MALARIA INTERDICTION IN KENYA

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Preface

This report was prepared as part of the Capstone Policy Seminar experience at the Pepperdine School of Public Policy. The Seminar, one of the integral parts of the preparation for students receiving the Master of Public Policy degree, provides students with the opportunity to explore a public policy program in depth and to prepare a set of specific recommendations to policy makers to solve the problem. These reports are prepared by a team of 6-8 students over the course of only twelve weeks, providing for an intensive and challenging experience.

The results of the team's analysis is then presented to a panel of experts in a public workshop setting where the student panelists are given the opportunity to interact directly with the policy professionals, not only presenting their findings but engaging in an exchange of ideas and views regarding the specifics of those recommendations. The policy expert panel for this report included health economist Angela Hawken of the Pepperdine School of Public Policy, Africa specialist Robert Lloyd from Pepperdine University, and public health advisor Andrew Weathers from the Division of International Health in the Epidemiology Program Office for the Centers for Disease Control.

The School of Public Policy would like to thank our students for their hard work and commitment in preparing this policy analysis. We are proud of your achievement.

Table of Contents

I. Introduction

The World Health Organization's 'Roll Back Malaria' initiative reports that malaria causes over 300 million acute illnesses in addition to approximately 1 million deaths each year. Furthermore, "ninety percent of deaths due to malaria occur in Africa, south of the Sahara- mostly among young children."[1] Despite the volatility caused by the high prevalence of HIV/AIDS in sub-Saharan Africa, it is important to note that malaria also poses a serious danger to the continent and will continue claiming lives and disrupting economic activities within the region until a solution is found. Whereas the onus for limiting exposure to HIV/AIDS largely rests with the individual, it is generally more difficult to limit one's exposure to malaria due to the nature of the disease. This difficulty necessitates concerted action by the government and civil society to assist the individual in limiting the risks of exposure to malaria.

Therefore it is necessary for the governments of sub-Saharan Africa, where possible, to take action and for the international community, including NGOs, to step in and do their part, as well. It is hoped that in implementing this proposal in Kenya we will gain insights which will be useful in addressing the problem in subsequent states.

Kenya, a nation with a high incidence of malaria and with a well-developed infrastructure compared to other nations in the region, may prove successful in largely eradicating malaria and be able to serve as a case study for the rest of the region. It is given that there may be a concern about the cost-effectiveness of initially concentrating research and funding in Kenya, as opposed to all sub-Saharan states impacted by this endemic disease. However, this concentration of research and resources on one country in a pilot program aimed at malaria eradication, with the support of all key players, will allow its strengths and weaknesses to be assessed and the results be applied to future efforts. As experiments are conducted in a laboratory, testing a policy in one country will allow for increased efficient in the long run.

There is a need to eliminate malaria-carrying mosquitoes throughout sub-Saharan Africa, immediately in Kenya. Particular attention will be focused on this endeavor, as it is the means of rooting out the problem at its source. There is nearly an endemic lack of resources to create a well-crafted public health infrastructure that can effectively address the factors that accelerate the spread of infectious disease. Although this is generally true throughout the developing world, it is keenly felt in Sub-Saharan Africa. Here the triple punch of AIDS, tuberculosis and malaria has overwhelmed public health systems. Furthermore, malaria is primarily a developing world disease – usually occurring in high-poverty areas.

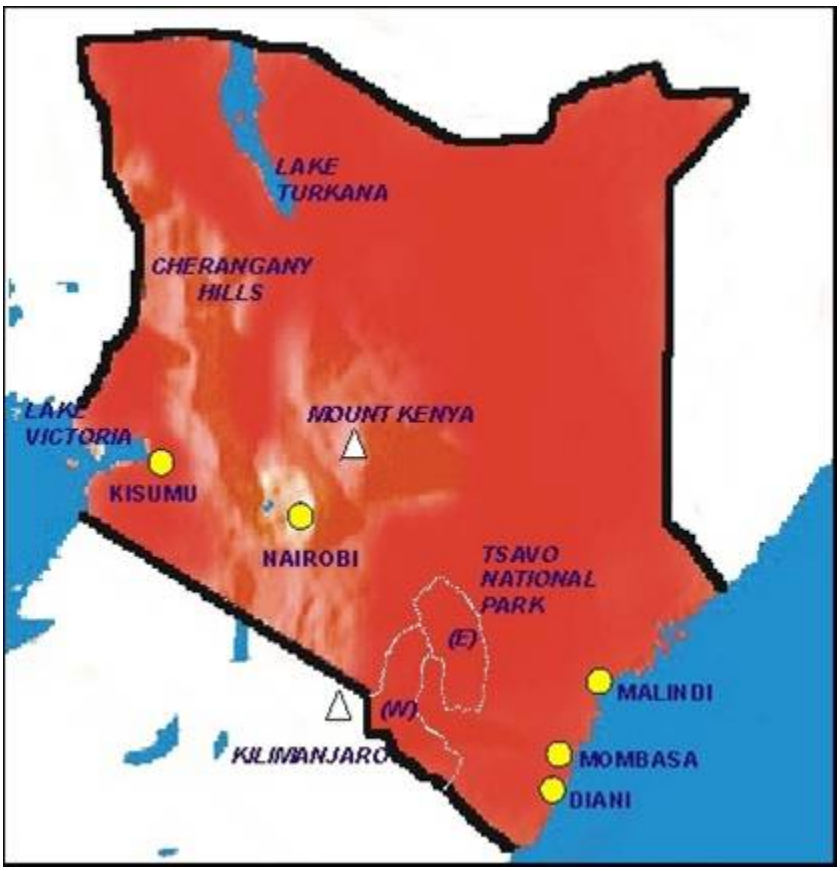
[1] World Health Organization, "Roll Back Malaria: 2001-2010 United Nations Decade to Roll Back Malaria," [online]: www.rbm.who.int, February 2004.

T.H. Weller, a Nobel Laureate, once said, "A malarious community is an impoverished community."[2] As a result of the incapacitation of the afflicted, malaria eventually negatively impacts the growth and development of the state, thereby contributing to the cycle of poverty that affects all individuals who inhabit these areas. The lack of monetary resources in such countries means that they are unable to implement programs to address prevention and treatment, which creates a high probability that individuals living in these endemic regions, will suffer from the disease.

The problem of malaria transmission is one of utmost importance, and it is in the public interest that the issue be addressed in a thorough and efficient manner through an analysis of the present situation. This paper will primarily deal with the issue of malaria transmission control and the problem confronting the general population in Kenya—how the Malaria situation confronting the people of this region may be subdued through consorted efforts by various agencies to "roll back" its spread and curb the disease. Given the reality that malaria affects the Kenyan population as a whole, it is crucial that any initiative or program be geared towards alleviating the risk of exposure to malaria within the general population, while giving primary focus to the most vulnerable demographic group for contraction of malaria—pregnant women and children. Clearly many measures that will be proposed will invariably benefit all members of society, yet it is important to recognize that as pregnant women and children are disproportionately affected by malaria they will naturally be a primary target of any program or initiative. In proposing a plan to alleviate the transmission of malaria, it is clear that cooperation within the region will be a key to any hope of success. Therefore, as a precursor to implementation of a continent wide policy, it is suggested that the policy primarily focus upon Kenya and the effect that malaria has had on its population.

