SUSTAINABLE PLAN TO ROLL BACK MALARIA IN CAMEROON VIA EDUCATION, USE OF INSECTICIDES IMPREGNATED BEDNETS AND ENVIRONMENTAL SANITATION

MASTER’S THESIS

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DEDICATIONS

This work is dedicated to my entire family especially to my Darling Father.

Mr Tamfor Fidelis Nwafor.

With all my love,
And my heartfelt “thank you”
For your astonishing faith in me
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Abstract

The following paper proposes a more sustainable approach to roll back malaria in Cameroon via education, use of insecticides impregnated bed nets and improvement in environmental sanitation. National efforts to roll back malaria in Cameroon will contribute to a reduction in the burden of malaria and benefit the health sector on a whole. Generally, a national vector control program of an insect borne disease such as malaria in Cameroon constitutes a rather specialised part of general rural or urban sanitation. The main aim of a national malaria control program is to roll back the incidence of malaria in Cameroon by proper case management and treatment of infected individual, and by reduction of the breeding sites for the vectors, which for the mosquitoes, is the accumulation of water suitable for breeding. Findings from key informants and health specialists, reveal that the most obvious environmental management measure of any vector including mosquitoes harbouring the malaria parasite, is the elimination of the breeding sites, which have been augmented in urban and rural regions in Cameroon by the existing environmental problems such as water leakages from pipe breakage on gravel roads, poor housing condition in most areas, untreated industrial waste flowing in most of the open drains in the housing area and improper disposal of waste from domestic activities. The presence of these factors in Cameroon favours the breeding sites of the anopheles mosquitoes, which are the vector of malaria.

Keywords: Malaria, Mosquitoes, Roll Back malaria, Environmental management, Insecticide impregnated nets.
### List of Abbreviations

<table>
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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>DDT</td>
<td>Dichlorodiphenyltrichloroethane</td>
</tr>
<tr>
<td>EHC</td>
<td>Environmental Health Criteria monograph</td>
</tr>
<tr>
<td>ESHAW</td>
<td>Eco-System and Health Analysis Workshop</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GNP</td>
<td>Gross National Product</td>
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<tr>
<td>HSG</td>
<td>Health and Safety Guide</td>
</tr>
<tr>
<td>IARC</td>
<td>Monographs on the Evaluation of Carcinogenic Risk to Humans</td>
</tr>
<tr>
<td>IDRC</td>
<td>International Development Research Center (IDRC)</td>
</tr>
<tr>
<td>ITN</td>
<td>Insecticide treated Nets</td>
</tr>
<tr>
<td>JMPR</td>
<td>An evaluation by the joint FAO/WHO Meeting on Pesticides Residues</td>
</tr>
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<td>MIM</td>
<td>Multilateral Initiative on Malaria</td>
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<tr>
<td>NGO</td>
<td>Non Governmental Organisation</td>
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<tr>
<td>NIAID</td>
<td>National Institute of Allergy and Infectious Diseases</td>
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<tr>
<td>RBM</td>
<td>Roll Back Malaria</td>
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<tr>
<td>SD</td>
<td>Sustainable Development</td>
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<tr>
<td>SNEL</td>
<td>Cameroon National Water Corporation</td>
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<tr>
<td>UNICEF</td>
<td>United Nation Children Education’s Fund</td>
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<tr>
<td>US-EPA</td>
<td>US-Environmental Protection Agency</td>
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<td>WHO</td>
<td>World Health Organisation</td>
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1 Introduction

1.1 Problem Definition

The Ministry of Public Health in the Republic of Cameroon rates malaria disease as a major public health problem in Cameroon (2000). This has become even more challenging since some malaria parasites have become resistant to commonly used drugs like chloroquine and the vector have become resistant to commonly used insecticides such as DDT. Malaria is a heavy burden to Cameroonianians, a major cause of high infant and maternal mortality, work loss and a serious impediment to economic development and productivity. The epidemiology of malaria is influenced by attributes of the mosquito vectors, which in turn are closely linked to environmental conditions. Malaria afflicts mostly the poor, who tend to live in malaria endemic areas and in dwellings that offer little or no protection against mosquitoes and by sapping their health, strength and productivity it further marginalizes and impoverishes them.

Efforts to combat malaria in Cameroon are hindered by the poor sanitations in most regions of the country, wide spread poverty, economic crisis, high birth rates, unstable political system in addition to health problems posed by other diseases such as AIDS, tuberculosis, typhoid fever and sleeping sickness. To this end the Government of Cameroon can only implement the principle of sustainable development by providing important strategies needed to sustain and improve health and well being. Thus, sustainable approach to reduce the burden of malaria in association with an international organisation such as Roll Back Malaria Movement in the World Health Organisation (WHO) is fundamental to the Government of Cameroon.

1.2 Objectives and Structure

Generally this paper will try to analyse a more sustainable approach to reduce the burden of malaria in Cameroon by an international project such as the Roll Back Malaria. The control of any parasitic disease like malaria "is a multifaceted operation that must take into account a large number of variables" such as the "aetiology (causative agent) of the disease, the natural history (epidemiology), including it's mode of transmission", which in the case of malaria is a vector borne disease (Cox 1993). To achieve this general objective specifically in this paper, more practical methods of control for malaria such as the use of insect repellent, environmental management and vector control by sanitation, use of insecticide impregnated bed nets, chemotherapy more specifically preventive chemotherapy, insecticide usage such as DDT and how feasible they can be adopted to roll back malaria in Cameroon will be discussed. The combination of environmental management and use of insecticide impregnated nets (ITNs) with increased surveillance, project evaluation basic research and training constitute an integrated approach to malaria control in Cameroon that will be vital for a long-term, successful, and sustainable effort. This can only be achieved by successful launching of a National Roll Back Malaria movement by the government of Cameroon encouraged and partly financed by the Roll Back Malaria project in World Health Organisation.

The analysis begins with a literature review on Malaria and Cameroon completed by a section on public health being viewed as an important indicator of sustainable development. Various preventative measures for control of malaria are discussed followed by a proposed plan that could
be followed by the Roll Back Malaria Global movement to reduce the burden of malaria in Cameroon.

1.3 Methodology

Data for this paper was collected using both primary and secondary sources of information. Secondary sources include publications, Internet search and related books, journals from the library. Most data or information gathered here was based on the malaria situation in Africa but Cameroon being Africa in miniature in many aspects like climate made it possible for conclusions to be drawn about Cameroon in particular from the published information. Personal experience, which is a primary source of information, was also used to validate most data collected from journals, books and the Internet. Being a victim of the disease and living for over twenty years with the illness among my community makes my observations very accurate for this study.

Lastly, there were lots of open discussions by phone and by email with many Cameroonian professionals. These professionals included masters and PhD students from the field of environmental science and biochemistry who are all studying in Europe but graduated from a Cameroon university. The discussions concentrated on the causes of malaria, possible eradication or prevention technique and above all what immediate action should be taken by the government and citizens to minimise this burden.

A causal loop diagram is used to show the dynamic feedback loops on how the subsystem of the malaria life cycle and transmission of the disease can be influenced by various control methods. Case control studies done in various parts of the world on different control strategies are used to support the fact that education, use of insecticides impregnated bed nets and improvement in environmental sanitation are more sustainable methods to roll back malaria in Cameroon.

1.4 Limitations

The clinical and curative aspect of malaria would not be discussed in detail, since focus will be directed towards prevention. Likewise, methods such as genetic control of mosquitoes, biological control through predators and parasites, zoo prophylactic (location of alternative hosts such as cattle to divert mosquito from man) and development of vaccine will not be discussed. This is because these methods of control are more scientifically and theoretical based prospects that hitherto have not yielded practical results.

It is worth of mention that there are insufficient data on many aspects of malaria in Cameroon and as a result, most of the analysis is based on general information on Malaria in Africa and lot of personal experience as a Cameroonian, having suffered a series of malaria attacks as well as watched lot of suffering and death in my community as a result of malaria.
2 Literature Review

2.1 What is Malaria?

Malaria is the name denoting the vector borne disease caused by the protozoan parasites of the genus *Plasmodium* of which, there are four main species known to infect humans. This include *Plasmodium falciparum*, *P. vivax*, *P. ovale* and *P. malariae* and of these four species, *P. falciparum* is the most widespread and dangerous species, which if untreated, can lead to fatal cerebral malaria. Human malaria is a threat to thousand of children and pregnant women, in Cameroon and is often cited as a substantial impediment to economic and social development.

The symptoms of malaria include “fever, shivering, pain in the joints, headache, repeated vomiting, anaemia, an enlarged spleen, severe abdominal pain, generalized convulsions and coma” as well as “extreme weakness and greater susceptibility to other diseases”. If the disease is not treated, particularly that caused by *P. falciparum*, it progresses to severe malaria, which is usually associated with death (Miller, 1999). The disease is transmitted when an uninfected female mosquito of any of the above mentioned species bites an infected person, ingests blood that contain the parasite and later bites an uninfected person.

2.2 The Life cycle of the Malaria Parasite.

![Life cycle of malaria parasite](image)

**Fig 1:** The life cycle of malaria parasite which circles from human to mosquitoes and back to human

Source: Adapted from Miller 2000

2.3 Anopheles vector and malaria Transmission

The level of transmission of malaria is determined by prevalence of the infection in man (reservoir), the seasonal incidence (temperature, humidity and rainfall) in addition to the characteristics of the indigenous mosquito, including their relative abundance, feeding and resting behaviour,
susceptibility to infection as well as their effectiveness as a vector. The overall biology of the life cycle of all mosquito species is similar with egg, larval and pupae stages. The duration of the life cycle is dependent on temperature. The female Anopheles needs a blood meal before laying the eggs. Thus its lifecycle consist of taking a suitable blood meal, resting while it is digested and flying off to lay eggs at a suitable water body. The eggs are usually deposited in selected aquatic habitats but any water containing structure, natural or artificial, such as,

- swampy areas, rice fields, reservoirs, water filled pothole on street,
- cisterns (water tanks) for storage of water,
- small ponds, borrow-pits, canals and ditches with stagnant water in and around villages,
- polluted streams and rivers or open streams and rivers with very slow-flowing water along their banks or
- pools of water left on the riverbed after the rains have ended or as a result of poor water management (like the case in Cameroon) could also serve as breeding grounds (Busvine, 1993).

