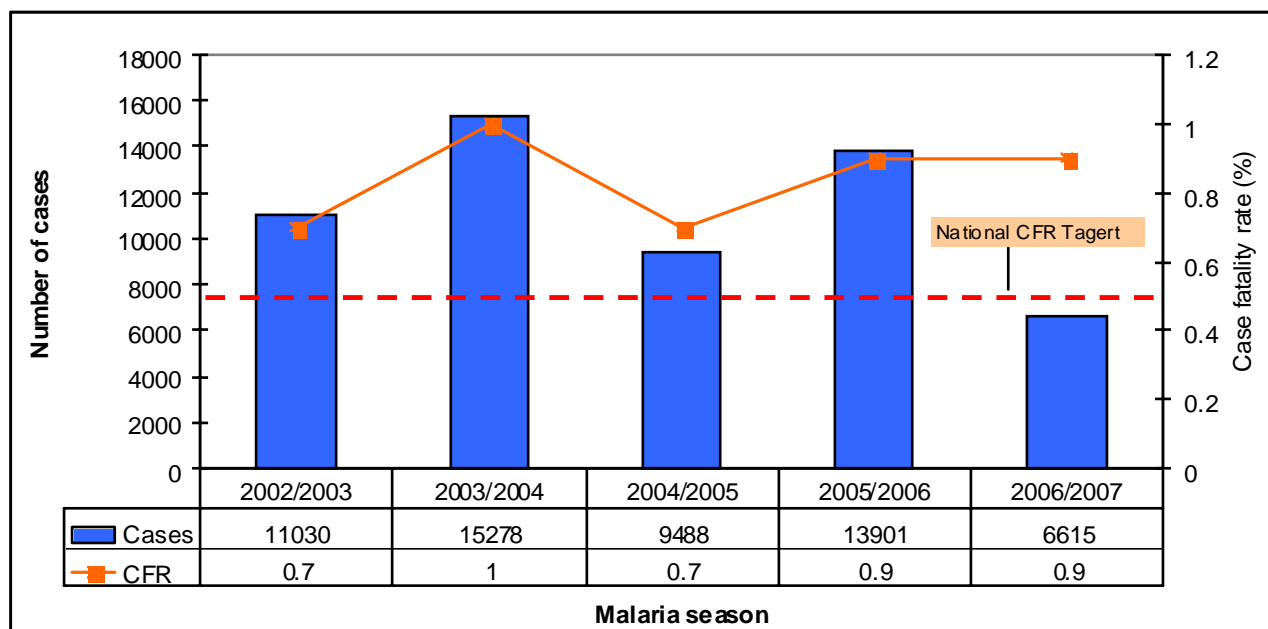
Source: Epidemiology and Surveillance Directorate and Communicable Disease Control Directorate

CFR: Case fatality rate

### 3.3 Seasonal national malaria cases in South Africa

The graph below depicts malaria cases reported in South Africa over the past five malaria seasons. During the 2006/2007 season, malaria cases in the country showed a marked decrease in comparison to the previous seasons. The distinctive peaks in the 2003/2004 and 2005/2006 season were largely

determined by the Limpopo and Mpumalanga cases, since these provinces had highest number of cases in those two periods. It is important to note that although the numbers of cases have decreased, the case fatality rates of 0.7% to 1.0% from 2002 to 2007, still remains above the national target of 0.5%.

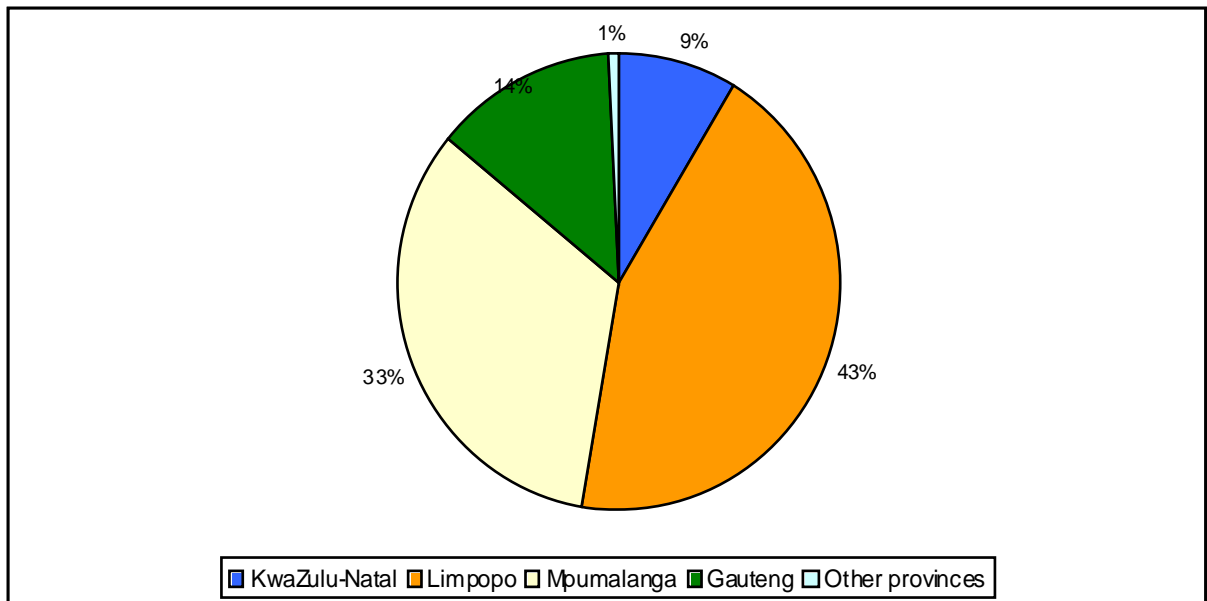


**Figure 2: Reported malaria cases and case fatality rates (CFR) for the past five malaria seasons, South Africa.**

Source: Epidemiology and Surveillance Directorate and Communicable Disease Control Directorate

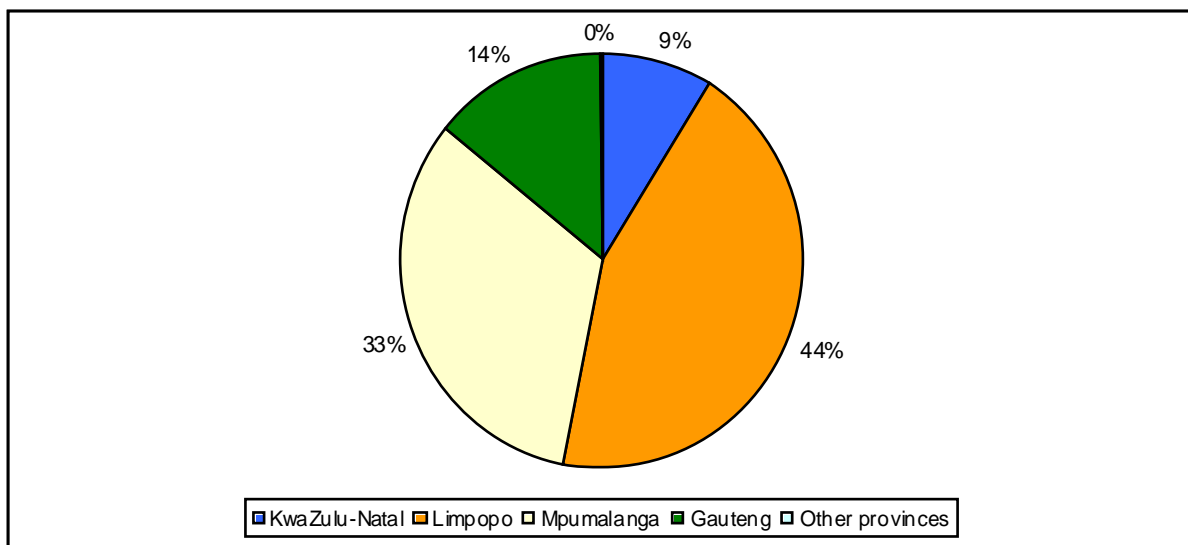
### 3.4 Malaria distribution by province, South Africa

In comparing the data from the 2005/2006 and the 2006/2007 season, the burden of malaria in South Africa appears to lie mainly in Limpopo province followed by Mpumalanga. Limpopo accounted for 43% of all the malaria cases in the 2005/2006 season and 44% during the 2006/2007 season (Figure 3 and 4). It is also important to note that although there is no local transmission of malaria in Gauteng, a considerable number of cases are reported in this province each year e.g. in 2006, 1 882 imported cases were and identified in Gauteng and in 2007 the numbers although still high, decreased slightly to 910 cases.