[2] Gallup, John Luke. Sachs, Jeffrey D., "Malaria, Climate, and Poverty," CAER Discussion Paper No. 48. July 1999. (p. 5).

Figure 1: Malaria Intensity in Kenya [3]



Source: Fit for Travel website, spring 2004.

A. Stages of Malaria

In order to understand what must be done in Kenya about Malaria, it is first important to understand the specific ways that the disease is transmitted and its effects on infected individuals. Malaria is caused by the parasite *plasmodium* of which there are four major strains: *Plasmodium falciparum*, *Plasmodium vivax* , *Plasmodium ovale* and *Plasmodium malariae.*[4] The most common form of malaria is caused by *Plasmodium falciparum*.[5] This parasite is transmitted to human beings through the female *Anopheles*

[3] Fit for Travel [online]: http://www.fitfortravel.scot.nhs.uk/Country/Kenya_Malaria_Map.htm, February 2004. This map is only intended as a guide since mosquitoes do not respect boundaries and the risk areas shown may not be exact. Substantial malaria risk is shaded in dark red - becoming lighter where the risk is less.

[4] The Special Program for Research and Training in Tropical Diseases, World Health Organization [online]: www.who.int./tdr/diseases/malaria/diseaseinfo.htm, February 2004.

[5] Ibid

mosquito.[6] Therefore, in order to reduce the rate of incidence of malaria, it is important to define the life cycle of *Plasmodium* and the anopheles mosquito.

The life cycle of a mosquito takes about a month.[7] The life cycle consists of four stages, which are the egg, larva, pupa, and adult. The female anopheles mosquito- after a blood meal from humans, which it requires to nourish its eggs-lays its fertilized eggs on the surface of water bodies that are relatively clam, such as ponds, streams, and stagnant pools of water. The female mosquito lays 30-150 eggs every 2-3 days. The larval stage is aquatic and the larvae shuttle from the subsurface where they feed on microorganisms to the surface in order to obtain oxygen through a snorkel-like breathing apparatus. There is no feeding during the pupa stage. The pupae attach to the surface of the water to obtain oxygen; and eventually hatch to release adult mosquitoes that live for 2-3 weeks.

The life cycle of *Plasmodium falciparum* takes place in both the female *anopheles* mosquito and human beings.[8] An infected mosquito carries *sporozoites* (the form in which the parasite exists at this stage) and when it feeds on human blood it injects these *sporozoites* into the person. The *sporozoites* enter the blood stream and travel to the liver where they repeatedly divide (asexual reproduction) and form *merozoites* that infect red blood cells. Some of the *merozoites* develop into male and female gametes, and when the female *anopheles* feeds, it ingests these gametes. The gametes go into the digestive system of the *anopheles* where they combine into zygotes (sexual reproduction). The zygotes divide into *sporozoites* that migrate to the salivary glands of the mosquito. The *sporozoites* are then injected into humans, along with saliva, which the mosquito injects in order to prevent the blood from coagulating when the mosquito feeds; and the life cycle is started all over again. Because of the nature in which the parasite is spread it can infect a large number of people within a short period of time; which poses a major challenge in dealing with malaria and its overall management.

B. The Physical, Social and Political Context of Kenya

In order to address malaria in Kenya, it is important to understand both the physical and social context where the policy will be applied. There are many issues that drive and complicate the malaria problem and that are specifically relevant to Kenya. One must take a variety of factors into consideration when trying to understand why the spread of malaria has become such a prevalent issue for countries most

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[6]Ibid

[7] This description is drawn from the State University of New Jersey Rutgers [online] www.rci.rutgers.edu/~insects/lcycle.htm; and www.enchantedlearning.com/subjects/insects/mosquito/lifecycle.shtml, February 2004.

[8]This portion of the description of the life cycle of the *Plasmodium falciparum* is drawn from the National Institute of Allergy and Infectious Diseases; National Institutes of Health, "Life Cycle" [online]: www.niaid.nih.gov/publications/malaria/life.htm; Ohio State University College of Biological Sciences [online]: www.biosci.ohio-state.edu/~parasite/lifecycles/plasmodium_lifecycle.htm, February 2004.

affected by the disease. These include issues of geographical settings of infectious regions, cross-border migratory trends, socioeconomic factors, quality of health care services and health care education, sanitation, and demographic trends including rural and urban differences. The total population of Kenya is 31,639,091, as established by July 2003 statistics.[9] The median age is 18.4 years. 55.8% of the population falls within the 15-64 age structure. The population growth rate, established in 2003, is 1.27%; birth rate is 28.81 births/1,000 populations; and death rate is 16.01 deaths/1,000 population. The infant mortality rate for the total population is 63.36 deaths/1,000 live births and life expectancy at birth for the total population is 45.22 years.[10]

Geography and Climate

Kenya is located in East Africa and covers an area of 582, 650 square km, bordering the Indian Ocean, between Somalia and Tanzania.[11] Kenya's climate is both tropical and arid. The weather becomes tropical along the coast and arid in the interior. Kenya's climate is also compromised of a rainy season accompanied by flooding, and a dry season, accompanied by drought.[12] The rainy season can be divided into long and short rains, where long rains last from the months of April to June, and short rains last from October to December. The hot and dry weather lasts from February to March, and becomes cold from July to August.[13]

Climate changes may hinder attempts to bring malaria vectors under control. "Increasing temperatures could create environmental conditions that would allow a net increase in the geographic range of areas climatically hospitable for malaria vectors." Furthermore, malaria epidemics usually occur at altitudes from 1500 to 2200 meters high.[14]

Government of Kenya

Kenya's unicameral National Assembly represents the legislative branch of the government and consists of 224 seats (210 elected members, 12 appointed members and 2 ex-official members).[15] Members are elected every five years, and political pressure groups – including human rights groups, labor unions, religious groups, and the National Convention Executive Council (NCEC), a coalition of political parties and nongovernmental organizations – play a strong hand in determining who gets

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[9] CIA World Factbook, February 2004.
[10] Ibid.
[11] Ibid.
[12] Ibid.
[13] [online]: Kenya.rcbowen.com/geography/geography.html, February 2004.
[14] Ebi, Kris, "Highland Malaria in Kenya", APF Case Study, 29 Aug 2003, p. 1-2, UNDP [online]: www.undp.org/cc/pdf/APF/UGB/APF%20CS_Ebi_Highland%20Malaria%20in%20Kenya_29%20August%202003.doc, February 2004.
[15] CIA World Factbook, February 2004.