The eggs, larvae, and pupae develop in the aquatic habitat and the winged adult emerges. The pupae have duration of about 3 days at tropical climate such as in Cameroon before the adults emerges. In temperate region the duration might be over a week. When the adult female emerges from the pupa, a blood meal is sought and this could be from an infected human that contain the plasmodium gametocytes. The parasites develop in the gut of the mosquito and infection is initiated when sporozoites from the salivary glands of the mosquito are inoculated during a blood meal into the human bloodstream. The parasite then invades the human blood cells causing malaria and making the infected individual a new reservoir. The malaria cycle repeats itself until immunity develops (usually within 3-5 years) or the patient is treated or is killed by the disease (Miller, 2000).

The epidemiology of malaria is influenced by the distribution of the mosquito’s population, which is closely linked to environmental conditions. The plasmodium parasite is transmitted by a single mosquito genus Anopheles. However, based on the WHO fact sheets on Malaria, there are about 380 different species of anopheline mosquitoes of which only 60 species can transmit the plasmodium species (WHO, 1998). These species vary in their habits, breeding places and in their effectiveness as vectors. Only the female Anopheles transmit the disease since they need a blood meal before laying their egg and the number and type determine the extent of transmission in a given area. The males do not transmit the disease as they feed only on plant juices. Likewise, for ecological reasons, only a few species of female Anopheles in any region can be important malaria vectors, since to transmit malaria the mosquitoes need to be sufficiently abundant. Also, they need to bite infected human rather than only some vertebrate host and they should be able to live long enough so that the ingested gametocytes from infected individuals can develop into sporozoites to continue transmission.

The behaviour of the adult mosquito determines which vector control strategies are most likely to be successful. The female adult Anopheline vary in their preferred feeding and resting habits, although a majority of them bite in the evening and night. They either bite indoors (endophagic) or outdoors (exophagic). In Cameroon the vectors are both endophilic and exophilic. This is rather unfortunate since success of many anti-malarial efforts has mainly been dependent on endophilic vectors in several continents and failures of eradication attempts has sometime resulted from many exophilic vectors being present in many forested areas, as the case in Cameroon. (Weatherall et al, 1996)
Transmission of malaria is also associated with other environmental characteristics such as the poor and damp housing in most regions in Cameroon especially in rural areas and the inadequate provision for the collection of garbage.

In addition to the above factors the geographical location, the local climatic conditions and the environmental features of Cameroon affect mosquito breeding and subsequently the incidence of malaria.

2.4 Cameroon and Malaria

2.4.1 The Country Cameroon

![Map of Cameroon and location of Cameroon in Africa. Source (Radbourne, 1999)](image)

The Republic of Cameroon is situated in the northeastern end of the Gulf of Guinea in Africa bounded by Lake Chad to the north, by Central African Republic to the east, by Congo, Gabon and Equatorial Guinea to the South and Nigeria to the West. As can be seen from the map the territory has the shape of an elongated triangle with an area of about 475,442sq km with a population of about 14.7 million (1999 estimate) (RBM, 2001).

The country has four topographical regions, which include a coastal plain and a region of dense equatorial rain forests in the southern part of the country. The centre region is a plateau region with elevation reaching about 1370m above sea level while there is a transitional area where forest gives way in the north to Savanna region. The Savanna region gradually slopes into marshland surrounding Lake Chad in the Far north of the country. The western parts of the country include
areas of high, forested mountains of volcanic origin including Mount Cameroon (4095m), which is the highest mountain in western Africa. Mosquitoes predominant mostly in these forested regions.

A number of streams and rivers flow in different region of the country. They include the Sanaga and Nyong Rivers, which flow west to the Atlantic Ocean, and the Mbere and Logone Rivers, which flow north from central plateau into Lake Chad among many others.

The Government of the Republic of Cameroon is structured on the French model, with a powerful Office of Presidency, Prime Minister and Ministers appointed by the Head of State, and a National Assembly, elected by popular vote every four years. Cameroon is divided into ten provinces and each province is governed by a Governor, who co-ordinates Divisional officers, and sub divisional officers. The two most important cities in Cameroon are Yaounde, the capital of Cameroon and Douala the economic capital of the country.

2.4.2 Climatic conditions in Cameroon

The climatic condition of Cameroon profoundly influences malaria transmission. Cameroon has a tropical climate, which is humid in the South but increasingly dry in the north. The average annual rainfall in the Coast is about 4060mm while in the exposed slopes of the Cameroon Mountains in the west, the rainfall is almost constant and sometimes reaches 10,160mm a year. In the semiarid north west of the country, average annual rainfall is about 380mm. The dry season in the north lasts from October to April and the average temperature in the 32°C in the north compare with 25°C in the south and 21°C on the plateau (Fosong, 2000).

Table 1: Climatic Table of Cameroon

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tr>
<td>Min.Temp °C</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
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<td>19</td>
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<td>Max.Temp °C</td>
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<td>27</td>
<td>27</td>
<td>27</td>
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<td>28</td>
</tr>
<tr>
<td>Humidity %</td>
<td>80</td>
<td>80</td>
<td>81</td>
<td>82</td>
<td>84</td>
<td>85</td>
<td>86</td>
<td>86</td>
<td>85</td>
<td>82</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Days of Rain</td>
<td>3</td>
<td>5</td>
<td>13</td>
<td>15</td>
<td>18</td>
<td>17</td>
<td>11</td>
<td>10</td>
<td>20</td>
<td>24</td>
<td>14</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: (Fit For Travel, 2000)

The monthly figures are average figures taken from one observation period and the figures are not regarded as absolute but can rather be used as information to estimate relative climate within each month in Cameroon (Fit for Travel, 2000)

2.4.3 Malaria Transmission and Epidemiology in Cameroon

Transmission of malaria is affected by climate and geography and often coincides with the rainy season. Malaria exists in any region due to climate and where appropriate breeding grounds for mosquito exist. The disease is associated with swampy low-lying area and the name malaria is derived from the Italian word for "bad air" (Madigan, et al, 1997).

The climate of Cameroon and the relative humidity especially (as can be seen from the table above) during the rainy season greatly favours malaria transmission. According to Strickland, the optimal condition for transmission occurs when the temperature is 20° to 30° and the relative humidity is at least 60% since sporogony does not occur below 16° or above 33°C. He goes further to highlight the
The fact that a high relative humidity increases mosquito’s longevity thus increasing the probability of mosquito becoming infective and the observed association of increased malaria incidence with rainfall (during rainy season in Cameroon) is due to the increase in breeding sites and the increased survival rates of the female Anopheles because of the rise in humidity (Strickland 1984). During the rainy season in Cameroon, which last from June to October, heavy rainfalls often occur, which provide mosquitoes breeding areas hence the population of mosquitoes increases. For this reason, the risk of malaria varies according to seasons in Cameroon, being highest at the end of the rainy season.

2.4.4 Malaria Prevalence in Cameroon.

Malaria is a common and serious tropical disease, which continues to be a huge public health problem in Cameroon, causing ill health and death throughout most parts of the country. The disease affects a greater proportion of Cameroonians than any other vector-transmitted disease. In Cameroon malaria is prevalent in the whole country rendering about 90% of the population at risk and due to the unstable nature of the disease transmission, epidemics are common causing high mortality and morbidity annually (Carnell, 2001). According to WHO, “Malaria is by far the world’s most important tropical parasitic disease, and kills more people than any other communicable disease except tuberculosis. In many developing countries, and in Africa especially, malaria exacts an enormous toll in lives, in medical costs, and in days of labour lost” (WHO, 1998).

The incidence of malaria in Cameroon according to 1994 population was reported to be 1065 clinical cases of malaria per 100,000 people (Carnell, 2001), while the reported number of malaria cases for population at risk (endemic malaria) in 1995 was 604,120 out of 12.6 million inhabitants and 645,309 in 1997 (Roll Back Malaria (RBM), 2001).

The prevalence of malaria in Cameroon according to Eco-system and health Analysis Workshop (ESHAW) varies in different regions of the country. The range is between 20% and 65% giving an average prevalence of approximately 43% implying that out of every 100 Cameroonians about 43 have malaria. (Anyamba, 1999)

As a result, malaria is a health hazard in Cameroon and the impact of the disease on the socio-economic development of the country is high. Malaria debilitates the active population causing low productivity and impairs economic growth. It strains the economy of the families and the country through cost incurred for treatment and control of the disease. Considering the burden of malaria on the population of Cameroon and the fact that it is a killer disease and a barrier to sustainable social and economic development, the government of Cameroon should consider the prevention of malaria among its top priority activities.

2.4 Roll Back Malaria Foundation International.

Roll Back Malaria project was initiated by the newly elected Director General of WHO in 1998, Gro Harlem Brundtland. She was the former Norwegian prime minister and after she was elected, she announced that she would train her sights on malaria, which is a scourge of Africa. The technical basis of this project is the Global Malaria Control Strategy and the project aims to reinforce a global partnership of malaria-affected countries, United Nations organizations, bilateral
development agencies, nongovernmental organizations, scientific institutions, private sector bodies and governments worldwide. This diverse partnership seeks to halve the world’s malaria burden by the year 2010 through a variety of means, including wider use of bed nets. There is significant financial investments in this project by the Director General to reaffirmed WHO endorsement of Global malaria control strategy and implementation and to call upon member states in Sub Sahara Africa to give full political support to malaria control and to ensure well coordinated multisectoral action (Mann, 1999).