**Figure 3: Proportion of malaria cases by province, South Africa, 2005/2006 malaria season**

Source: Epidemiology and Surveillance Directorate and Communicable Disease Control Directorate

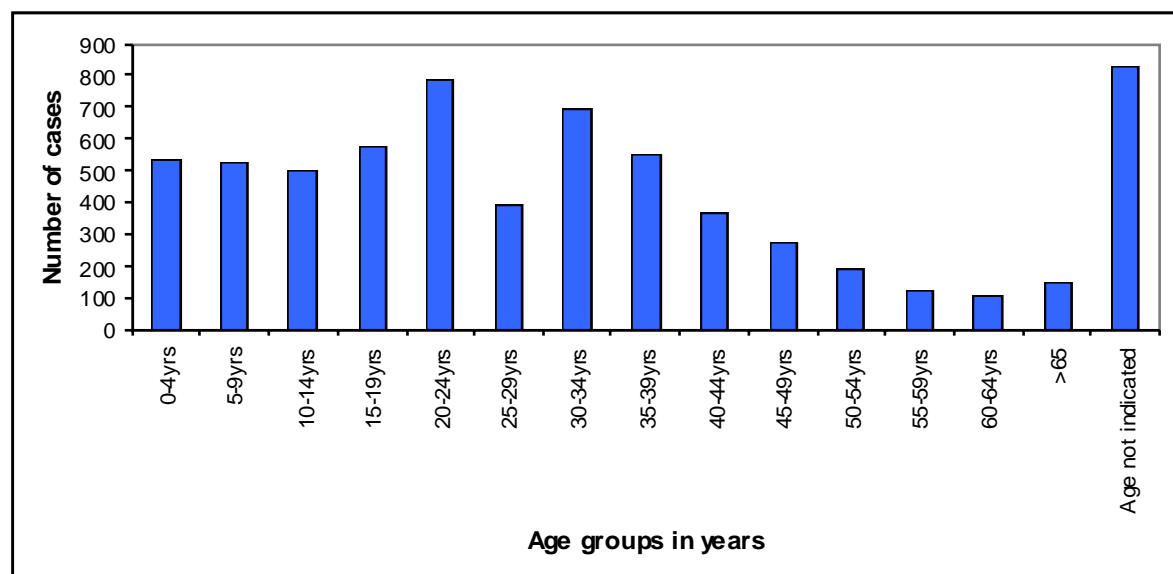


**Figure 4: Proportion of malaria cases by province, South Africa, 2006/2007 malaria season**

Source: Epidemiology and Surveillance Directorate and Communicable Disease Control Directorate

### 3.5 Prevalence of malaria by age-group and sex, South Africa

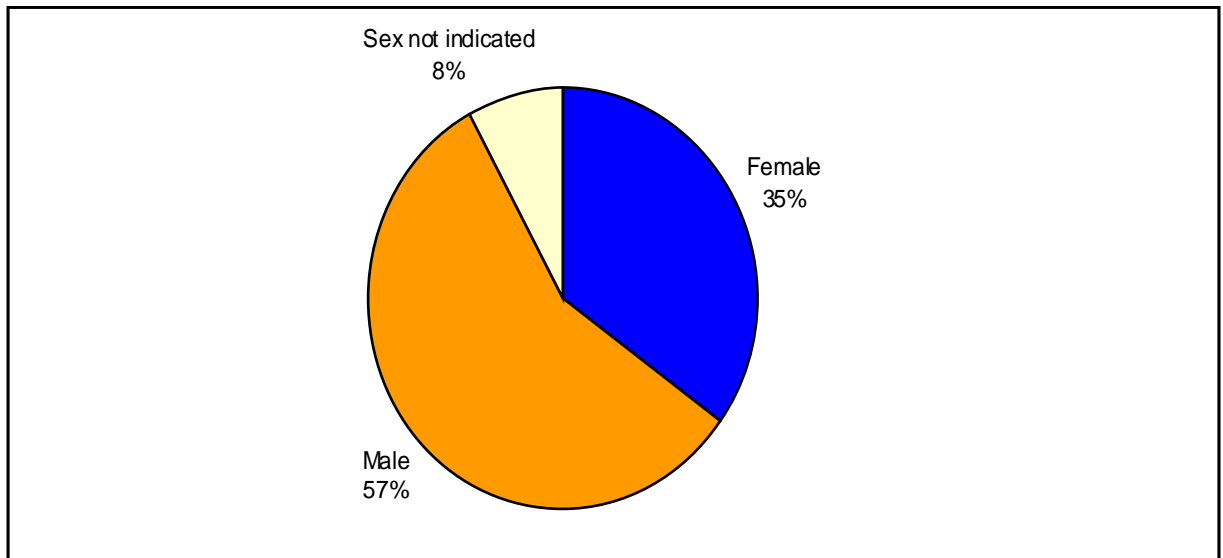
Malaria cases increased from early childhood, peaked in the age group 20 - 24 years and then gradually decreased in older age groups. Of the 6 615 cases reported, a total of 2 144 cases (37%) were classified as children under the age of 18 years, 538 (9%) of whom were under the age of 5 years. The ages were not indicated in 825 (12%) of the cases see figure 5.



**Figure 5.1: Reported malaria cases by age-group, South Africa, 2006/2007 malaria season**

Source: Epidemiology and Surveillance Directorate and Communicable Disease Control Directorate

The distribution by sex shows that a higher proportion of those affected are males (3 772) than females (2 324) (Figure 6).



**Figure 5.2: Proportion of malaria cases by sex, South Africa, 2006/2007 malaria season**

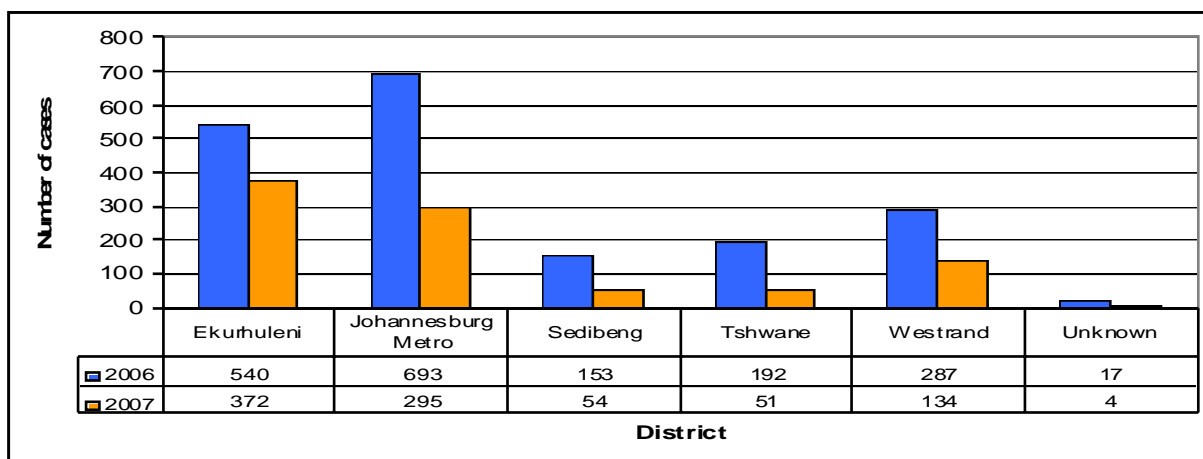
Source: Epidemiology and Surveillance Directorate and Communicable Disease Control Directorate

### **3.6 PREVALANCE OF MALARIA IN GAUTENG PROVINCE**

Malaria in Gauteng is not transmitted locally; all the cases reported in this province are from people who had travelled to malaria endemic areas. When these cases are analysed, they are always found to be imported cases from countries like Mozambique and Zimbabwe, see figure 3.