elected. Pressing issues that dominate the national discourse include corruption in governance, the nation's stagnated economy, a poor educational system, public health issues and a myriad of environmental concerns including water pollution from urban and industrial waste, deforestation, soil erosion, desertification, and poor water quality caused by the increasing use of fertilizers and pesticides.[16]

The governing party of Kenya, the National Rainbow Coalition (NARC), occupies a majority of the seats in the Assembly with a total of 125. Bills passing through the Assembly become law under the approval of President Mwai Kibaki. NARC's victory in the 2002 elections, which unseated the 40-year reign of the Kenya African National Union (KANU), was powered largely by widespread concerns over the country's failing health and educational systems and by Kibaki's pledge to correct those failings. Many Kenyans have complained about a lack of progress in those areas since NARC assumed control of the government, and both the legislature and the president are under pressure to alleviate some of the more immediate problems.[17]

Socio-Cultural Issues

Kenya is a region full of religious and ethnic diversity. Its ethnic make-up is composed of the Kikuyu which accounts for 22% of the population; the Luhya at 14%; the Luo at 13%; the Kalenjin at 12%; the Kamba at 11%; the Kisii at 6%; the Meru at 6%; other African groups accounting for 15%; [and] non-African (Asian, European, and Arab) groups making up 1% of the total population.[18] Religiously, 45% of Kenyans are Protestant, 33 % are Roman Catholic, indigenous beliefs and Islam account for 10%, and other religions make up 2% of the population.[19]

As a result of continued violence in neighboring states throughout the years, many refugees fled their homes and sought refuge in Kenya. By the end of 2002, the vast territory of Kenya became home to approximately 220,000 refugees and asylum-seekers from the neighboring states of Somalia (approximately 140,000), Sudan (roughly 70,000), Ethiopia (approximately 10,000), and other countries (more than 1,000). The number of refugees and asylum-seekers do not include some 230,000 Kenyans who were forced to flee their homes by the end of 2003. These Kenyans are classified as internally displaced persons, or IDPs.[20] Most internally displaced Kenyans were rural farmers and

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[16] Ibid.
[17] "Day of Reckoning for Kenya Graft," BBC, 20 Oct. 2003, [online]: http://news.bbc.co.uk/1/hi/world/africa/3208206.stm, February 2004.
[18] CIA World Factbook, February 2004.
[19] Ibid.
[20] U.S. Committee for Refugees [online]: http://www.refugees.org/world/countryrpt/africa/2003/kenya.cfm, February 2004.

herders who were forced to take up refuge in urban centers, after the government seized their land in the 1990s.[21] Thus, Kenya is faced with a variety of issues within its social and cultural context.

Ministry of Health

The National Malaria Control Program (NMCP), created by the government of Kenya in 1994, was officially changed to the Division of Malaria Control (DOMC) in October 2000. The DOMC, located under the Department of Preventive and Promotive Health Services, defines and disseminates the national malaria strategy for the government of Kenya. It is also responsible for creating partnerships with other ministries, development partners, NGOs and various UN agencies, as well as, engaging in the research, monitoring and evaluation of malaria throughout the region of Kenya.[22] The Inter-Agency Coordinating Committee for Malaria (ICC) plays a key role in providing "a forum for partners in malaria control in Kenya to exchange information on malaria control and research activities and to identify and advise on areas of coordination." Furthermore, it helps advise the Kenyan Ministry of Health on its national malaria policy, its Roll Back Malaria Initiative, and a number of cross-border issues that affect Kenya and its neighbors.[23]

There are four components to the malaria control strategy, as proposed by the National Malaria Strategy (NMS) of the Kenyan Ministry of Health. They are: "1) case management: guaranteeing people access to quick and effective treatment; 2) ensuring the use of insecticide treated nets (ITNs) and other vector control[24] measures by the at risk communities; 3) providing malaria prevention and treatment to pregnant women; 4) and improving malaria epidemic preparedness and response."[25] Through the NMS, the government of Kenya will use two strategies to carry out the above-mentioned approaches to malaria control: 1) information, education, and communication; and 2) monitoring, evaluation and research.[26] The National Malaria Strategy 2001-2010, has earmarked 2006 as the year to reach its specified targets on current malaria control policies.

> The NMS states that the DOMC will continue to be the operational arm of the National Malaria Control Programme at the national level . . . For many of the activities the DOMC will operate nationally. However for some of the capacity development activities, it will not be possible to cover all the country in one year and so particular districts, generally those with the highest malaria burden, will be targeted first. The DOMC will however continue to support requests

[21] Ibid.
[22] Kenya Malaria Information Service (KMIS) "Division of Malaria Control" [online]: www.kmis.org/DOMC.htm, February 2004.
[23] Ibid.
[24] "The control of insects and other organisms which are able to transmit infectious agents of disease." For the purpose of this paper, this term refers to malaria and mosquito control. (www.geoparent.com/dictionary)
[25] KMIS, "Division of Malaria Control," February 2004.
[26] Ibid.

for help from the other districts as far as capacity and funds allow.27

A few risk and assumptions were also taken into account by the DOMC. These include the availability and search for funding, the ability to obtain human resources, and maintaining and strengthening successful partnerships, which have already been created while seeking to build new partnerships now and into the future.[28] Funds have been obtained from WHO, RBM/AFRO, and the Department for International Development (UK) East Africa. By 2006, the NMS seeks to reach its goal of reducing malaria morbidity and mortality by 30%.[29] Without the necessary funding the NMS will not reach its goal.

National Health Infrastructure

National public health is not only composed of the systems put in place by the government to deliver basic health care to the Kenyan population, but is also composed of the system of infrastructure such as roads, electricity and clean water supply. Without adequate infrastructure, healthcare systems cannot operate effectively.[30] In developing countries, inadequacies in both the delivery of healthcare and the upkeep of the infrastructure system, pose a problem to the provision of good pubic health services. This is further compounded by the allocation of few resources to the healthcare sector, and in most Sub-Saharan African countries government spends less than $20 per patient per year on healthcare.[31] In Kenya total expenditure on health as a percentage of GDP in the year 2000 was 8.3% and in 2001 it was 7.8%.[32]

Healthcare facilities are not placed according to need, but rather according to political factors or physician choice. The problem in the public health arena is further exacerbated by the existence of a lack in healthcare personnel that cannot meet the demand of the health sector. Many African countries have only 1 doctor per 10,000 people, and most healthcare providers are concentrated in cities, whilst the majority of the population lives in the countryside.[33] According to World Health Organization (WHO) health statistics in 1995, Kenya had 13.2 doctors per 100,000 people and 90.1 nurses per 100,000 people.[34] Inefficiency and waste also plague the system. In the case of pharmaceuticals, the

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[27] Kenya Malaria Information Service, "Biennial Plan of Action for January 2002 to December 2003," October 2001, p. 5, Division of Malaria Control, Ministry of Health, Government of Kenya [online]: http://www.kmis.org/FullReports.htm, February 2004.
[28] Ibid. at p. 6.
[29] Ibid.
[30] Pharmaceutical Research and Manufacturers of America (PHRMA), "Healthcare in the Developing World" [online]: http://world.phrma.org/challenges.health.infra.html, February 2004
[31] Ibid
[32] World Health Organization "WHO Estimates of Health Personnel" [online]: http://www3.who.int/whosis/health_personnel/health_personnel.cfm, February 2004.
[33] PHRMA, "Health Care," February 2004.
[34] "WHO estimates," February 2004.