2.6 Importance of Human Health for sustainable Development

Sustainable Development (SD) according to the world commission on Environment and Development is development that meets the needs of the present without compromising the ability of future generation to meet their own needs (1987). The Webster’s New World Dictionary defines health as the “physical and mental well-being” in addition to “freedom from disease, pain, or defect”. Good health is the foundation of human welfare and productivity and as such, the link between human health and sustainable development could not be stronger. Thus, the health status of a community is an important indicator of SD although it is a complex concept that cannot be measured easily.

“Human beings are the centres of concern for sustainable development. They are entitled to a healthy and productive life in harmony with nature” (First Principle Rio Declaration, 1992). As such, the proper maintenance and improvement of human health should be the centre of concern about environment and development according to WHO commission on Health and the Environment (1992).

Sustainable development is fundamental to the ministry of health activities and success in Cameroon. As this ministry work to attain optimal health, they should also take account of the environment, social/cultural and economic factors that influence health and well-being both now and in the long term. Thus the ideal of SD must be continuously incorporated into everyday life when the opportunity arises since SD is not just an intellectual exercise and many sustainable development factors have a direct or indirect impact on health and the quality of life.

For the above-mentioned reasons, in a developing country like Cameroon a broad-based health policy is essential for sustainable development since most of the critical health problems are closely related to environmental and developmental problems. Deficiencies in important basic environmental needs of housing, water supply, sanitation, and health care are often visible manifestation of environmental stress. Failure to meet these needs in Cameroon is one of the major causes of communicable diseases such as malaria, cholera and typhoid. However, malaria is the most important parasitic disease in Cameroon and its prevalence is closely related to environmental sanitation in personal hygiene, construction of dwellings and the environment of towns and countryside.

The link between malaria, environment and development implies that malaria health policies cannot conceive purely of curative or preventive chemotherapy, or even in terms of greater attention to public health. Integrated approaches are needed that reflect key health objectives in areas such as water supply and sanitation, industrial policy, particularly with regard to safety and waste disposal and the planning of human settlements (World Commission on Environment and Development, 1987). Thus a national control program to significantly reduce malaria burden in Cameroon,
initiated by the Roll Back Malaria Foundation in WHO will be greatly welcome and this control program for malaria can only be successful if it is considered as part of sustainable national development.
3 Prospects for Rolling Back Malaria in Cameroon

3.1 Causal Loop Diagram (CLD).

As self-illustrative in the CLD above, the subsystem of the mosquito’s life cycle and transmission of malaria can be influenced by a number of variables. Poor sanitation services increase environmental degradation. The variable sanitation includes, waste and sewage treatment in addition to domestic hygiene. Increase in environmental degradation with the suitable climate in Cameroon increases the breeding grounds for the Anopheline mosquito. Like other mosquito the Anopheline breeds in stagnant water and these breeding grounds have been made available in Cameroon by the poor environmental management. These include water leakages from pipe breakage in most of the Urban areas, untreated industrial and household waste flowing in open drains in the housing areas in big cities like Douala and Yaounde, improper waste disposal both at the national and domestic levels. Increase in the breeding sites increases the mosquito population, which increases the incidence of malaria in Cameroon as can be seen from the increasing prevalence of malaria in Cameroon. Increase in the population of mosquito encourages the use of the various insecticide for control, which poses a lot of ecological risk in the environment, as will be dealt with later on. Increases in ecological risk further degrade the environment, which increases the population of mosquito on the long run. Increase in the incidence of malaria decreases the human population as malaria causes lot of death among individual especially among children under fives years of age and the elderly. Decrease human population decreases socio economic development, as more than any other disease, malaria hits the poor and the costs to countries include costs for control and lost workdays-estimated to be 1-5% of GDP in Africa while for individuals the costs include the price of treatment and prevention, and lost income (WHO, 1998).
The majority of Cameroonians are farmers who live in small towns or villages in Southern and Central Cameroon while the semi-nomadic herders inhabit the North. Decrease in the human population especially those in the working age group causes a decrease in socio economic development since the decreasing population affects both the social and economic systems in the long run. Rural areas in Cameroon are particularly affected since the rainy season is often the period for intensive agricultural activities when rural farmers earn most of their incomes. Malaria hinders work on the farm and impoverishes these families while in children it leads to chronic school absenteeism.

Increase in the incidence of malaria increases the use of anti-malarial drugs, which causes a decrease in the incidence of malaria. In Cameroon the increasing levels of chloroquine resistance and other anti malarial drugs with the fears of toxicity and decreased efficacy of most of the insecticide used pose an urgent need for an affordable, effective and safe alternative to present anti-malarial drugs and insecticides in use. These pose a lot of problems since they involve more medical research, which increases cost in addition to the fact that alternative drugs may prove to be costly, less effective less feasible or acceptable especially to most Cameroonians.

In my opinion environmental management for vector control through integrated urban development and the use of insecticide impregnated bed nets will be a very cost effective control means of malaria in Cameroon. According to health experts, prevention is the best approach to reduce the spread of malaria since most of the research being done to develop new anti-malarial drugs, vaccines, biological controls and alternative more environmentally friendly insecticides for control of Anopheles mosquito “are under funded and are proving more difficult than originally thought” (Miller, 1999). Hence instead of spending lot of money for research on new drugs and insecticides, a lot should be done to increase the use of insecticide impregnated bed nets and improvement of the existing environmental problems, which is a more cost-effective and sustainable means of malaria control.

3.2 Malaria problems and Possibilities in Cameroon.

Like other mosquitoes the Anopheline breeds in stagnant water and these breeding grounds have been made available by the poor water and sanitation services in Cameroon in addition to other factors.

Increase in risk of malaria in Cameroon is also associated with changes in land use linked to activities like road construction, mining, creation of dams, commercial tree cropping and deforestation, and agricultural and irrigation projects leading to poor environmental management in the country. Demographic pressure has increased the need for land and the exploitation of new areas leads to large changes in the vegetation such as the destruction of the tropical forest in southern part of the country. Most of the rivers and streams have been managed for power production and irrigation. The use of dams such as Bamendjim dam on the Noun River and the cultivation of rice in the paddy fields in certain regions (like in the Ndop plain) produce large expanses of water, which are suitable breeding grounds for the mosquitoes.

Urbanisation imposes similar effects to the rural environment while the suburban environment is made worse by poor sanitation conditions such as poor waste and sewage disposal systems. Most of
the rivers and streams passing through urban areas in Cameroon like the River Wouri passing through Douala are polluted by household and industrial wastes making the rivers filthy and providing more breeding sites for the parasite carrying mosquito. The Urban municipal authorities have failed to provide the needs of the urban poor so the gap between the rich and the masses keeps widening. The municipal authorities are either irresponsible or lack means to solve these problems. Policies such as teaching residence that littering are an offence, which carries a penalty, has not been developed. Living under unsanitary conditions in most urban areas seems to be a way of life and the population is completely cut off from any decision making process that affects their lives.

The dwelling and its immediate surroundings constitute perhaps the most important elements in relation to insect borne disease such as malaria (Busvine, 1993). Hopefully no Cameroonian is homeless but a good number of them live in inadequate shelters. These vary from crude rural dwelling such as the poorly constructed plank buildings in the South West province (about 90% of the houses) to the makeshift shelters in the large slums around main cities like Douala and Yaounde. The rural dwellings range from very simple temporary shelter such as the thatched tents in the Eastern province of Cameroon to fairly solid, permanent dwellings such as those constructed with sun-dried mud in the grassland region of Cameroon. In addition to many well-constructed modern buildings in the urban areas, the slum shelters are crudely constructed from materials such as planks, flattened metal tins and corrugated iron and odd boards. Most of these poor shelters lack simple hygienic amenities such as water supply, waste disposal systems and proper drainage. Thus, household refuse and wastewater are discharged around houses and stagnate in puddles providing more breeding grounds. Many Cameroonian slum dwellers do not care and are unaware of the dangers they are exposed to in the filthy, degraded and overcrowded housing condition under which they live. (Neba 1987) Despite availability of latrines and waste disposal units in most households in rural areas some people still use open air or rivers as restrooms and for dumping of waste, polluting the river and making them available for breeding of the malaria vector.

Also, the threat posed by malaria in Cameroon is increasing as a result of wide spread of drug-resistant parasite strains and insecticides-resistant mosquitoes, changing epidemiological and ecological patterns that alter the distribution of the disease and requirements for control, and limitations of medical and public health infrastructures in Cameroon.

3.3 The Economic cost of malaria

According to WHO the estimated cost of malaria in terms of strains on the health systems and economic activity lost, are enormous. In affected countries as many as 3 in 10 hospital beds are occupied by victims of malaria while in Cameroon where malaria reaches a peak at harvest time and hits young adults especially hard, a single bout of the disease costs an estimated equivalent of 10 working days (WHO, 1999). Malaria continues to cripple the economic productivity of Cameroon through deaths, absenteeism from work and inability to raise output at work. According to Sachs the Center for International Development at Harvard University is working with Roll Back Malaria, Malaria is a serious impediment to economic development and highly malarious countries such as Cameroon and most sub Sahara countries grew one percent less per year, compared to countries without malaria during 1965-1990,taking economic policies into consideration. Also the annual loss of growth from malaria is estimated to range as high as 1.3 percentage points per year and this loss is compounded for fifteen years, the Gross National Product (GNP) in the fifteenth year is reduced by nearly a fifth. As a result losses from malaria retard development if something is not done to
control the disease in the country (Sachs, 2001). As such, Malaria seriously affect the economic of Cameroon and although a lot is being done to control the disease basically at the individual levels, a lot still need to be done to reduce the burden of malaria in Cameroon to a level that is commensurate with socio-economic development.
4 Control of malaria in Cameroon.