#### **3.6.1 Malaria distribution by district, Gauteng**

The distribution of the number of cases identified in Gauteng province shown in Figure 6. The numbers of malaria cases have decreased in all districts between 2006 and 2007. However, the majority of the cases still come from Ekurhuleni and Johannesburg Metro accounting for over 30% of all the notified cases in 2006 and 2007.

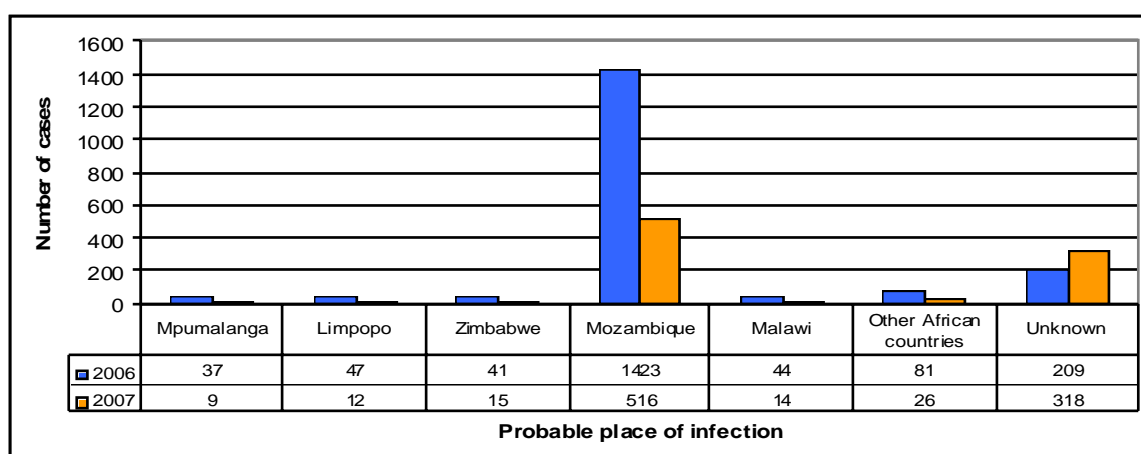


**Figure 6: Reported malaria cases by district, Gauteng, Jan 2006 to Dec 2007**

Source: Public Health Directorate, Gauteng Health

### 3.6.2 Sources of malaria infections in Gauteng

A notable observation from the data is that of all the cases in which the probable place of infection was known, the majority in both years (75% in 2006 and 56% in 2007) were infected during a recent visit in Mozambique; very few of the cases were acquired in Limpopo, Mpumalanga and other neighbouring SADAC countries (Figure 7). Information regarding the place of infection was missing for a considerable number of cases. Many immigrants often hide their place of origin due to the fear of being deported.



**Figure 7: Proportion of imported malaria cases from identified in Gauteng from Jan 2006 to Dec 2007.**

Source: Public Health Directorate, Gauteng Health

### 3.7 PREVALANCE OF MALARIA IN LIMPOPO PROVINCE

#### 3.7.1 Seasonal malaria cases and case fatality rates in Limpopo

The number of malaria cases and case fatality rates for the past five malaria seasons in Limpopo are shown in Figure 8. The seasonal malaria trend for Limpopo closely follows the national trend (Figure 2). Although there has been a general decline in the number of cases reported from the 2002/2003 (5 134) to the 2006/2007 (2 898) season, Limpopo experienced high malaria peaks in the 2003/2004 and the 2005/2006 season, recording 6 387 and 6 144 cases respectively. The case fatality rate remains above the national target of 0.5%.

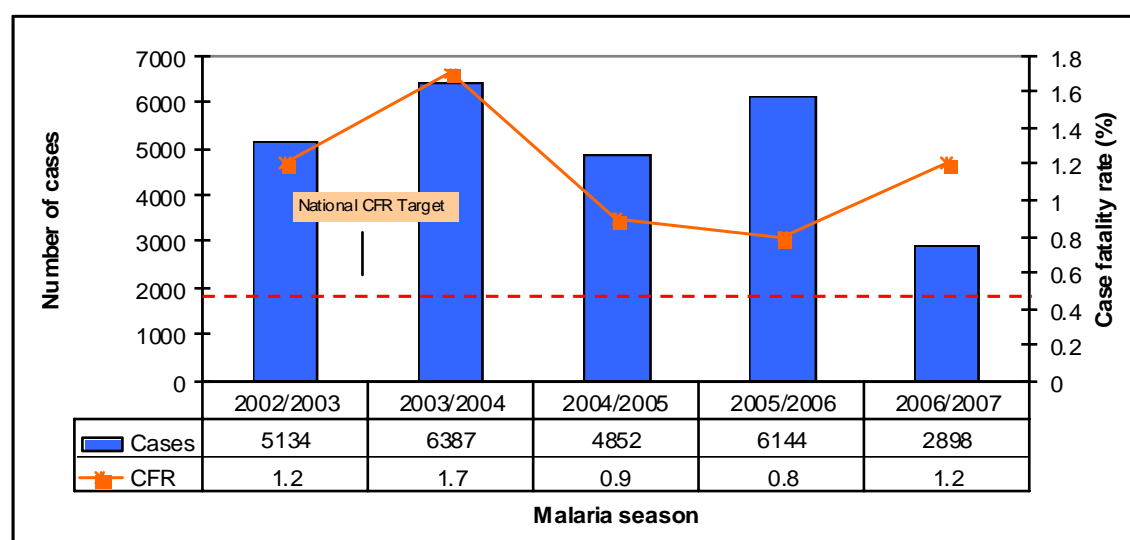
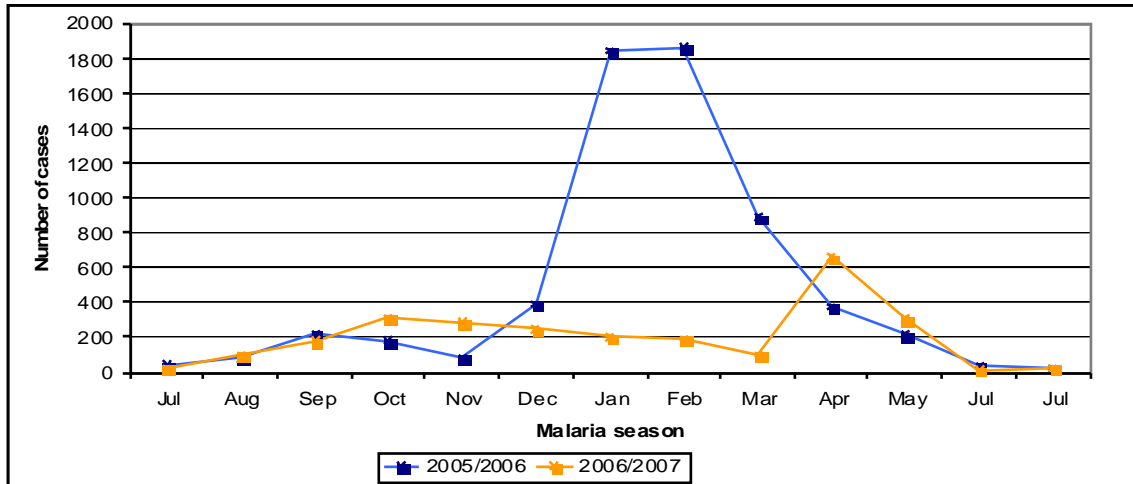


Figure 8: Reported malaria cases and case fatality rates (CFR) for the past five malaria seasons, Limpopo

Source: Limpopo Malaria Control Programme

#### 3.7.2 Limpopo malaria season 2005/2006 and 2006/2007

There is a monthly variation in the number of cases for the malaria season 2005/2006 and 2006/2007. The highest numbers of cases were observed in January and February of the 2005/2006 season and April of the 2006/2007 season. Cases only started to decline gradually during the month of May this decline continues until the end of June (Figure 9).