World Bank has found that "inefficiencies in the procurement, storage, prescribing, and use of drugs are so extensive…that consumers in some countries get the benefits of only $12 worth of drugs for each $100 spent on drugs by the public sector."[35]

At independence, Kenya inherited a three-tier health system, with the central government providing services at the district, provincial and national level; missionaries providing services at the sub-district level; and local government providing services in urban areas.[36] However, in the 1970s, government began to establish a system of comprehensive rural health services in which health centers became the crucial points from which preventive, promotive, and limited curative services are to be delivered.[37]

Currently alongside government, missionaries and non-governmental organizations provide health services.[38] Kenya has a relatively large non-government healthcare-providing sector. This sector accounts for 50% of all hospitals and 36% of hospital beds.[39] Non-governmental healthcare providers also account for approximately 21% of health centers and 51% of all other outpatient treatment facilities.[40]

There are many types of health facilities within the health sector of Kenya: hospitals, health centers and health sub-centers as well as dispensaries and mobile clinics. The public sector has a greater number of health centers (79%), sub-health centers (92%), and dispensaries (60%). The non-governmental sector, on the other hand, is dominant in the health clinics, maternity and nursing homes (94%), and medical centers (86%).[41] The distribution of health facilities varies by region. Between 1990 and 1999 the Rift Valley province had the highest number of facilities, followed by the Eastern Province, and the North Eastern Province, partly due to its low population, having the lowest number of facilities.[42]

Improving Sanitation Conditions Reduces Malaria

According to the World Health Organization (WHO) over three quarters of the illnesses in the world could be prevented or cured by better nutrition, clean water supply, sanitation, immunization, and health education. In rural areas, the major causes of death are still likely to be related to the lack of basic

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[35] PHRMA, "Health Care," February 2004.
[36] Kimalu, Paul Kieti, "Debt Relief and Health Care in Kenya," ,July 24, 2001, paper prepared for presentation at a Conference on Debt Relief and Poverty Reduction, UNU/WIDER, Helsinki, Finland, August 17-18, 2001,World Institute for Development Economics Research, United Nations Universities, [online]: http://www.wider.unu.edu/conference/conference-2001-2/poster%20papers/kimalu.pdf, February 2004.
[37] Ibid.
[38] Ibid
[39] Eldis Organization "Kenya: Non-Governmental Health Care Provision" [online]: www.eldis.org/static/DOC6135.htm, February 2004.
[40] Ibid
[41] Kimalu, "Debt Relief," February 2004.
[42] Ibid

sanitation. Adequate sanitation is the foundation of development - but a decent latrine or toilet is an unknown luxury to half the people on earth.[43] The issue of sanitation therefore becomes very important in combating malaria in sub-Saharan Africa. This is because improper sanitation is very prevalent in this region and poses a major public health issue. The existence of refuse dumps and open clogged drains, open sewers, provide a favorable breeding ground for malaria parasites and mosquitoes. There are many reported cases of malaria reduction due to proper management of drainage.

For the most part, sanitation is a major problem in developing countries due to poor education. People do not realize the adverse effects that their unhygienic habits have on public health. There is also a great disparity between the rural and urban situations, as rural inhabitants have limited access to sanitary conditions; whereas the more affluent tend to live in the urban areas that have greater access to sanitary conditions.

Thus in Kenya, the issue of sanitation is of major concern and has an impact on initiatives within the health sector. In Kenya, as elsewhere, the major reason for deteriorating sanitary conditions has been an increase in population beyond which existing infrastructure can support. Kenya's population increased from about 6 million at independence to about 30 million in 2002. Deterioration in the infrastructure is itself a problem, as is an increased trend in rural-urban migration; that has led to significant concentrations of population in urban centers, mostly in unplanned informal settlements.[44]

The government's current health policy seeks to focus on preventative health care rather than curative. Whereas sanitation had previously been low on the development agenda, it is now viewed as key to a program of preventative health care; as more resources are being allocated towards programs focused on improving sanitation.[45] Currently, there are a number of ongoing and planned projects focused on improving sanitation within Kenya, especially in major urban areas such as the capital, Nairobi. These projects are being undertaken by the government, in conjunction with international non-governmental organizations like the United Nations Development Project (UNDP), the Danish International Aid Association (DANIDA), and CARE to name a few. With an increased effort towards improving sanitation health, care initiatives are likely to become more successful while proving to have a greater impact healthcare situation. Such policies will allow for a reduction in the incidence of malaria in Kenya.

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[43] WomenAid International [online]:www.womenaid.org/development/water.htm, Februrary 2004.
[44] [online]: www.buildingkenyatogether.com/downloads/Water_Sanitation.pdf, February 2004.
[45] World Health Organization Regional Office for Africa, "National Environmental Health Policy" [online]: www.afro.who.int/des/phe/country_profiles/kenya_policy.pdf, February 2004.

Rural and Urban Issues

According to PBS, rural to urban migration has created a standstill in Kenya, as access to health care facilities is becoming more difficult.[46] Most of the Kenyan population lives in the western region of Kenya, or what is also known as the Highlands. 25% of the urban population is distributed within the larger cities, such as Nairobi and Mombasa. The rural population resides in the more fertile regions of Kenya where agriculture acts as the main form of subsistence.[47]

Findings of the *Kenya Poverty Assessment*, carried out by the World Bank and its member governments in the region of Africa stated that, in 1992, approximately half of Kenya's rural population, or 9 million Kenyans, were considered to be below the poverty line. According to the same study, 30% of the urban population, or a million and a quarter of urban Kenyans, lives below the poverty line.[48] Furthermore, the rural poor do not receive the same kind of attention at public health facilities as urban areas do.[49]

> In the health sector, the share of preventive health in the public budget should be increased with an expanded program of child immunization targeted at the poorer districts and poor families. Within the curative budget, spending must shift towards health centers that are used more frequently by the poor and away from hospitals. Although cost recovery is providing significant revenues at the health centers, this must go hand in hand with reallocation of public expenditures towards facilities most used by the poor . . . Broad-based economic growth and the provision of basic social services to the poor are the two mutually reinforcing strategies that could assure rapid and sustainable progress for the people of Kenya. One without the other is insufficient and inadequate progress in one constrains the other.50

Thus, there should be an increased focus on the equitable distribution of health care within the rural areas of Kenya, as resources shall permit.