Prevention of malaria in Cameroon encompass a variety of measure, which includes protection against infection, development of diseases in infected individuals with some degree of environmental control. Measures of protection against infection are directed against mosquito control both at the personal and community levels. Personal protection by individual Cameroonians involves the use of insecticides or environmental management to control transmission. Normally, in Cameroon, malaria control depends on chemotherapy and the use of insecticide spraying. Unfortunately, one of the greatest challenges facing malaria control worldwide is the spread and intensification of parasite resistance to anti-malarial drugs and mosquito resistance to insecticides. In addition the limited number of anti-malarial drugs and environmentally friendly insecticide for mosquitoes hinders the development of insecticide and anti-malarial drug policies and adequate disease management.

With the above mentioned set backs in the use of insecticide spraying or/and drug usage as major control techniques for malaria in Cameroon, selective use of methods such as insecticide-treated nets (ITN) along side with environmental management for vector control can probably be cost-effective and much more sustainable.

4.1 Use of Insect Repellents

4.1.1 Use of mosquito coils

Most Cameroonians especially those in mosquito endemic areas use mosquito coils to avoid bites from the mosquito. When these coils (pyrethroid mosquito coils in some cases) are burnt in bedrooms at night the smoke keeps the insects away or kills the insects when they fly through the smoke. The coils are not very expensive and are especially useful early in the evening when people sit outdoor. However these coils have been associated with certain respiratory disorder and as such are not the best method of control. For instance from a case control study carried out in Jakarta (the capital of the Republic of Indonesia) between the indoor environmental and respiratory diseases in mothers and children, there was a significant correlation to the occurrence of respiratory diseases in the mother and the use of mosquito coils. From this study, “a multiple logistic regression analysis for the significant variables associated with the occurrence of mother’s respiratory diseases shows that mothers who use mosquito coils are 1.3 times more likely to suffer from respiratory diseases compared to mother who do not” (Surjadi, 1993). As a result, burning mosquito coil to reduce the incidence of malaria in Cameroon is very unsustainable since using mosquito coil is already a health problem to present generation.

4.1.2 Other Use of Insect Repellent

This is another method of control whereby sprays and lotion containing compounds such as N, N-diethyl-m-toluamide (deet) or dimethyl phthalate are applied to the skin creating a barrier between the mosquito and the man. This repellent deters the mosquito from landing on a person in order to feed and they provide only a temporal barrier since they can be easily wear off when an individual sweats, thus it need to be applied regularly. Insect repellent are not widely used in Cameroon since most local Cameroonians cannot afford them. In addition, they are difficult to apply properly and the need for re-application can be tiresome and boring when it is not a long-term viable option.
Whatever the case, they are mostly used by foresters to keep away the mosquitoes while they are logging or planting trees.

4.2 The Use of Insecticides.

The use of conventional insecticides such as organochlorines, organophosphates, carbamates and synthetic pyrenoids have been the insecticides of choice for control of mosquitoes by indoor house spraying for Anopheles in Cameroon. Indoor house spraying with the use of insecticide can be an effective way to reduce malaria transmission since the malaria vector species usually rest on walls or ceilings (endophilic) and tend to feed on humans indoors (endophagic). Mosquitoes that land on sprayed surfaces contact the insecticides with their feet and they are either killed or are irritated sufficiently to leave the house, usually breaking the transmission cycle of malaria. A good number of different insecticides could be suitable for indoor residual spraying and, an appropriate insecticide is expected to be easy to apply, relatively cheap, highly toxic to the vector, safe for humans, persistent on the wall or ceiling surface and acceptable to the inhabitants of the house, (Newsome et al, 1999).

4.2.1 Dichlorodiphenyltrichloroethane (DDT)

The advent of insecticides in the 1940s, with the widespread use of DDT, resulted in less emphasis on the environmental control of mosquito in Cameroon. Previously, DDT was the only effective, affordable insecticide that could be used for indoor house spraying against malaria without acute toxicity, until the publication of Rachel Carson’s Silent Spring in 1962 describing the proven deleterious environmental effects of the persistent insecticides and the development of insecticide resistance, arose the need to develop integrated vector control strategies for malaria compatible with cost-effectiveness and sensitive environmental management (Cox, 1994). DDT was also the powerful tool in global efforts to eradicate malaria in malarious regions until problems such as ecological concern development of resistance to DDT by the mosquito and the financial drain imposed by long-term vector control campaigns in resource poor countries such as Cameroon limited its effectiveness (Fauci, 2000).

The wide usage of DDT has led to widespread contamination of water, soil, fish, wildlife, and people since DDT is readily metabolised into a stable and equally toxic compound, DDE. The persistence of DDT and it tendency to bioaccumulate in body fat has chronic effects on human health. These include neurodevelopmental effects (A major target of acute DDT exposure is the nervous system), Carcinogen effects (Workplace exposure to DDT cause increases risk of pancreatic cancer, liver cancer and multiple myelomas), and reproductive effects since chronic DDT exposure may cause health effects related to disruption of the endocrine system. In addition, the accumulation of DDT in breast milk produces poor neurological reflexes (using Brozelton Neonatal Behavioural Assessment scale) have been reported in newborn infants exposure to DDT through breast milk although the long-term effects are not known. (Newsome et al 1999)

Thus DDT resistance and human health effects prompt the use of alternatives insecticides such as organophosphates, carbamates and more recently synthetic pyrethroids have been introduced as the spectrum of resistance has widened. Some alternatives to DDT for indoor spraying for mosquito are listed in the table below.
4.2.2 Insecticides used for indoor spraying.

Table 2 Technical grade ingredients of insecticide used for indoor house spraying for mosquito's control

<table>
<thead>
<tr>
<th>Chemical Type</th>
<th>Insecticide common name</th>
<th>UN no</th>
<th>LD50 mg/kg</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organochlorines</td>
<td>DDT [ISO]</td>
<td>2761</td>
<td>113</td>
<td>DS21; EHC9; 83; IARC5; 42,53; ICSC34; JMPR 2001</td>
</tr>
<tr>
<td>Organophosphates</td>
<td>Malathion [ISO]</td>
<td>3082</td>
<td>C2100</td>
<td>DS 29; IARC 30; ICSC 172; JMPR 1998</td>
</tr>
<tr>
<td></td>
<td>Fenitrothion [ISO]</td>
<td>-</td>
<td>503</td>
<td>DS 30; EHC 133; HSG 65; ICSC 622; JMPR 2001</td>
</tr>
<tr>
<td></td>
<td>Pirimiphos methyl [ISO]</td>
<td>-</td>
<td>2018</td>
<td>DS 49; JMPR 1993</td>
</tr>
<tr>
<td>Carbamates</td>
<td>Bendiocarb [ISO]</td>
<td>2757</td>
<td>55</td>
<td>DS52-donate a WHO/FAO Data sheet on Pesticides</td>
</tr>
<tr>
<td></td>
<td>Propoxur [ISO]</td>
<td>2757</td>
<td>95</td>
<td>DS 25; ICSC 191; JMPR 1990</td>
</tr>
<tr>
<td>Pyrethroids</td>
<td>Cyfluthrin [ISO]</td>
<td>-</td>
<td>C250</td>
<td>JECFA1997</td>
</tr>
<tr>
<td></td>
<td>Cypermethrin [ISO]</td>
<td>3352</td>
<td>C250</td>
<td>DS58; EHC 82; HSG22; ICSC246; JECFA 1996</td>
</tr>
<tr>
<td></td>
<td>Deltamethrin [ISO]</td>
<td>3349</td>
<td>C135</td>
<td>DS 50; EHC 97; HSG 30; IARC 53; ICSC 247; JMPR 2001</td>
</tr>
<tr>
<td></td>
<td>Permethrin [ISO]</td>
<td>3352</td>
<td>C500</td>
<td>DS 51; EHS 94; HSG 33; IARC 53; ICSC 312; JMPR 2000</td>
</tr>
<tr>
<td></td>
<td>Lambda-cyhalothrin [ISO]</td>
<td>3349</td>
<td>C56</td>
<td>EHC 142; HSG 38</td>
</tr>
</tbody>
</table>

Source: Adapted from The WHO Recommended classification of Pesticides by Hazard and Guidelines to Classification 2000-01. WHO/PCS/01.4

Description of Columns:

1. **Chemical Type.** According to the World Health Organization report, the chemical type is a determinant of the UN numbering system and they are included only for convenience and do not represent a recommendation as to the way in which the pesticide should be classified.

2. **Insecticide common Name [ISO]:** This denotes the common name of the active ingredient approved by the international Organisation for Standardization. Such names when available are preferable by WHO to other common names.

3. **UN Number:** It refers to the UN recommendations on the transport of dangerous goods. This number only refers to the active ingredient of the insecticide. For instant liquid product have different numbers based on their flammability.
4. The LD$_{50}$ value is a statistical estimation of the number of mg of toxicant per kg of body weight required to kill 50% of a large population of test animals: which in this case is the rat being used. "c" preceding the value indicates that it is a value within a wider than usual range, adopted for classification purposes.

5. **Remarks** are used to indicate cases in which the classification of technical product has been adjusted (i.e., the oral LD$_{50}$ value is not directly used as the basis of classification). This column also include source of further information for the various insecticides. DS denotes a WHO/FAO Data Sheet on Pesticides, EHC-Environmental Health Criteria monograph, HSG-Health and Safety Guide, IARC—Monographs on the Evaluation of Carcinogenic Risks to Humans, ICSC an International Chemical Safety Card and JMPR an evaluation by the joint FAO/WHO Meeting on Pesticide Residues. These publication except for IARC Monographs can be found on the IPCS website (WHO 2000).