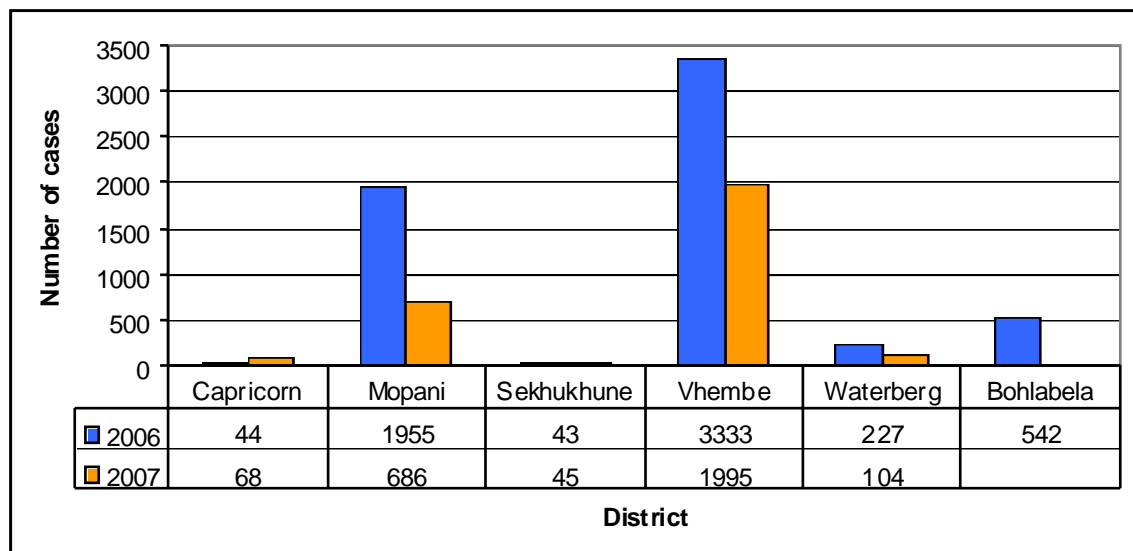


**Figure 9: Reported malaria cases in the 2005/2006 and 2006/2007 season in Limpopo**

Source: Limpopo Malaria Control Programme

### 3.7.3 Malaria distribution by district, Limpopo

Vhembe district, the northern most part of Limpopo, where South Africa borders Zimbabwe, remains the most affected district followed by Mopani (bordering Mozambique). The relatively low risk areas of Sekhukhune, Waterberg and Capricorn reported fewer cases in both years (Figure 10).

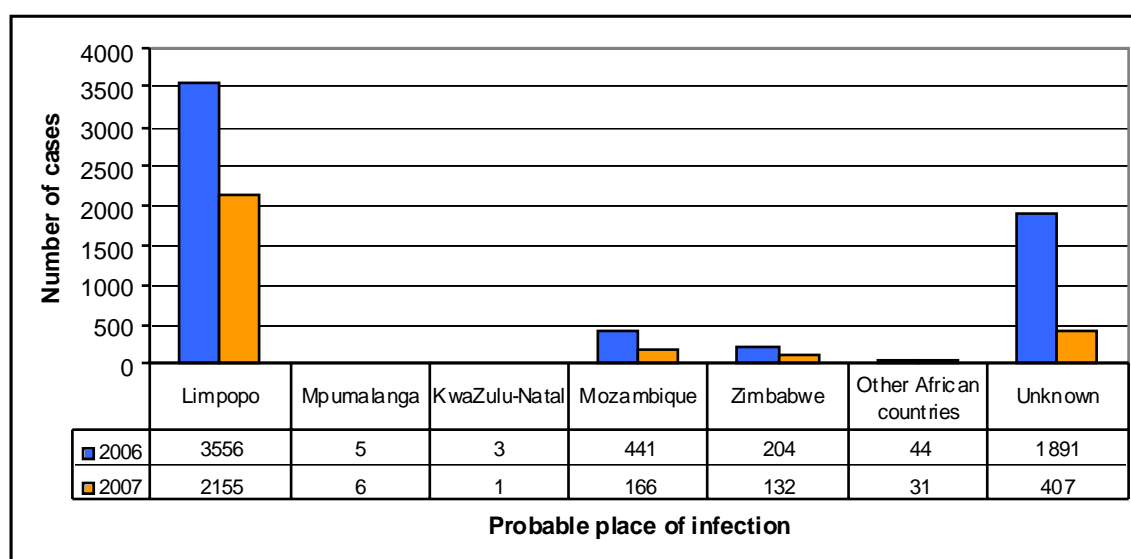


**Figure 10: Reported malaria cases by district Limpopo, 2006/2007 malaria season**

Source: Limpopo Malaria Control Programme

### 3.7.4 Sources of malaria infections in Limpopo

The majority of the cases reported during these two periods were acquired locally (Figure 11). Fewer cases were imported from Mozambique, Zimbabwe, Mpumalanga and KwaZulu-Natal. The travel history of a substantial number of cases was not known. This can be attributed to migrant workers providing incorrect personal records to health care providers.



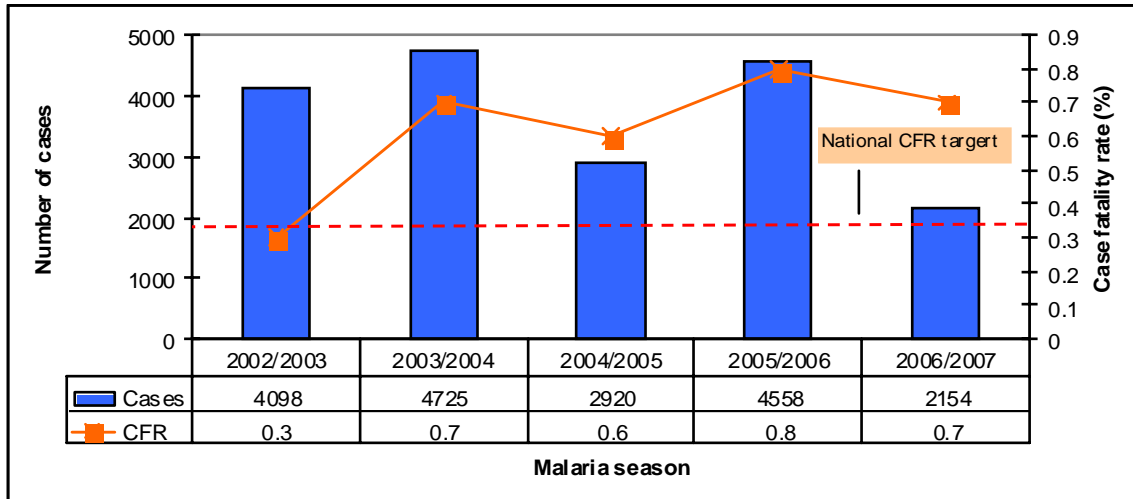
**Figure 11: Reported malaria cases by probable place of infection, Limpopo, 2006/2007 malaria season**

Source: Limpopo Malaria Control Programme

## 3.8 PREVALENCE OF MALARIA IN MPUMALANGA PROVINCE

### 3.8.1 Seasonal malaria cases and case fatality rates, Mpumalanga

The seasonal malaria trend of Mpumalanga also closely resembles the national trend (Figure 12). Mpumalanga experienced three peaks between the 2002/2003 and the 2006/2007 season. Although the number of cases reported during the 2006/2007 season decreased by almost half when compared to the 2005/2006 season, the case fatality rate remains above the national target of 0.5%.