Pregnant Women and Children

The Kenya Central Bureau of Statistics, Ministry of Planning and National Development compiled the following statistics in the Demographic and Health Survey (KDHS) for 2003, a program conducted every five years in order to provide information for stakeholder planning. According to the results, the average Kenyan woman will give birth to approximately 5 children during her childbearing years, also taking into consideration that the total fertility rate (TFR) for women in rural areas (5.6 births) is higher than those in urban areas (3.3 births). These results also show that the fertility rate in Kenya is on the

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[46] PBS, "Kenya Facts & Figures" [online]: www.pbs.org/sixbillion/images/LHKenya.pdf. February 2004, provided by the National Audubon Society's Population and Habitat Program.
[47] Safaris & Travel Kenya.com [online]: www.kenya.com/people/people_006.htm. February 2004.
[48] "Findings Report: *Assessing Poverty in Kenya,"* Number 55, January 1996, Report No. 13152-KE, Washington, D.C.: World Bank, World Bank, Population and Human Resources Division, Eastern Africa Department, Africa Region. [online]: www.worldbank.org/afr/findings/english/find55.htm, February 2004.
[49] Ibid.
[50] Ibid.

decline, and has stagnated over the past two decades.[51] Most mothers in both rural and urban areas receive antenatal care, with a higher percentage receiving care in urban centers.[52]

Organization of This Study

To address the important problem above, this study will analyze a number of factors that will help determine an effective policy that can lead to malaria eradication. Studies and recent scholarship will be consulted as well as UN and WHO policy and successful international NGO initiatives. Since the problem has been defined and a brief sketch of relevant Kenyan issues has been drawn, it will now be important to consider these factors in light of a series of policy options. These options have been selected as prevalent within mainstream scholarship and are viewed as largely viable. A policy recommendation will be made based on the most legitimate option(s), as determined by our analysis. Once a recommendation has been made, the details of the recommendation will be discussed. A discussion of the implementation of these details of the recommendation will follow, including how to energize stakeholders to carry out the recommendation, establishing funding mechanisms, dealing with legislative hurdles, involving NGOs, and the order of implementation. Finally, obstacles, including unintended consequences and potential spoilers are dealt with.

[51] Kenya Central Bureau of Statistics, "Kenya Demographic and Health Survey" [online]: www.cbs.go.ke/kdhs2003_highlights.html, February 2004.
[52] Ibid.

II. Identifying the Proper Course of Action

Given the complexity of the problem of malaria, major goals must be identified while selecting an option to solve this problem. The most important goal, of course, is saving peoples' lives from malaria. This is the moral ground on which any recommendation must be built. Other criteria that will help focus our research and that must be taken into consideration when evaluating options for the optimum plan to alleviate the malaria problem in East Africa include: cost-effectiveness, efficiency, feasibility and satisfaction of stakeholders' interests.

Saving human lives is clearly the most important objective. Malaria has an enormous impact on demographics in Sub-Saharan Africa claiming a child's life every 12 seconds. Each policy option will be weighed on the basis of how many lives it will save. While other criteria including cost-effectiveness, efficiency, and feasibility are important to gauge the qualitative differences of proposed options, saving lives is the overarching goal of any policy proposal.

Secondly, cost-effectiveness is clearly of high concern given the many demands made upon the resources of any state, including Kenya. Besides the obvious price tag of implementing each program to fight malaria and its consequences, it is vital that these issues are addressed: the cost-effectiveness of saving lives in Kenya; the effects of disrupting eco-systems which will affect many lives for generations to come; and the costs associated with balancing the prevention and treatment of malaria.

Additionally, programs that are the most efficient in terms of treatment and prevention of malaria are the most desirable. Efficiency speaks to the capability of a program to have the largest positive impact on the problem of malaria transmission in the shortest possible time. Speed, impact and durability are all important components of efficiency that will help to weigh options. Speed refers to the time frame required for implementation of a particular program. The faster a program can be implemented, the quicker it can start saving lives. Impact shows the extent to which a program fights the spread of malaria in the region, particularly within the target population. The efficiency of a policy also depends on the durability of a policy and its ability to have long-term effects. Within the category of efficiency, impact and durability of a program have equal weight, and are each more important than the speed with which a program can be implemented.

Although cost-effectiveness and efficiency are necessary conditions, they are not solely sufficient in weighing the merits of various options. The political, social/cultural, and environmental feasibility of a program are also important components for a successful proposal. A program may be cost effective and may be quickly implemented with significant impact and future durability but may not be feasible due

to political unrest, lack of resources and/or infrastructure, cultural inadaptability, negative environmental impact, or other reasons.

For a program to be successful, it must be politically feasible. Given the current political situation in Kenya, are those in power willing to accept assistance and work with the international community to fight malaria? In order for a policy to achieve success, the government must support it or at least not oppose it. In addition to governmental support, a policy option or proposal must conform to social and cultural standards. A program could be cost-effective and efficient but not culturally acceptable to the people of Kenya, the target population. Kenya is a very diverse country in Africa with more than 300 ethnic tribes, likely making social and cultural feasibility even more difficult. If proposals offend the people, they cannot and should not be implemented. Environmental friendliness is another important component of the feasibility of each program. The impact of proposed policies on the ecosystem within the region must be considered. According to the United Nations Environment Program (UNEP), poverty is a major cause and consequence of the environmental degradation and resource depletion that threaten the region. Major environmental challenges include deforestation, soil degradation and desertification, declining biodiversity and marine resources, water scarcity, and deteriorating water and air quality[53]. At the same time, Kenya is home to thousands of species of flora and fauna, making it a unique ecosystem that must be protected. An estimated 60 to 70 percent of Kenya's wildlife lives outside protected areas, making the conservation of game on communal and private lands vitally important for the health of the nation's wildlife resource base. "The cost of maintaining these animals has always been borne by the landowners," said Kenya Wildlife Service Director Dr David Western[54]. The potential environmental impact of proposed options makes environmental feasibility an essential criterion. Kenya's diverse and delicate eco-system cannot be disrupted by a policy that saves lives at the stake of the environment. If a program is acceptable politically, socially and culturally and protects the environment, then it will be deemed highly feasible overall.

Finally, with many stakeholders holding competing interests, it is necessary, to the extent possible, to balance these actors and their concerns. Selecting an option that satisfies the maximum number of stakeholders to the maximum extent possible will help insure its enduring success. Of course, there are competing interests among some of the stakeholders, which must be recognized. However, as trade-offs are necessary, they should be weighed against the overarching goal of saving peoples' lives. The largest stakeholder, the general population of Kenya, must be addressed first in the implementation of any proposed recommendation. However, it is imperative that other stakeholders be considered as

[53] United Nations Environment Program [online]: http://www.unep.org/geo2000/ov-e/0004.htm, GEO-2000, February 2004.