Chemicals are grouped in 4 main classes in the guidelines to classification of pesticides by hazard according to the WHO recommended classification of Pesticides by hazard and guidelines to classification 2000-01. The classes Includes, Extremely hazardous technical grade active ingredient of Pesticides (Ia), Highly hazardous (Ib), Moderately hazardous (II) and Slightly hazardous (III).

Thankfully none of the above listed insecticides for indoor spraying of malaria vector are classified in class Ia (the extremely hazardous) non-in class Iib (Highly hazardous). Except for Malathion and Pirimiphos-menthyl under the chemical types Organophosphates classified under class III (Slightly Hazardous) the rest including DDT, which is widely used in Cameroon, are classified in class II, which are moderately hazardous. This implies using insecticides, as a vector control method for malaria is very costly in addition to being environmentally unfriendly.

4.2.3 **Cost Comparisons for some insecticides used for indoor spraying.**

DDT still remains the cheapest insecticide for indoor house spraying of mosquito but the cost differences with alternative insecticides are no longer as great as they once were. As the price of synthetic pyrethroids drops that of DDT increases simultaneously. Likewise, the market for DDT is shrinking, and only three known producers remain (India, China, and Mexico--the latter is now phasing out its production). The price of synthetic pyrethroids can be expected to decrease as demand increases (Newsome 1999).

A 1999 cost comparison by the U.S. Environmental Protection Agency shows that indoor house spraying with pyrethroid insecticides is becoming competitive with DDT spraying (Personal Communication, K. Walker, U.S. EPA --pp. 78-80). Estimated product cost per house treated with DDT ranges from US$1.60 - $4.27, with similar bottom of range costs for synthetic pyrethroids: permethrin, $2.10 - $8.40; cyfluthrin, $3.30 - $7.73; lambdacyhalothrin, $3.76 - $7.52; and deltamethrin, $4.00 - $8.00 as better view in the table below.
Table 3: Cost Comparisons for some of the above-mentioned insecticides for indoors house spraying. (EPA, Personal Communication, Walker)

<table>
<thead>
<tr>
<th>Chemical Type</th>
<th>Insecticides</th>
<th>Number of spray per six months period</th>
<th>Cost (USD) per kg or litre of insecticides</th>
<th>Product cost per house per 6 month - 200m2/house</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organophosphates</strong></td>
<td>Malathion</td>
<td>2</td>
<td>2.00-4.00, 2.55</td>
<td>3.20-6.40, 4.08</td>
<td>Cheminova 1998, WHO 1998</td>
</tr>
<tr>
<td></td>
<td>Fenitrothion</td>
<td>2</td>
<td>7.50</td>
<td>12.00</td>
<td>WHO 1990</td>
</tr>
<tr>
<td><strong>Carbamates</strong></td>
<td>Bendiocarb</td>
<td>2</td>
<td>50.00</td>
<td>50.00-10.00</td>
<td>A-J et al. 1993</td>
</tr>
<tr>
<td></td>
<td>propoxur</td>
<td>2</td>
<td>9.30, 35.00</td>
<td>37.20, 28.00-56.00</td>
<td>WHO 1990, Bayer 1998</td>
</tr>
<tr>
<td><strong>Pyrethroids</strong></td>
<td>Lambda-cyhalothrin</td>
<td>1</td>
<td>75.00, 75.20</td>
<td>4.50, 3.76-7.52</td>
<td>Zeneca 1999, WHO 1998</td>
</tr>
<tr>
<td></td>
<td>deltamethrin</td>
<td>1</td>
<td>25-28.00, 20.00</td>
<td>5.00-5.600, 4.00-8.00</td>
<td>WHO 1990, WHO 1998</td>
</tr>
<tr>
<td></td>
<td>permethrin</td>
<td>2</td>
<td>30.00, 21.00</td>
<td>6.00, 2.10-8.40</td>
<td>WHO 1990, WHO 1998</td>
</tr>
<tr>
<td></td>
<td>cyfluthrin</td>
<td>1</td>
<td>128.82, 55.00</td>
<td>7.73, 3.30-5.50</td>
<td>A-J et al. 1993, Bayer 1998</td>
</tr>
</tbody>
</table>


**Description of Columns:**

1. **Insecticides** listed Include some of the products recommended by WHO in place of DDT.

2. **Number of Spray** is provided by the information sources cited. Where this information was not available, spray rate were taken from Chavasse, D. and Yap, Chemical methods for Control of vectors and pests of public health importance, WHO 1997

3. **Cost** are averages quoted by the references. Pirimiphos-menthyl and cypermethrin are not listed due to insufficient price data.
The use of these residual insecticides listed in the table above applied to walls and other indoor surfaces gives a far more persistent effect, in such a way that DDT at 2g/m² remains toxic to endophilic anophelines for 6 months or more on a non-absorbent wall material as may lambda-cyhalothrin at a much lower dosage. Organophosphate insecticides such as malathion, propoxur and fenitrothion at the same dosage last for about 3 months.

Based on the US-EPA price quotation above of DDT and the appropriate formulation of the eight other insecticides (two carbamates, four pyrethroids and two organophosphate) commonly used for indoor spraying in malaria control programs, DDT is still approximately the least expensive insecticides on a cost per house basis, although the price is rising as DDT production declines. Likewise the prices of Pyrethroids are declining making them only slightly more expensive than DDT at low dosages application.

4.2.4 Pyrethroids
Pyrethroids appear to be the safest alternative to DDT since they are less persistent and bioaccumulative as well as can be used in significantly smaller amounts. Synthetic pyrethroids are substance derived from a plant common in East Africa know as chrysanthemum plant, which has a long safety history and is environmentally friendly (Busvine 1993). They are generally less toxic to humans when compare to the other insecticides such as the organophosphates and the carbamate but are highly toxic to aquatic life. Pyrethroid can be widely used both in indoor spraying for mosquito or they can be impregnated in bed net to keep the vector away as will be deal with later. However, if
periodic exposure of an organism to pyrethroids exceeds its ability to metabolize the chemicals concentration builds up. Pyrethroids established toxicity for fish and other aquatic organisms has important consequences for the disposal of net treatment and washing liquids. In order to avoid adverse impacts on non-target species, burial or pit latrines have been identified as the best disposal method (Newsome 1999).

Despite their low toxicity, a number of the pyrethroids have also been found to have endocrine disrupting properties although there is limited research conducted to date on synthetic pyrethroids to fully assess exposure to them. Further study is also needed to determine the endocrine disruption potential and other possible health effects of synthetic pyrethroids. However pyrethroids appear to be the safest transition pesticide for use in malaria vector control when considering the stronger endocrine disrupting properties of DDT and it has widely been used to impregnate bed nets (Newsome et al).

4.2.5 Insecticide Impregnated bed nets

The general cost of an insecticide-impregnated bed nets according to the International Development Research Center (IDRC) is 5-10USD per year. Recently the use of bed nets impregnated with synthetic pyrethroids has been found to give substantial malaria protection in endemic areas even reducing the number of clinical attacks in areas of high transmission. Most studies of ITNs and other physical barrier conducted in many regions of the world shows reduction in malaria disease rates between 20% and 90%. According to the IDRC studies in Kenya and Ghana suggest that using ITNs “could save the life of as many as 500,000 children each year who could normally die from the direct or indirect effects of malaria” (Newsome et al, 1999).

Disease reduction with the use of ITNs is due to a combination of reduced access of mosquito to humans as a result of the net, a repellant and lethal effect of the insecticide on the vector trying to bite. A study done on the “efficacy of insecticide impregnated bed-nets to control malaria in a rural forested area in Southern Cameroon” (using deltamethrin, at 25mg/m²) obtains similar results as in Kenya and Ghana. In this trial, a noteworthy reduction of both transmission and high parasitaemia of P.falciparum of about 78% implying a drop of malaria morbidity (Le Goff et al, 1992). This is one of the few trials that have been done in the forest region of Cameroon where transmission is permanent.

ITNs are the most effective when malaria vector are endophilic and can give good protection to children in cots. Large scale operational use of ITNs in endemic areas is explored presently and should be widely encouraged in Cameroon since presently it’s the most hopeful means of malaria control pending the development of a malaria vaccine hopefully in the near future. Results from studies in China consisted a general reduction of “malaria incidence” impending treatment of nets in different areas. In the study, the incidence fell from 11.6 to 1.09% with a population of over 30,000 were nearly 25,000nets were treated. Bed net were regarded to be more effective than insecticide spraying following a study done in Jaingsu province, in two towns with about 20,000 inhabitants were the nets were treated with permethrin in one of the town and deltamethrin in another and these results were compared with six villages in which the residence were sprayed with DDT. The results show a drop in malaria incidence in both net-treated towns of about 77% and only 36% in DDT-treated villages. In Hainan province where the mosquito is exophilic, and residual spraying with dieldrin was discouraged and bed net used produced a substantial reduction in malaria (Plasmodium vivax) from 27% to 2% and P.falciparum from 58% to Zero in 2 years. (Busvine 1992) Thus, ITNs
should be widely encouraged and used in Cameroon especially in malaria endemic regions and should be used as a component of the national malaria control strategy.