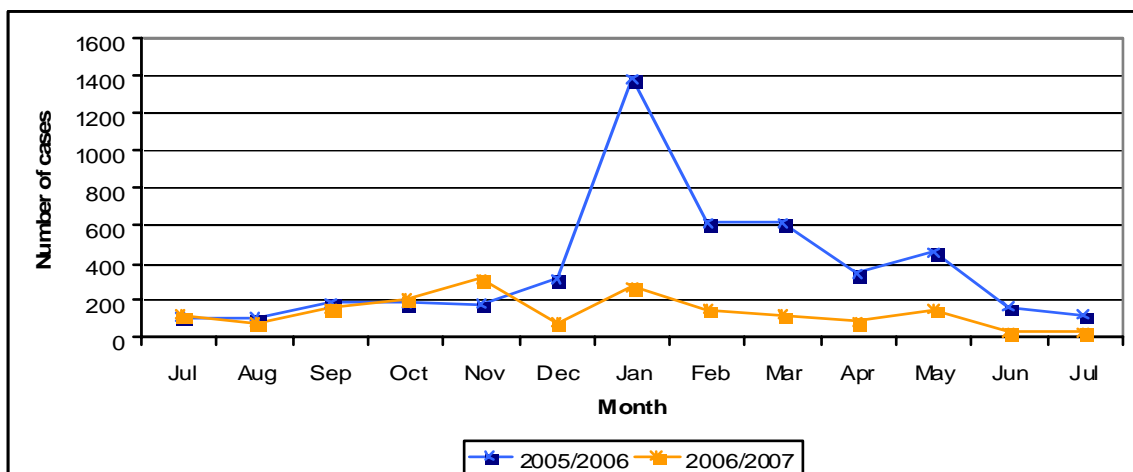


**Figure 12: Reported malaria cases and case fatality rates (CFR) for the past five malaria seasons, Mpumalanga**

Source: Mpumalanga Malaria Control Programme

### 3.8.2 Mpumalanga malaria season 2005/2006 and 2006/2007

The observed pattern of monthly malaria notifications between the 2005/2006 and 2006/2007 malaria season is shown in Figure 13. Transmission of malaria in Mpumalanga is seasonal occurring between October and May. Malaria cases were infrequent from July to September and then gradually increased, with the most cases being between January and May and gradually waning thereafter.

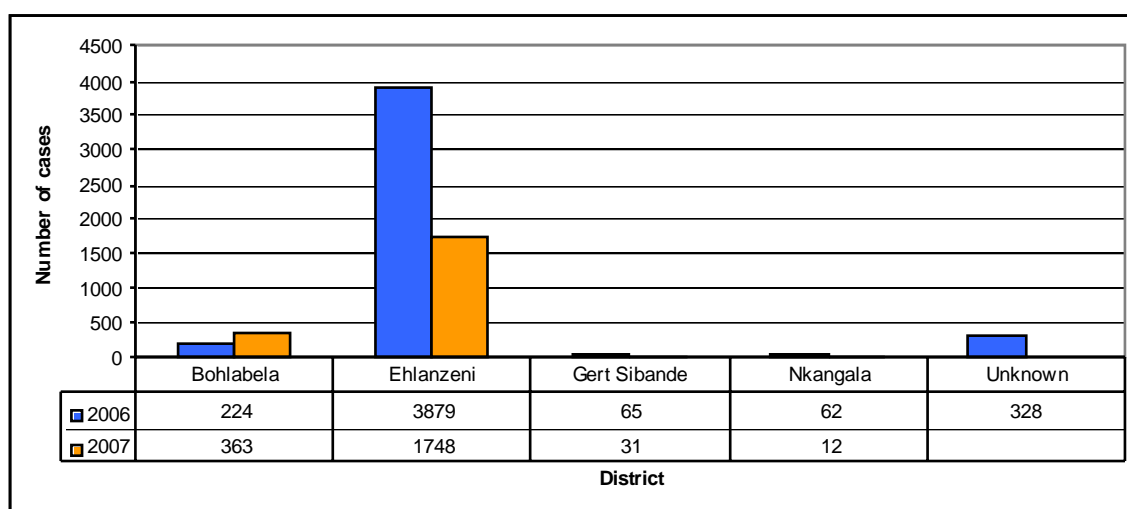


**Figure 13: Reported malaria cases in the 2005/2006 and 2006/2007 malaria season in Mpumalanga**

Source: Mpumalanga Malaria Control Programme

### 3.8.3 Malaria distribution by district, Mpumalanga

There are well defined patterns of population movement in Mpumalanga which are of direct relevance to malaria and other communicable diseases <sup>10</sup>. In particular, movement of people across the border from the unsprayed areas of Mozambique, tourists to the Kruger National Park and migrant workers visiting families in malarious areas. As a result, areas along these routes, especially areas along the border of Mozambique, regularly report the highest malaria incidence (see graph below). The majority of the cases in both seasons were reported from Ehlanzeni, a district which borders Mozambique. Nkangala, Gert Sibande and Bohlabela were less affected.

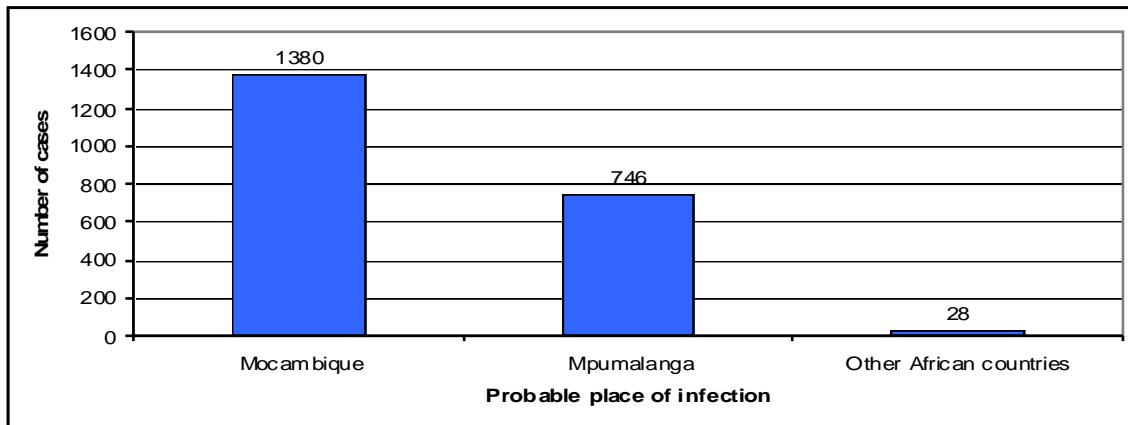


**Figure 14 Reported malaria cases by district, Mpumalanga, 2006/2007 malaria season**

Source: Mpumalanga Malaria Control Programme

### 3.8.4 Sources of malaria infections in Mpumalanga

Mpumalanga is situated between KwaZulu-Natal in the south, Swaziland and Mozambique in the east, Limpopo in the north and Gauteng in the west. Areas along the border of Mozambique regularly report the highest malaria incidence. Figure 15 clearly shows that the majority of the cases (64%) were from people who had recently travelled to Mozambique



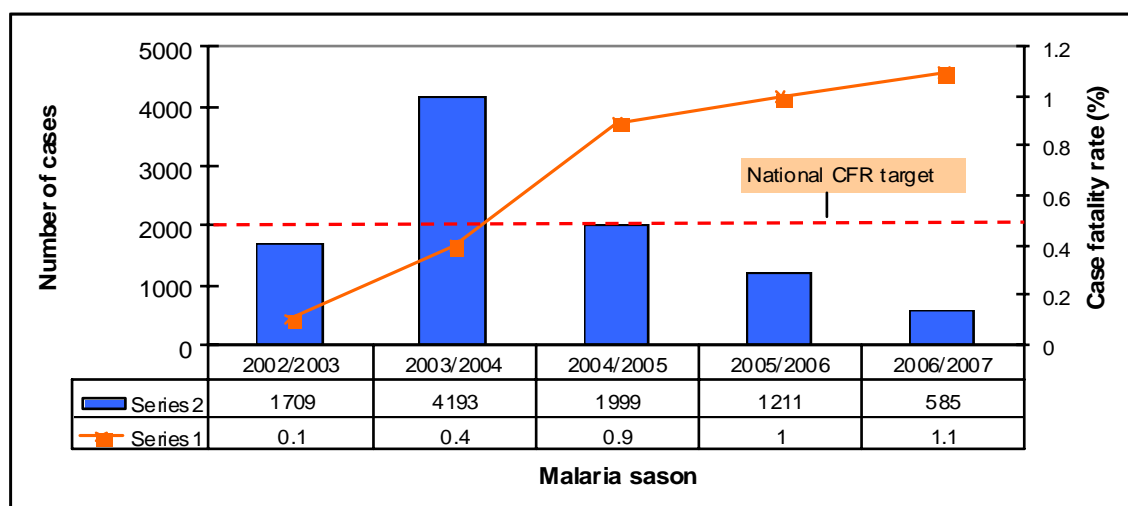
**Figure 15: Reported malaria cases by probable place of infection, Mpumalanga, 2006/2007 malaria season**

Source: Mpumalanga Malaria Control Programme

### 3.9 PREVALENCE OF MALARIA IN KWAZULU-NATAL

#### 3.9.1 Seasonal malaria cases and case fatality rates, KwaZulu-Natal

Malaria cases have been steadily decreasing in KwaZulu-Natal, except for the peak in the 2003/2004 season where a total of 4 193 cases were reported, (Figure 16). A similar trend is however shown in KwaZulu-Natal, where, like other provinces, the case fatality rate remains high, above the national target of 0.5%.