[54] Ngunjiri, Philip: "Environment-Kenya: Making Wildlife Pay" *Inter Press Service*, 15 Dec. 1997 [online]: http://www.ips.fi/koulut/199751/12.htm, February 2004.

well, including the various levels of government in Kenya, the World Health Organization, the United Nations, numerous non-governmental organizations (NGOs) and other segments of civil society, and neighboring states. Focusing on the people first who are to benefit followed by the government and other stakeholders, will ensure the proper balance.

A. Approaches to Solving Kenya's Malaria Crisis

Malaria in Kenya is neither a new nor a simple problem to solve. Public health literature is vast and although there are certainly other options available to Kenya, it is judged after careful consideration that these options represent the best range of possible actions that the Kenyan government might adopt. These proposed options have both strengths and weaknesses in terms of how they meet our criteria for saving peoples' lives, cost-effectiveness, and feasibility.

Option 1: Preventative Malarial Drugs

Many indigenous people in highly endemic regions have developed a natural immunity to malaria. But for those who do not have built-in immunity taking preventative medications is a measure that will greatly reduce their risk of acquiring the deadly disease. Though malaria is curable, any delays in commencing treatment, even for a day, may lead to life-threatening complications, including coma and kidney failure. Stopping malaria before it progresses is the safer and more cost-effective course of action.

Pregnant women and their unborn children are at an especially high risk of malaria because pregnancy reduces immunity. Thirty million women living in endemic regions in Africa become pregnant every year with malarial infections accounting for about 200,000 newborn deaths. The onset of the disease can also cause spontaneous abortion, stillbirth, low birth weight, premature birth, and intrauterine growth retardation for the child, as well as illness and anemia for the mother. Taking preventative medications can save the life of both the mother and the child as well as reduce the chances of difficulties at birth.[55]

Numerous preventative measures for malaria are already on the market; British travelers who visit Africa are encouraged to take one of three recommended drugs: *Mefloquine, Doxycycline*, or a combination of *Atovaquone* and *Proguanil* called *Malarone*. In the past, *Chloroquine* has been the American drug of choice for protection from malaria. With emerging resistance, however, it is now only designated for use in areas where 3 of the 4 malarial types, *Plasmodium vivax*, *P. oval*, and *P. malariae,* are prevalent. For travelers headed to areas where the increasingly drug-resistant *falciparum*

[55] World Health Organization, "Lives At Risk: Malaria in Pregnancy" [online]: http://www.who.int/features/2003/04b/en/, February 2004.

malaria is known to occur, the present drug of choice is *Mefloquine*. *Mefloquine* has been approved by the FDA and is effective at preventing Falciparum Malaria. Other drugs include *Proguanil* (available only in Africa), *Fansidar* – a combination of *pyrimeth* and *sulfadoxine* and *Malarone*.[56]

Strengths

In 1996, the Division of Parasitic Diseases, the National Center for Infectious Diseases, the Centers for Disease Control and Prevention, Atlanta, Georgia, USA published a study on "The effect of malaria and malaria prevention in pregnancy on offspring birth weight, prematurity, and intrauterine growth retardation in rural Malawi." According to this study, effective prevention of malaria in pregnant women in malaria-endemic settings may reduce the likelihood of low birth weight (LBW) by 5-14%, and may reduce the amount of preventable LBW by more than 30%. When evaluating antenatal care programs, public health policy makers must consider providing an effective preventative drug (either *Mefloquine* or other drugs identified in additional studies, e.g., *sulfa-pyrimethamine* compounds) as a means to prevent low birth weight and its consequences.[57] According to the World Health Organization, "Intermittent treatment with an antimalarial drug is a cost-effective means of preventing malaria in pregnancy. The current recommendation is to give at least two doses of a safe and effective antimalarial (currently, *sulphadoxine-pyrimethamine*) to all pregnant women living in these areas."[58] The report continues, "In areas of low or unstable malaria transmission, pregnant women have low immunity to malaria and a two- to threefold higher risk of severe malarial illness than non-pregnant women. In these areas, use of ITNs and prompt case management of pregnant women with fever and malarial illness are the main strategies for malaria prevention and treatment."[59]

A 1999 study by the London School of Hygiene and Tropical Medicine entitled "Intermittent *Sulphadoxine-pyrimethamine* to Prevent Severe Anemia Secondary to Malaria in Pregnancy: a Randomized Placebo-Controlled Trial" looked at the effects of intermittent treatment of *sulphadoxine-pyrimethamine* in preventing malaria in pregnant women of the Kilifi District of Kenya. The study found that 5.3% of those receiving *sulphadoxine-pyrimethamine* treatment had peripheral parasitaemia, while 35.3% of the women who were given a placebo had the same condition. Similarly, 14.5% of the first group had severe anemia, compared to 23.7% of the placebo group. The study

[56] Malaria Prevention, [online] http://health.allrefer.com/health/malaria-prevention.html, February 2004.
[57] National Center for Biotechnology Information, "The effect of Malaria and Malaria prevention in pregnancy on offspring birth weight, prematurity, and intrauterine growth retardation in rural Malawi", [online]: http://www.ncbi.nlm.nih.gov, February 2004.
[58] World Health Organization, "Lives at Risk," February 2004.
[59] Ibid.

interpreted these findings as being indicative that treatment by *sulphadoxine-pyrimethamine* was an "effective, practicable strategy to decrease the risk of severe anemia.[60]

Intermittent preventative treatment is a relatively cost-effective approach to fighting malaria, and it is also one that has been widely accepted in endemic regions. The Malawi study found that nearly 75% of all women took advantage of preventative treatment when it was offered. Other preventative drugs have had mixed results and some tend to have side effects that could be harmful to both the mother and the child during pregnancy. *Mefloquine*, for example, is considered dangerous to women in their first three months of pregnancy, and it is often advised that women should use contraceptives for about three months after taking the drug. On the whole, a program emphasizing preventative drugs would be effective in the sense that the people and government of Kenya are already accustomed to that approach. Kenya has a healthy pharmaceutical industry, and preventative drugs are socially and politically feasible.

Weaknesses

There would, however, be at least two drawbacks. First, many areas of the country, including where malaria is most prevalent, severely lack the needed infrastructure, as doctors, medical facilities, and even the means to transport the drugs are in short supply. Drugs may not reach the most needy individuals, and total eradication would be exceedingly difficult. Additionally, in some cases there has been an emerging resistance to certain preventative drugs, as with *chloroquine*. Any long-term plan focusing on preventative treatment will require that trends towards resistance be monitored and the development and distribution of newer, more powerful drugs could carry additional costs. An additional weakness is medium and long side-effects that accompany the use of malarial drugs.