### 4.2.6 Feasibility of Bednet usage in Cameroon.

With the appropriate approach and education to Cameroonian, bed nets will probably be widely used since many Cameroonians who can afford bed nets are already using them. The difficulties will only be to make the nets available to all who need them, especially to the underprivileged. There might also be problems such as coverage, daily use, reimpregnation, and renewal of old and torn nets. Further evaluation has to point out the possible shift of the clinical spectrum and the age-specific admission of malaria cases to assess the long-term benefit of this control method (Binka & Adongo, 1997)

Likewise the successful trials that reduced malaria (as described above) were done under medical supervision and the pyrethroids used offered no toxicity. Practically human behaviors might impose limitation to the benefits of these nets. Rural villagers could hardly be expected to go to bed early enough to escape infectious bites and some might prefer to sleep in the open air on very hot nights such as in the coastal villages in Cameroon. Neither are they expected to sleep under the net during biting activities. Whatever the case, impregnated nets will be fairly welcome and people will be very willing to undertake impregnation lesson. It has been found that the population is much more likely to use the nets and curtains when the insecticide was offered free of charge, as the people mostly at risk are very poor. One way of targeting the group most at risk from malaria - the young children is free distribution of insecticide through mother and child health services. However, in my opinion most Cameroonians will appreciate the nets more if, they are provided at a subsidies price since individual would value it more when they purchase it at a give away price than receiving it freely.

### 4.2.7 Conclusion on house spraying with insecticides and use of ITNs

House spraying programs and insecticides impregnated nets programs are more likely to be effective where the principle vectors are endophilic and endophagic, and where strong financial support can ensure timely applications by well-trained operators using appropriate equipment and insecticides. Since indoor spraying is very costly and needs human resources in combination with the potential for vector resistance and environmental concerns, indoor residual spraying could be used only in well defined, high or special risk situations such as the case in Douala. Likewise the controlled use of insecticides could pose negligible environmental hazards or risks of inducing pesticide resistance but as the case with most aspects of malaria control, development of environmentally friendly pesticides for public health use has stimulated little commercial interest, although it is clear that mosquito resistance to insecticides poses the same type of ingoing challenge to malaria control as does preventive chemotherapy resistance to the plasmodium species.

### 4.3 Prophylactic Chemotherapy

The Chemotherapy of malaria involves the prevention and treatment of malaria by the administration of drugs. The components of chemotherapy are prophylactic chemotherapy, which is taking drugs to prevent infection, and curative chemotherapy, which is the treatment of infected individuals with drugs. In spite of drug resistance, malaria is a curable disease although there are
only a limited number of efficient drugs. If these drugs are properly used and targeted to those at greatest risk (which is not the case in Cameroon), deaths caused by malaria can be greatly reduced.

Likewise mass prophylactic chemotherapy as method of control is a well-tried but very expensive method of control for the individual. It can also lead to the development of resistance hence it is not widely used and supported except in epidemic conditions such as the case of malaria in Cameroon. From source materials, there is no ideal drug for prophylaxis and chemoprophylaxis is only limited to travelers, special groups such as army and, in some situations, pregnant women. It’s too expensive to be recommended to local inhabitants.

Ideally, any prophylactic drug recommended in Cameroon should be cheap since the country does not have the available monetary resources for expensive measures. It's also needed to be taken at least once a week since a lot of Cameroonians who are at risk from malaria live in isolated hinterland and they cannot visit health workers regularly due to the poor transportation systems in some parts of the country.

4.3.1 Drugs Used for Prophylaxis

The main drugs available for use as prophylactics in Cameroon are limited to chloroquine, Mefloquine, Proguanil, Doxycycline and Pyrimethamine among others. These drugs are used both for curative and prophylactic purposes. However only their prophylactic usage will be discussed.
Table 4: Anti-malarial drugs also used as malaria prophylactic in Cameroon

<table>
<thead>
<tr>
<th>Prophylactic Drug</th>
<th>Dosage</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloroquine (4 aminoquinoline)</td>
<td>-300mg (capsule or tablet) taken once a week on same day each week. -100mg taken daily for 6 days per week</td>
<td>-Safe during pregnancy and lactation. -Overdose (Plasma conc 250ng/ml) produce symptoms such as dizziness, disturbed visual accommodation, nausea, malaise headache, diplopia, drowsiness, blurring of vision &amp; hypotension</td>
</tr>
<tr>
<td>Mefloquine (structurally similar to quinine)</td>
<td>One tablet 250mg taken once a week on same day of each week</td>
<td>-Mild gastrointestinal symptoms in 10-15% of patients -Side effect can be quite toxic. Dizziness, nausea, vomiting, postural hypotension “Acute brain syndrome” consisting of fatigue, seizures and psychosis</td>
</tr>
<tr>
<td>Proguanil</td>
<td>Daily dosage of 200mg in combination with chloroquine</td>
<td>Increase in dosage result in mouth ulcers, hair loss &amp; gastrointestinal symptoms -Recommended for pregnant women</td>
</tr>
<tr>
<td>Doxycline</td>
<td>100mg capsule taken each day</td>
<td>Effective against resistant falciparum malaria</td>
</tr>
<tr>
<td>Pyrimethamine</td>
<td></td>
<td>Use as prophylactic in combination with other drugs such as chloroquine -Causes haemolysis in patient with congenital deficiencies G6PD erythrocyte enzymes -Can cross the placenta and cause haemolysis in G6PD-deficient fetus</td>
</tr>
</tbody>
</table>

Source: Adapted from (Radbourne, 1999)

4.3.2 Problem with chemoprophylactic

Chloroquine was the most widely used antimalarial agent in Cameroon, until chloroquine resistant strains of *P. falciparum* started to become a problem. Drug resistance particularly multi-drug resistance is harmful for the treatment and control of malaria. In Cameroon there is widespread resistance to almost all of the available drugs most notably chloroquine (the cheapest and most commonly used anti-malaria drug) and the need for new malaria drugs is urgent. Chloroquine resistance has been reported in vitro in isolates in many regions of the country. From a number of studies of in vivo response to chloroquine treatment in different regions in Cameroon, chloroquine resistance now seems to be well established and widespread in Cameroon. Thus *P. falciparum* resistance to Chloroquine and other commonly used antimalarial drugs such as quinine and mefloquine continues to pose a serious threat to chemotherapeutic facet of malaria control.
strategies. (Ndifor et al, 1992) This is a major problem in Cameroon with the present bleak economic state and often-higher cost of alternatives to chloroquine.

Since malaria risk-predominantly in the malignant (*P. falciparum*) form exists throughout the year in Cameroon and resistance to chloroquine and sulfadoxine-pyrimethamine have been reported, Mefloquine have been recommended by WHO as the prophylaxis of choice in Cameroon (D’Ancona, 2000). Attempts to reverse chloroquine resistance have also been successful since an alternative to chloroquine such as pyronaridine has been found to be 100% effective among children with uncomplicated forms of malaria in Cameroon in an area of high chloroquine resistance in Cameroon, while mefloquine (another common useful drug in the treatment of both chloroquine sensitive and resistance infection) has a major drawback. It has the tendency of precipitating mental confusion, in non-predisposed individuals (Okenu, 1999)

Contrasting situations were encountered with a study done in Northern and Southern Cameroon on sensitivity to various antimalarial drugs to *P. falciparum*. In Northern Cameroon where mefloquine resistance is prevalent a close correlation was found between the responses of falciparum malaria to Mefloquine and Quinine but not between Mefloquine and Chloroquine while in the Southern Cameroon where Chloroquine resistance is highly prevalent no correlation was found between the responses to Quinine and Chloroquine or Chloroquine and Mefloquine. The responses to Chloroquine and Quinine appear partly correlated (Brasseur et al, 1992). The emergence of *P. falciparum* resistance to chloroquine and sulfadoxine/ pyrimethamine in Cameroon is a matter of concern because of the much greater cost of alternative treatments.

As a result, medical options to control malaria have suffered setbacks in most developing countries including Cameroon. This is as a result of malaria parasite resistance to the most commonly used anti-malaria drugs, unsuccessful development of vaccine to produce reliable and permanent safe control measures. Moreover, the suggestion of the extensive use of either chemoprophylaxis or widespread immunisation is hopeless. In addition to being costly, there is the problem of reaching all the huge population of Cameroonian, dispersed in vast hinterland with inadequate transport systems in many regions of Cameroon especially in rural areas. Most of the streets are narrow and poorly maintained, many containing potholes. From source material, of the approximately 70,050km of roads in Cameroon, about 11 percent are paved and most of the unpaved roads are frequently impassable during the rainy season which unfortunately happened to be the season of high malaria incidence in Cameroon (Funk, 1995)

Also, some of the drug administration requires medical supervision while the numbers of national doctors are insufficient. The ratio of doctor to patient is 1:12500 while infant motility rate from malaria exceed 6% (Coverdell, 2000). The limited number of doctors, trained staff and a shortage of supplies have resulted in sudden and severe reductions in the quality of health care in Cameroon, including the diagnosis, management and prevention of malaria. Moreover, the limited numbers of national doctors have pressed claims and quite naturally prefer more lucrative and comfortable practices in urban area. Due to the economic crisis in Cameroon most Cameroonians have limited access to health services due to financial difficulties.

Finally, the fact that a number of the large pharmaceutical companies in the western world are daunted by the slow and largely expensive research and tested needs of indigenous patients in tropical countries prefer to produce more profitable analgesic or tranquillisers (Busvine, 1993). This further draws back medical option as a major malaria control measures.
Thus, the rapid development and spread of parasite resistance to chemically useful drugs, the lack of acceptable adequate and more effective alternatives to anti-malarial drugs and the poorly managed health services in Cameroon further draws back medical option as a major control of malaria in Cameroon. Also, the fact that the fatality rate of imported *Falciparum* malaria cases in the western world (1.5-7.0%) is unacceptable and incompatible with the generally high standards of medical care in these regions suggesting that both diagnosis and management of the malaria are inadequate (WHO 1998). Whatever the case medical option could be used simultaneously with environmental management for vector control.