**Figure 16: Malaria cases and case fatality rates (CFR) for the past five malaria seasons in KwaZulu-Natal province**

Source: KwaZulu-Natal Malaria Control Programme

### 3.9.2 KwaZulu-Natal malaria season 2005/2006 and 2006/2007

The 2006/2007 transmission pattern closely follows that of the previous season (Figure 17) with cases peaking during the warm, rainy summer months. Malaria cases were low in July and August but started to gradually increase in September and peaked in January and February. Cases only started to decline gradually in April, this decline continued until the end of June.

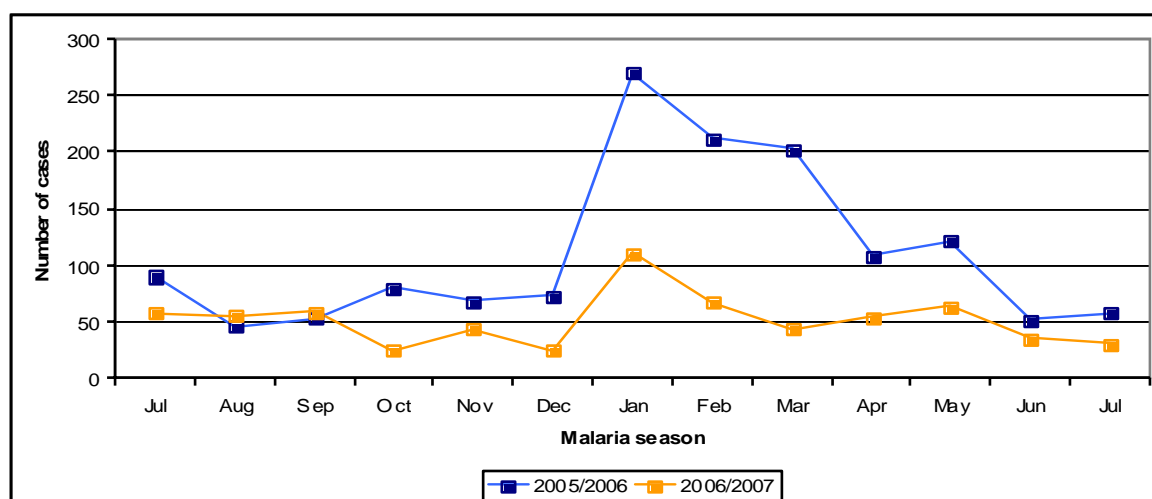
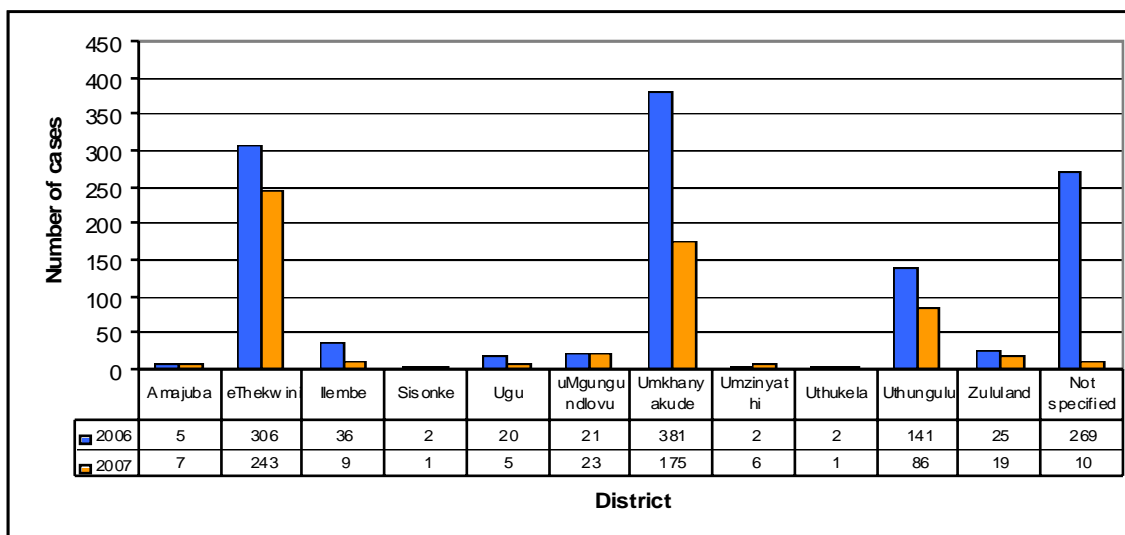


Figure 17: Reported malaria cases in the 2005/2006 and 2006/2007 malaria season, in KwaZulu-Natal

Source: KwaZulu-Natal Malaria Control Programme

### 3.9.3 Malaria distribution by district, KwaZulu-Natal

The majority of the cases (43%) came from uMkhanyakude (situated along the Mozambique border) followed by eThekweni as shown in (Figure 18). There is no malaria transmission in eThekweni, all the cases that are reported in this district are from people who had acquired malaria while traveling in malaria endemic areas. Other districts Ilembe, Sisonke, Mgugundlovu, Ugu Uthungulu and Zululand reported very few cases.

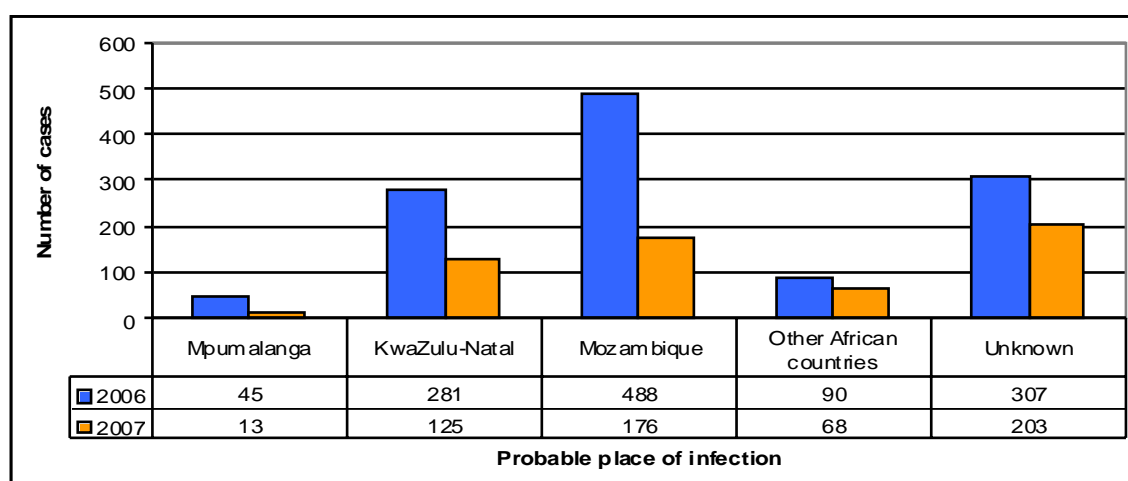


**Figure 18: Reported malaria cases by district KwaZulu-Natal, 2006/2007 malaria season**

Source: KwaZulu-Natal Malaria Control Programme

### 3.9.4 Sources of malaria infections, KwaZulu-Natal

Although there is local malaria transmission in KwaZulu-Natal, the majority of the cases reported in this province are imported or introduced from the neighbouring country of Mozambique (40% in the 2005/2006 season and 30% in the 2006/2007 season). Very few cases were acquired locally (Figure 19).