Option 2: Malaria Vaccines, Cautious Optimism

Malaria has four species, with two species -*Plasmodium vivax* and *Plasmodium falciparum*- accounting for nearly all clinical cases and deaths.[61] Scientists have concentrated on developing a vaccine for these forms of malaria for over 50 years but have been largely unsuccessful. Recent innovations in genetic mapping of the malaria protozoa and new understanding about the development of its proteins have given new hope for finding a successful vaccine. Studies have also shown that injections of irradiated *sporozoites*, which mosquitoes carry and inject into the blood stream, protect or partially protect

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[60] Shulman, C.E. and others, "Intermittent Sulphadoxine-Pyrimethamine to Prevent Severe Anaemia Secondary to Malaria in Pregnancy: A Randomised Placebo-Controlled Trial," *Lancet,* 1999 Feb 20; 353(9153): 632-6. [online, PubMed]: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?holding=npg&cmd=Retrieve&db=PubMed&list_uids=10030329&dopt=Abstract, February 2004.

[61] Thomas L. Richie, Allan Saul, "Progress and Challenges for Malaria Vaccines," *Nature* Vol. 415, February 7, 2002. [online]: http://rbm.who.int/cmc_upload/0/000/015/332/415694a_r.pdf, February 2004.

rodents, monkeys, and humans.[62] Early stages of success in vaccine trials, including a vaccine developed for children are also promising. Additionally, natural immunities found in some native groups in endemic regions have brought renewed hope.

Significant hurdles to vaccine development still exist. While small successes have been seen, malaria is a very complicated infectious disease. A protozoa, it produces different antigens at different stages of development, making it difficult for scientists to develop a vaccine that must target multiple antigens. As opposed to most infectious diseases, in which vaccines can target the same antigen throughout the life of the infection, malaria may in fact require a series of vaccines aimed at different malarial stages and at different antigens. Each new wave of development of the parasite produces a new variant surface antigen, making a vaccine that focuses on the preceding forms ineffective.[63] A vaccine designer must choose from 5,000 to 6,000 malaria proteins in picking one or two to target.

Because of the complexity of the malaria protozoa, vaccines are currently being targeted at the different stages of development. The first proposal, known as the pre-erythrocytic, aims to prevent the malaria from infecting the blood, thereby precluding infection entirely. Another form, known as blood stage vaccines, aims at limiting the ability of the infection to spread within an individual once the individual has been infected. Intended to reduce the replication and spread of toxic cells, this vaccine would be useful for treating infected individuals. A third type of vaccine in development would prevent the spread of the disease in mosquitoes, thus reducing mosquito transmission and therefore the spread of infection.

The Malaria Vaccine Initiative (MVI), a non-profit, non-governmental organization is sponsoring a number of other private-private and public-private partnerships in vaccine development.[64] The U.S. Army's Walter Reed Army Institute for Research, known for successful development of vaccines, is currently working with the Malaria Vaccine Initiative, the U.S. Army Medical Research Unit-Kenya, the Kenya Medical Research Institute and the U.S. Agency for International Development on a promising malaria vaccine. Though in the earliest stages of clinical testing, the vaccine has provided high levels of protection against the infection and is using an adjuvant or agent developed by GlaxoSmithKline, the world's second largest and most involved pharmaceutical company. If the doses are administered successfully in the remaining two vaccine trials, larger trials involving children will follow, and then the vaccine will be ready to treat malaria in East Africa and Kenya's most vulnerable

[62] Ibid.
[63] Ibid., Proteins produced exhibit polymorphism, "which potentially limits the effectiveness of vaccines not incorporating distinct variants of the protein."
[64] Malaria Vaccine Initiative, "MVI Development Vaccine Projects" [online]: http://www.malariavaccine.org/ab-current_projects.htm, February 2004.

population, children under 5 years of age. Oxford University is also testing three vaccines in a similar manner, including applying vaccines developed for other diseases that may help "boost" the immune system.

Strengths

Vaccines for other diseases, including yellow fever and hepatitis B, are currently in use in Kenya and in Eastern Africa. With no inherent concerns over vaccine usage, cultural practices embrace using vaccines. Vaccines produce no toxins, or in any other way, adversely harm the environment. Its environmental feasibility, therefore, should be unquestioned. Environmental groups, including international NGOs with strong environmental concerns will not object to the use of vaccines to treat malaria as they may with the use of DDT or other pesticides. The UN and its agency the WHO, as well as international NGOs including the Malaria Vaccine Initiative and foreign governments have already begun putting significant resources into developing a vaccine. Many multi-lateral efforts involving these actors, and companies such as GlaxoSmithKline, and universities around the world, are in the midst of a number of projects aimed at different population groups and different stages of malaria protozoan development. While a vaccine may be far off into the future, its potential is significant and could lead to the eradication of the disease.

Weaknesses

The hurdles for vaccine development remain, however. It will be at least another 10-15 years before a successful, comprehensive vaccine can be developed. Additionally, early successes may not be indicative of later successes. Not only is this the case with all medical studies, but often with vaccines and especially with malaria. At best, in some circumstances and in some limited testing, vaccines have been successful. The likelihood is that successful vaccines will be developed that can only temporarily immunize, requiring annual or frequent re-administrations, or that may be successful in combating malaria at certain stages of development. If scientists overcome these hurdles and develop a successful vaccine, the impact could be enormous, with the potentiality to eliminate malarial infections.

The Kenyan government has already begun working with the international community, including the United States Army in developing a vaccine. It will be unlikely, however, to pay development costs. While long-term costs would be made up with an effective vaccine that prevents infection and consequently lowers costs of control and treatment programs implemented by the government, developing a malaria vaccine is not cost-effective in the short-term. Kenya already has a significant pharmaceutical industry and the Parliament has in the past, in dealing with other diseases, given significant funding for developing drugs. They will likely focus their limited resources on other treatment and prevention mechanisms with the potential for greater success.

While private funding continues to fuel malaria research, lesser developed countries, including Kenya, should focus their scarce resources on other approaches to controlling and eradicating the disease. While scientists remain optimistic, the complexity of malaria makes a successful vaccine a long-term proposal. Within that time period, many lives will be lost. Continued private funding will allow governments in East Africa and Kenya to focus resources elsewhere, immediately and directly fighting malaria.

Option 3: Insecticide Treated Nets as Effective Prevention Tools

Mosquito netting has been used for a long time in prevention and protection against malaria in tropical regions. Mosquito nets are designed for use on cots, bedrolls, hammocks, steel beds, and shelter half tents.[65] Most malaria-carrying mosquitoes bite at night. Thus, the netting prevents the mosquito from biting people as they sleep at night when they are most vulnerable.