4.4 Environmental management via Vector Control Program.

Mosquitoes may be controlled by removing, poisoning or changing their larval habitats through destruction of the breeding sites or by killing the adult mosquitoes using insecticides as described above. Environmental control of malaria by restructuring of the existing sanitation systems in Cameroon can greatly reduce the epidemiology of malaria. Vector control for malaria may be accomplished by environmental management that consist of permanent or long term modification, temporary or seasonal manipulation of the environment and modifying our lifestyle and practices to reduce human vector contact. The fact that environmental management for vector control alone or combined with other methods have been very successful in many places and the future of Environmental management for vector control of infectious diseases including malaria is very promising (Ault, 1994).

This can only be effective if there are government policies that integrate vector control as part of national health development and support and sustain local community action for control by intersectoral collaboration at all levels and by monitoring, training and evaluation of basic research. Malaria control via environmental management can only be successful in Cameroon if all Cameroonians participate to it equally, including community members and people working in education, churches, environment, water supply, sanitation, and community development.

Environmental management of malaria vector can dramatically reduce the use of insecticides and chemoprophylactic with their associated costs while greatly contributing to sustained disease reduction. The selective destruction of vector breeding sites is a very long-term method of mosquito control. Breeding sites can be rendered unsuitable for mosquito breeding control by the following techniques.

- Firstly, there should be improvement in housing and sanitation by community education and participation to reduce human-vector contact in Cameroon. For instance vector population reduction through habitat modification played a major role in reducing malaria transmission in southeastern United States. This anti-malarial campaign was successful and occurred before DDT became available and the modification and elimination of aquatic habitats was to reduce mosquito breeding was the primary method of control (Kitron & Spielman, 1989). Attempt to introduce modern concert building to replace the traditional building in rural areas in Cameroon (such as those constructed with dried mud with thatched roof in the Northern region of Cameroon) will tend to be very costly in addition to being unwelcome by the local inhabitants. Thus the best method will be to study the traditional designs by architectures and work out feasible improvement to limit the extent of malaria transmission. In addition to modification of old buildings, newly constructed dwelling as a result of
increasing population should be designed to prevent or at least reduce the entry of flying vectors like the mosquitoes. The use of screening with introduction of netting impregnated with pyrethroids can be difficult to employ unless the entry site such as windows and doors can be covered since complete screening of windows and doors will only do with western style building or using strategically placed curtains in traditional buildings.

- Improved drainage or water flow, by clearing away vegetation and other matter from the banks of streams to speed up the flow of water. The clearing of vegetation in residential neighborhood and planting of tree that soak up water in low-lying marshed areas in the coastal region of Cameroon where mosquitoes thrive could be very helpful. In Cameroon there are different types of drains including L-shaped drains between gutters and cambered roads and U-shaped drains lined with cement among former watercourses. These drains are usually intended to discharge into sea or some of the rivers and streams but they are often flooded into low-lying area between towns and sea wall forming a “lagoon” of polluted water. There are also neglected house plots in most urban areas flooded with water. A better control method is to drain most of these polluted lagoons through an opening in the river when they are full after the rains, and by pumping during the rainy season. A more permanent solution will be to improve these drains by increasing their fall and deepening their depth by the local municipality.

- Pools of water caused by leakages from taps, spillage from pipes and wells or poor household drains system could be eliminated by repair or improvement of water supply system by the water company in Cameroon (SNEC). This could be done through the provision of safe water supplies and proper water manipulation in dams and irrigation systems,

- There could be improvement in wastewater management and improvement of the existing sewage system in Cameroon and removal of discarded containers that might collect water and other human made breeding sites. There should be provision of proper sanitation via solid waste management facilities, sewerage and excreta disposal systems,

- Sand could be used to fill in pools, ponds and borrow pits in and around villages and towns in Cameroon.

The above listed approaches for environmental management of mosquitoes control in Cameroon can be successful only via community participation.
5 Rolling Back Malaria in Cameroon

WHO Global efforts have greatly reduced the distribution of malaria in many regions of the world. In most cases the improvement have occurred mainly in the Developed Temperate zones following rises in economic status and education. There is hope that improvement might extend to developing countries like Cameroon though, economic crises, poverty, high birth rates and unstable political systems are serious impediments. In addition there are other diseases such as AIDS, typhoid fever, onchocerciasis and sleeping sickness that also need attention. Thus national efforts to roll back malaria in Cameroon can only be encouraged by an international organisation such as the Roll Back Malaria Movement in the World Health Organisation. Presently the status of the Roll Back Malaria movement in Cameroon is negotiating on statement of intent for inception action to be organised by WHO region. Cameroon has expressed commitment from the highest political levels and preparation of the statement of intent is in progress in dialogue with WHO. With the current economic crises in Cameroon WHO is requested to provide assistance with planning and management of a vector control campaign for malaria.

A budgeting exercise for RBM initiative is expected to cover
- The training of personnel on treatment of malaria;
- Establishing a revolving fund for ITNs for pregnant women; implementing Information, Education and Communication (IEC) strategies;
- Contracting with NGOs for social marketing;
- Establishing a drug resistance surveillance system; and
- Monitoring by community management committees.

According to information in the Cameroon RBM country update report, US$2.8 million from the core Ministry of Public Health budget for 2000/01 is shared across more than one programme, including malaria, but this allocation had yet to be confirmed. The RBM country update also reports other sources of direct funding for malaria, including extra budgetary support from WHO ($170,000 in 2000) (RBM, 2001). When the negotiation have been completed, a good plan of action to control malaria in Cameroon could be done as follows.

5.2 A proposed Plan to Roll Back Malaria in Cameroon.

Improvement in malaria situation can only be successful and sustainable if the government maintains the commitment to control disease. The Government of Cameroon is required to expand the health services and research and development in control of malaria should be strengthened to provide new tools and approaches. From the fund that could be obtained from RBM, diagnostic tools should be improved and made affordable. Thus the government of Cameroon and the private sectors should be made aware of the need to invest in malaria control efforts to ensure reduction in morbidity and mortality.

Recognising the burden that malaria places on the population of Cameroon and the fact that it remains a killer disease and a barrier to sustainable social and economic development, a National conference on Roll Back Malaria in collaboration with WHO and UNICEF could be organised in Cameroon by the President via the Ministry of Health. Delegates from both within the country and abroad should be invited and they should include, Representatives of WHO Head Quarters, Cameroon representatives of multilateral agencies representative of bilateral agencies, social sectors, governors of the ten provinces in Cameroon, representatives from all ministries, NGOs such
as Living Earth Cameroon, religious organisation, institutions of higher education and research in Cameroon, international and national media, insecticide and bed nets factories or companies, community representative such as local chiefs in all villages in Cameroon among several others.

The main aim of the conference should be to accelerate and strengthen the efforts to control malaria in Cameroon via sustainable partnership in line with the principles of the Global Roll Back Malaria Initiative and with the context of the Ministry of Public Health and Development program in Cameroon. According to the WHO expert community team on malaria, one of the main priorities in all malaria control programmes is training. Cameroon lack technical expertise at the central level to plan and evaluate the national program at the intermediate and peripheral levels in all the ten provinces to manage and implement control. There is also lack of adequate information systems that are sensitive, reliable and timely to sustain the logical capacity required for a rapid and effective response to disease epidemics. Community members and health care members in private sectors should be trained in a health care reform program for the control of malaria. Likewise, there should be decentralization of all function in the vector control program from policy-making to programme implementation (WHO, 1998)

Techniques that could be adopted in a national malaria control program could include the use of methods such as; reducing breeding habitats through improved drainage or water flow, improvement of housing and sanitation in Cameroon especially in the Urban slum, through community education and participation including proper diagnosis and treatment of cases. A National control program for malaria might have several components, such as the six key elements of strategy to roll back malaria adopted in WHO global malaria controls strategy. These elements include,

- Effective management of malaria including disease outbreak,
- Early diagnosis and treatment of sick individuals,
- Multiple and cost effective means of preventing infection,
- Focused research to develop and test/introduce new products,
- A well coordinated movement through a stronger capacity to health system and community reform and
- A dynamic global partnership (RBM, 2001).

However, the comprehensive malaria control strategies described by the Environmental and Health project of the US agency (that comprises all the elements mentioned above) for international development could be adopted in Cameroon. This plan consists of three major components that include case management, surveillance and prevention.

5.2.1 Case management

Proper management of sick individuals are fundamental to malaria control since improper diagnosis can lead to inappropriate treatment, flawed surveillance, and misguided preventive activities and information about malaria situation are required by public health authorities to design and manage responses. A detailed knowledge of the ecology of the local insect, vector, the incidence of malaria and the behaviour of people in endemic areas are essential for determining the most effective methods to control the disease.
Thus a most appropriate beginning of a national control project will be to identify regions and populations at risk in Cameroon and to educate families and community members to understand the malaria disease and to take appropriate and timely action to manage the disease. A community based malaria control program could be initiated in all local communities of Cameroon such as was done in Tigrag region of northern Ethiopia where community residents helped to plan and implement health services through health committees and community health workers. In this program, 681 volunteers chosen by their communities have received malaria training and serve a rural population of 1,682,319 (population ratio 1:2,500). The principal success of the programme at this stage is that a significant proportion of the rural population at risk for malaria is now being treated at the village level (Ghebreyesus et al, 1996). Thus herbalists and health workers in the local community could be trained and supported, conduction in drug supply management courses, monitoring and reinforcement of skills after training and develop guides to improve household management of childhood malaria and malaria in pregnant women. In case management, there should be strict observation of good clinical practice, re-training and updating the knowledge of clinical workers. Likewise, provision of essential drugs, supplies and equipment in rural health centers should be taken into consideration and quality health care services should be made accessible enough for any sick individual who need professional care.