**Figure 19: Reported malaria cases by probable place of infection, KwaZulu-Natal, 2006/2007 malaria season**

Source: KwaZulu-Natal Malaria Control Programme

#### 4. DISCUSSION

A total of 6 615 malaria cases and 60 deaths were reported to the National Department Health, Epidemiology and Surveillance Directorate during this period representing an decrease of almost 50% from the 13 901 cases reported for the same period in 2006. Despite this decrease, the case fatality rate has remained high at 0.9%, a rate above the national target of 0.5%.

Data from this report also shows that, while there is no malaria transmission in Gauteng, a large number of malaria cases are reported in this province annually. This is due to the influx of economic migrants into the province from other regions (particularly Mozambique and Zimbabwe) where malaria is endemic. Gauteng accounted for 14% of the total national malaria burden in the 2005/2006 and the 2006/2007 season.

In addition, data from this report also indicates that the burden of malaria in South Africa has shifted from KwaZulu-Natal to Limpopo and Mpumalanga. Malaria cases in KwaZulu-Natal, once the country's worst affected province have dropped by nearly 99% since the introduction of DDT in 1999 and the creation of the Lubombo Spatial Development Initiative in northern KwaZulu-Natal, eastern Swaziland and southern Mozambique in 2000. This province currently carries only 585 cases (9% of the country's malaria burden) down from 27 238 (53% of the national burden) in 1999 while Limpopo and Mpumalanga provinces currently account for 43% and 44% of the national burden respectively.

In order to deal with the growing burden of malaria in Mpumalanga and Limpopo especially in areas along the borders, cross border malaria interventions will need to be heightened. Mpumalanga forms the main thoroughfare to South Africa from Mozambique, while Limpopo forms the link to Zimbabwe in the north and to Mozambique in the east. People cross these borders daily for various reasons.

The evidence presented in this report shows that areas along these borders regularly report the highest malaria incidence in the country. In addition, people coming across these borders, mostly being non-symptomatic, do not present at public health facilities and remain untreated, thereby contributing significantly to

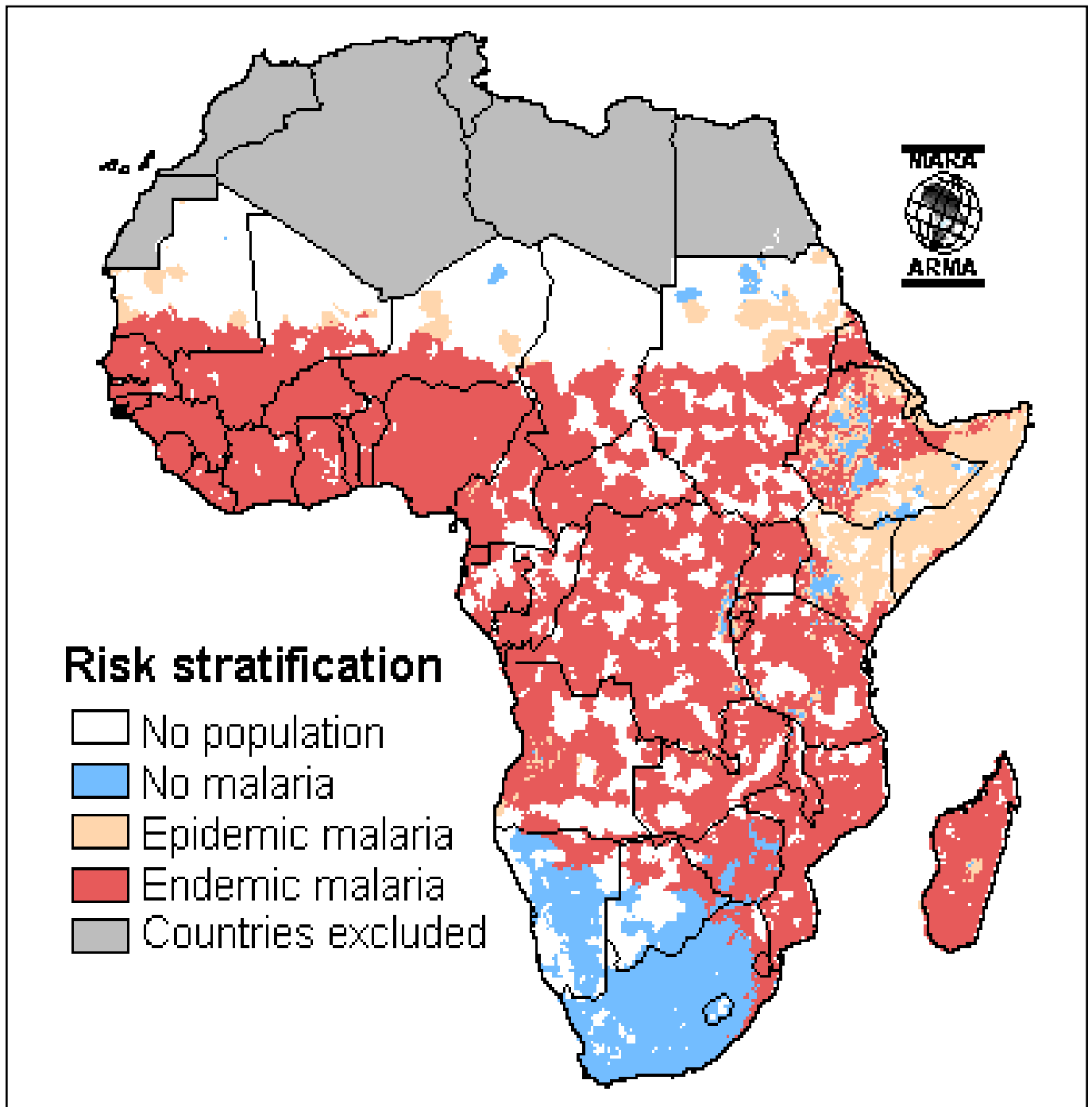
the local malaria transmission/burden. The data also shows that a large number of cases, due to the fear of being deported are reported with no place of origin specified. Most of these unspecified cases are probably also imported and originate largely from Mozambique and to a lesser extent from Zimbabwe (cases origination from other countries like Swaziland, Zambia, Ethiopia are essentially negligible).

One of the main objectives of the malaria control programme is prevention of premature deaths due to malaria. Despite extensive measures to prevent malaria deaths, a number of deaths are still notified every year. The country has not been able to achieve its case fatality target of 0.5%. The case fatality rates have ranged between 0.7 and 1.2% in the last five years, some provinces fairing less well than others. The main reason for the occurrence of malaria deaths in South Africa is, inability of health care workers to recognize signs and symptoms in low transmission area, late diagnosis and the delay in treatment seeking behaviour.