5.5.2 Surveillance.

According to the Environment & Health Project of US Agency for International Development surveillance is real time monitoring of the occurrence or increase of a disease such as malaria in a region since national geographic data makes it possible to observe large-scale trends, and for it, to be useful in program design and implementation, surveillance must be local as well. Local surveillance and assessment of site-specific malaria problems is essential before embarking on any control activity. Surveillance and assessment information should also include information on underlying risk factors relating to predisposing human behaviors and environmental conditions. GIS (geographic information system) mapping has become a useful tool for surveillance.

5.2.3 Prevention.

Most of the prevention method of malaria has been described above both at the individual level such as usage of impregnated bed nets and insect repellent, and at a variety of community wide preventive method such as massive or house spraying of insecticides, chemotherapy and environmental management for control but from reading lots of articles and trials done on these methods of control the most recommended method of control for malaria by most scholar is the use of insecticide impregnated bed nets in line with environmental management.

Insecticides usage, chemotherapy, repellent involve components derived from the industrialized world and have made massive contribution to control malaria in most parts of the world but there have been lots of disappointments because expectations have been greater than reality or actual possibilities. As such environmental management could be a more practical approach to control of malaria in Cameroon since it is “not being subjected to pest control, it can often lead to a more permanent solution (with little maintenance), it pose less hidden risk to the environment and may even lead to improve living standards”, and “above all, it can usually be implemented by local people, with the kind of supervision which they would find acceptable” (Busvine, 1993)
A National Roll Back Malaria (RBM) Project in Cameroon

Decentralisation concrete Action

Local Administration
- wastewater & sewage management
- distribution of ITNs esp to nursing mothers
- control of domestic & peri domestic breeding sites

Health sectors
- better health care delivery for motivation
- improvement in overall health status

Community participation
- consider campaign as important & participate effectively
- Group discussion & seminars on simple control methods

Educational system
- integration of simple control methods (SCM) into school curriculum

Religious leaders
- encapsulation of SCM in local "soap"
- SCM integration in church sermons

Media
- SCM broadcast in national TV & Radio
- use poster & leaflet

Presidential degrees via Ministry of Health to RBM

Improvement in overall health status

Fig 5: Decentralisation of concrete Action in the National Roll Back Malaria Movement
5.3 Decentralisation of Concrete Action

A malaria control program initiated in Cameroon by Roll back Malaria movement can only be successful via massive decentralisation of funding and functions from policy making to program implementation as shown in the flow chart above. In a given rural or urban area in Cameroon implementation of simple methods for control of malaria such as use of ITNs and environmental management, which include proper housing modification, can only be successful through educational programs and increased funding from various stakeholders. As illustrated above, various subsystems in the community can roll back malaria in Cameroon as follows:

5.3.1 The president of Cameroon

According to Okenu, “Roll Back” malaria roll the ball into the court of the African governments so the responsibility lies in the hands of the government of Cameroon to ensure that efforts are maximised towards alleviating the burden of malaria in the country.

This could be done by actively involving the minister of Health in Cameroon to improve the primary health care schemes directed towards disease prevention and control. Improvement in living conditions via provision of jobs and solving the impending urban crisis by promoting self-help housing and urban services by and for the poor, and a more positive approach to the role of the informal sectors such as the governors, supported by sufficient funds for water supply, sanitation and other services. If people can get enough money and services to sustain their family then they can improve their housing conditions.

Developmental projects like construction of dams, urban planning and construction of the Chad-Cameroon pipeline should involve health professionals to avoid environmental degradation that gives rise to new breeding sites for mosquitoes. Health personnel should properly evaluate the health risk associated with such projects in their immediate community and thrive to improve project designs. The minister of health is to take the initiative to strengthen the malaria control support team, initiate RBM movements in regions, promote local production of insecticide impregnated bed nets and scale-up the effort to control the diseases in collaboration with its partners.

The present economic crises in Cameroon will greatly slow down progress and the support in technical skill and funding got from WHO could be used to meet most and while not all of these demands to reduce the epidemiology of malaria in Cameroon.

5.3.2 The Governors

The governor of each province in Cameroon ought to help in the vector campaign by providing both the finance and the manpower needed for proper wastewater and sewer management in their various provinces. The governor of each province in Cameroon will need to develop explicit settlement strategies to guide the process of urbanisation by building up smaller towns and cities and ensuring that they are closely integrated with their rural hinterlands.
This will greatly reduce the mushrooming illegal settlements with primitive facilities and the rampant diseases linked to an unhealthy environment such as malaria, as well as improve the existing environmental problems. They could also ensure proper waste management from industries around this area and thrive to discourage corruption by ensuring proper implementation of environmental policies both at the individual and industrial levels. A proper way to ensure good city and town management requires decentralisation of funds, political power and personnel to local authorities such as town mayors, quarter heads or chiefs in various villages within the community who are best placed to appreciate and manage local needs.

5.3.3 The Health-Care System

According to Alnwick, three interventions could be introduced within a year or two in a very poor health infrastructure system such as the distribution and use of ITNs, rapid and prompt treatment of all suspected cases and routine treatment of pregnant women. These combined could halve the burden of malaria in most vulnerable groups such as in most villages in Cameroon (Alnwick, 2000).

Since it is very costly for resident to depend on private health services for treating malaria, it is rather a pity because better health care centres are needed for motivation and the health care must be supplemented by effective health education. Providing primary health care facilities especially in rural areas and making sure everyone has the opportunity to use them are the best starting point for a proper health care delivery system. Non-governmental organisations (NGOs) and private-sector industries, especially the pharmaceuticals with a stake on national health should be encouraged by sound health policies to participate in disease prevention and control. Hospitals, especially university teaching hospitals and general hospitals should be properly equipped for prompt and adequate diagnosis, monitoring and surveillance of drug resistance. Malaria drug therapy may soon be changing to a multiple drug regimen, as in the treatment of tuberculosis, due to widespread resistance, but such decisions must be based on scientific evidence, to avoid expensive and unaffordable prescriptions in health centres, and drug policies that may increase the prevalence of resistant malaria in the community (Okenu, 1999). The health care systems should have a better place to educate individuals especially the women folk on vector control through control of domestic and peri-domestic breeding sites. The health care system ought to be capable of responding to and controlling aid in rolling back malaria in Cameroon via integrating control into the health-care delivery system and providing education concerning the tools to control malaria in the most feasible and cost effective way.

5.3.4 The Educational system

According to Allison, education and communication are vitally important in order to impress each individual of his or her responsibility regarding the healthy future of the Earth and the best way for students to recognise that their action can make a difference is to have projects organised by the school or community on which the students can work. Once convinced that they can help, students tend to change their attitude and their behaviour. (Allison, 1986)

In addition to integration of National Malaria Control Program into the education curriculum at all levels to foster a sense of responsibility for the control of malaria and to teach students how to monitor, protect and improve malaria epidemiology, adult group discussions and seminars should be organised on simple vector control methods. These could be achieved by the involvement of students in sub roll back malaria movements in schools through nature clubs and other special
interest groups in schools. Likewise, simple malaria control method should be a very important topic in health and hygiene studies done in school.

Religious leaders could also aid in the control of malaria in Cameroon. They could help in control of malaria by integrating simple control strategies in church sermons as well as help provide direction and motivation in forming new values that would stress individual and joint responsibility towards control of malaria in the community.

Community education efforts that explain the role of mosquitoes as disease vectors, and their preferred breeding habitats and feeding behaviors, improve the success rates of a malaria control program. When parent are made to understand that insecticide impregnated net protect their sleeping child from becoming ill with malaria, they are more likely to acquire, use, and care for them properly. The use of posters and leaflet or if drafted by the skill of commercial advertisement, or the message might be best encapsulated in local “soap” and shown in daily national Television in the local languages.

5.3.5 The community

The local community in various urban and rural areas in Cameroon can participate directly in the malaria control campaign by improving the sanitation of their dwellings. The introduction of penalties for households who refuse or neglect to control the vector through proper cleaning of their surrounding household could be helpful with local inspectors to monitor these project. In effect, very strong incentives are needed to sustain this operation. The community should be encouraged to participate in the local production, distribution and use of bed nets, as well as variables pertaining to the process of periodically treating the bed nets with insecticides. The community should be encouraged to regulate the frequency of impregnated net wash and to repair damaged net when necessary. Strategies to increase the availability of bed net by working with manufacturers to bring down the cost and means to encourage retreat bed nets should be discussed by local communities. Some of the funding got from RBM program could be used to subsidize local manufacture and increasing people’s understanding by seminars or group discussion organized by head of local communities such as village head or chiefs.
6 Conclusion

To obtain human health and sustainable development in Cameroon, Malaria must be rolled back by:

- Improved information and education on the disease
- Use of impregnated bed nets by all Cameroonians especially those living in endemic areas.
- Vector control by elimination of breeding sites through environmental management by improved sanitation and provision of better housing.

Unlike the use of insect repellent, burning coils insecticides spraying and prophylactics these methods are cost effective and can be easily implemented by the local population if they are provided with the kind of supervision, they find acceptable. Thus the use of environmental management and bed nets can dramatically reduce the use of insecticides and chemoprophylactics with their associated costs while contributing to sustainable disease reduction.

Success in a Roll Back Malaria movement in Cameroon can only be achieved if there is coordinated action implemented by the government with local participation in policy making to program implementation of malaria control at all levels. i.e. all Cameroonians are given equal opportunity to participate in the program including community members and people working in education, churches, environment, sanitation, and community development among many others.

If insecticides impregnated bed nets are made available to all households in Cameroon and there is improvement in the sanitation and housing conditions in all regions, the population of mosquitoes will be greatly reduced. This will greatly reduce the incidence of malaria in Cameroon to a level that is acceptable to the community by reducing morbidity to levels commensurate with socio-economic development since from source materials, eradication is only possible when researchers finally comes out with a vaccine for malaria hopefully in the near future.
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