## **5. Conclusions**

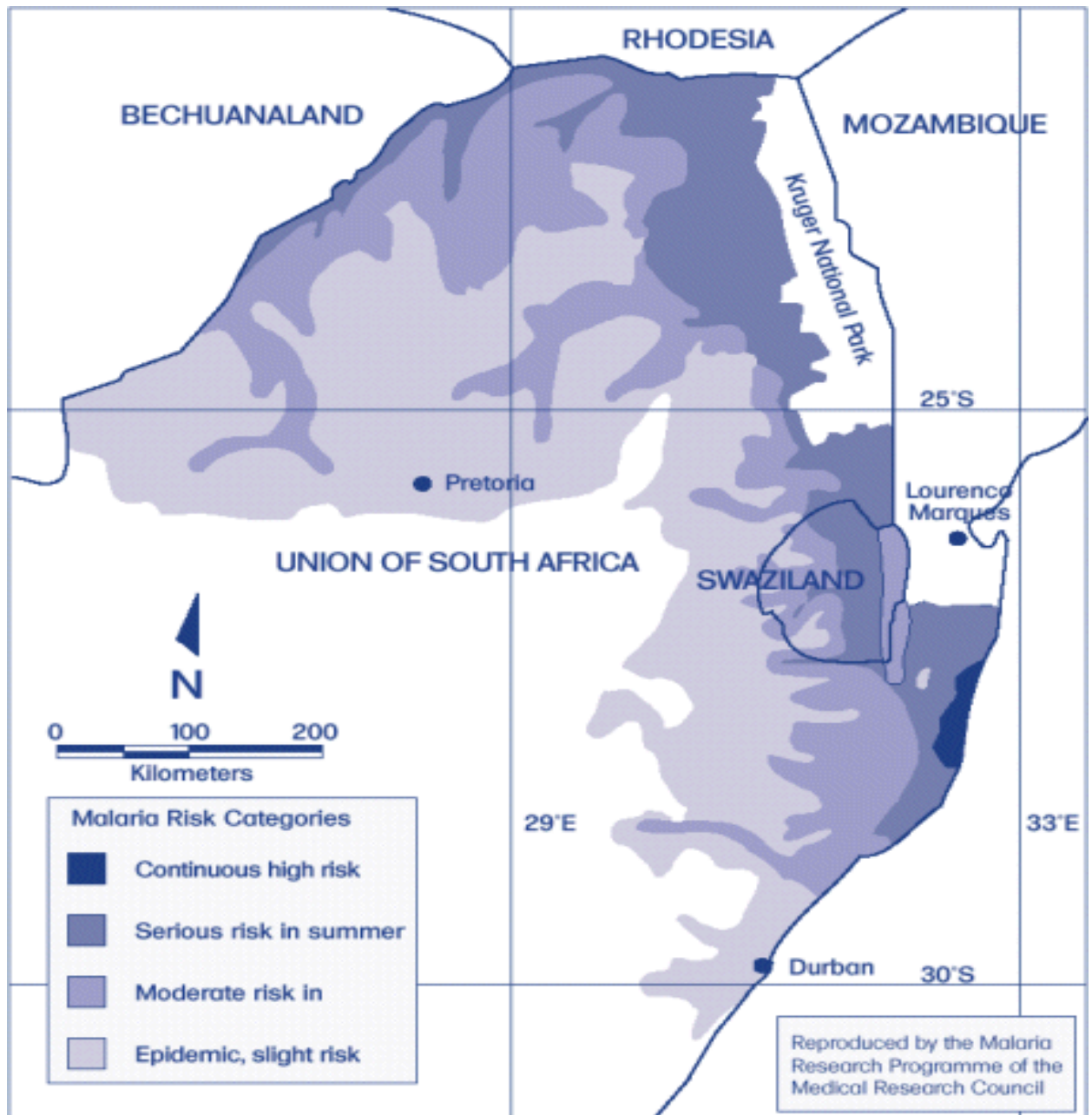
Malaria in South Africa is primarily a border and a population movement problem, as can be seen from the persistence of malaria in the KwaZulu-Natal, Limpopo and Mpumalanga border areas in the face of intense local malaria control (Appendices 2a and 2b) and the great number of imported malaria cases reported each year. Population movement is also increasingly implicated in the spread of drug resistance<sup>11</sup>, another challenge facing the South African malaria control programmes together with vector insecticide resistance. The malaria control programmes in South Africa will need to strengthen their interventions especially at district level. Strategies to address cross border malaria control between the Limpopo and Mozambique, Limpopo and Zimbabwe and Mpumalanga and Mozambique are expected to have a similar impact on malaria reduction in South Africa as the achievements of the Lubombo Spatial Development Malaria Initiative.

## APPENDIX 1: MALARIA RISK AREAS OF AFRICA



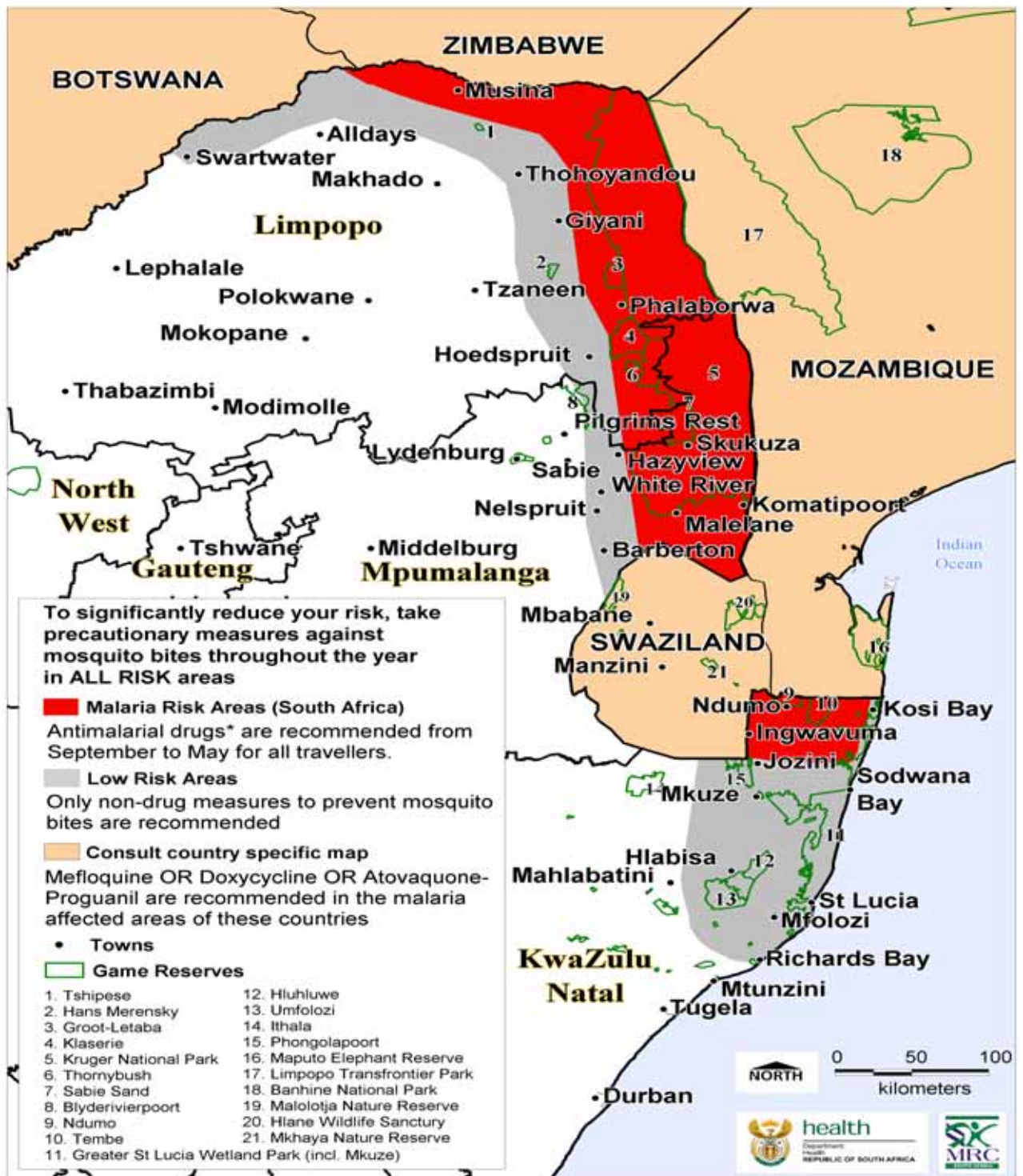
Source: [www.mara.org.za](http://www.mara.org.za)

**APPENDIX 2a: THE DISTRIBUTION OF MALARIA IN SOUTH AFRICA, 1938**



Source: Malaria Survey by the Department of Public Health of the Union of South Africa.

APPENDIX 2b: THE DISTRIBUTION OF MALARIA IN SOUTH AFRICA, 2006



Source: NDOH Guidelines for the prevention of malaria in South Africa

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