The use of mosquito netting has been made more effective by treating the nets with insecticides that repel mosquitoes, kill them, or shorten their life span. The nets are treated with insecticides from the group of chemicals known as pyrethroid, which have no harmful effect on humans. Insecticide-treated mosquito nets (ITNs) were initially used after the introduction of synthetic insecticides during World War II.[66] The American navy experimented with the use of DDT treated ITNs. (Takken, citing Harper et al. 1947). However, this experimentation led to the global adoption of spraying synthetic insecticides indoors as a malaria control measure rather than the use of ITNs. This was perhaps due to insecticide resistance and environmental concerns surrounding the use of insecticides - especially the use of DDT. It was not until the 1970s, with the development of synthetic pyrethriods that "a new class of highly potent insecticide with relatively low toxicity for vertebrates and significantly fewer environmental effects compared with other classes of insecticides" renewed interest in the use of ITNs for malaria control.[67]

Bed nets treated with insecticides were re-introduced in the late 1980s, in response to a pending crisis in the lack of adequate intervention methods. They were to protect the user from being bitten by malaria-infectious mosquitoes, and hence contribute to a reduction of transmission risk.[68] It was reported that untreated nets did not provide adequate protection, presumably because the mosquitoes could bite the occupants through the netting or through tears in the net because of excessive use. This gave

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[65] Virtual Naval Hospital "Malaria Prevention and Control" [online]: http://www.vnh.org/Malaria/ch2.html#2, February 2004.
[66] Takken, Willem. "Do insecticide-treated mosquito nets have an effect on malaria vectors?" *Tropical Medicine and International Health*, Vol. 7 No. 12 pp.1022-1030 December 2002.
[67] Ibid.
[68] Ibid

mosquitoes easy access to a blood host.[69] The trial use of treated mosquito netting in the 1980s and 1990s reduced Malaria deaths in young children by 20%.[70] One major drawback of the treated netting is that it requires frequent re-treatment. It has been estimated in some areas that less than 5% of mosquito nets being used maintain enough insecticide to achieve the desired impact.[71] Also, insecticide-treated mosquito nets are expensive for poor families.

There is an urgent need to make ITNs more accessible to the poor populations of both rural and urban Kenya – especially in light of the fact that women and children are more susceptible to malaria transmission in these areas. Use and ownership of mosquito nets varies from urban to rural areas in Kenya. Use of mosquito nets is higher in urban than in rural areas, and only 21 percent of the households surveyed, in the Demographic and Health Survey (KDHS) of 2003, reported owning a mosquito net, while only 6 percent reported having an insecticide – treated net (ITN).[72] This may be accomplished through increased education in the area of effective ITN use and maintenance of cheaper and longer lasting treated nets. A new type of insecticide treated mosquito net has been developed known as long-lasting insecticidal nets (LLINs). These nets are pre-treated and have a life span of up to 4-5 years without requiring re-treatment.[73] They have been developed in response to the low rates of re-treatment of conventional ITNs. LLINs are relatively new in the market, though, and not quite accessible to the average person in Africa.[74] While this is the case, the WHO and the Roll Back Malaria Program are looking into how to make ITNs more accessible to poor populations and are now working to make LLINs available and at a lower cost. Clive Shiff, of the Johns Hopkins School of Public Health, believes that the low- tech and community-based nature of ITN use is the direction one must go in malaria prevention.[75]

Strengths

Insecticide treated mosquito nets are relatively inexpensive compared to other forms of prevention. The netting costs $5 and the cost of insecticide per treatment is $0.50. Treatment is required about twice a year, bringing the cost of ITNs to $6 for the first year with an additional cost of $1 every year afterwards. Though this is not within the reach of most people in sub-Saharan Africa, it is a cheaper means of prevention than prophylaxis drugs. Insecticide treated mosquito nets are a durable solution in

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[69] Ibid.
[70] World Health Organization [online]:http://www.who.int/inf-fs/en/InfomationSheet05, February 2004.
[71] Ibid
[72] "Kenyan Demographic and Health Survey," February 2004.
[73] South Africa Department of Health, "Long Lasting Insecticidal Treated Nets: Are They Available?" [online]: http://www.doh.gov.za/issues/malaria/red_reference/vector_control/vc7.pdf, February 2004.
[74] Ibid.
[75] All Mosquito Netting Info, "Mosquito Netting Project in Tanzania" [online]: http://www.mosquito-netting.com/netting-exp.html, February 2004.

respect to the prevention of malaria. If they are habitually used, they reduce exposure to mosquito bites, and thus infection. Also, ITN use can be introduced in a relatively short amount of time. ITNs would be politically and environmentally feasible since they have no adverse impact on the environment and offer no point of political contention. The use of ITNs will be favorable to all stakeholders involved since it is an effective and inexpensive way to prevent malaria infection. Hence, even with its shortfalls, ITNs are a good tool for preventing the transmission and spread of Malaria and will be important in this fight.

Weaknesses

The impact of ITNs will be insignificant unless individuals make it a habit to use the nets properly. Extensive education will be required in order to convince people to adopt the practice of correct usage. On the whole, ITNs may prove to be quite inefficient in the face of cultural traditions and practices. ITN usage may not readily catch on, as its use may be completely foreign to the practices and traditions of the people of Kenya.

Though ITNs may not be very efficient in saving lives, the reality is that it is a means of preventing mosquito bites. Therefore, it reduces the rate of malaria transmission and will continue to play a substantial role in reducing the potential number of malaria deaths, as long as it is used correctly and regularly.

Option 4: Public Health Education on Malaria Risks and Options

We recognize that public health education will be critical to any successful program; however, it is also important to analyze public health as an isolated option.

In Kenya, it is estimated that there are 8.2 million cases of malaria per year, the most common cause for admission to a hospital.[76] One of the greatest challenges that the Ministry of Health, and indeed the entire Kenyan government is facing, is how to reach those at risk for malaria and educate them about ways to reduce their malarial risk. The Ministry of Health, headed by Minister Charity Ngilu, is charged with, among other responsibilities, preventative health services, public health services, and health education programs. Although there are health education programs that are already in place in Kenya, there is a need for a nationally coordinated malaria education plan.

The KMED Program:

In response to the need for public health education programming for malaria, President Kibaki ought to charge the Ministry of Health with implementation of the Kenyan Malaria Education Program (KMED). Essentially KMED program content should focus upon three points: publicizing the

[76] Médecins Sans Frontières [online]: www.msf.org, March 2004.

symptoms and risk factors of malaria, encouraging people to seek out preventative measures, and identifying places to go for medical assistance and programs for financial assistance for medical services. These messages will acknowledge that malaria transmission is a national problem and inform those most at risk about their options including where to go for help.

KMED will include a national media campaign and local information-sharing sessions to educate the public about lowering their malaria risk. There are several media outlets available in Kenya, including: several radio stations, 8 television channels, and at least 4 newspapers. As a nationally coordinated plan, KMED can direct its education and information messages via print, through the radio and on television. Kenyan literacy rates are 90.6% for men and 79.7% for women[77], indicating that a print campaign could be effective in reaching adults. The media avenues that are open to the KMED plan are important opportunities for mass exposure to information, yet it is also important to employ less traditional means of conveying information so as to reach a greater number of people. In particular those most at risk must be informed in an effective way.

As a component of the KMED plan, civil society organizations such as churches, schools and other forms of civic association should be involved in information sharing. In conjunction with religious and educational institutions, officials or employees from the Ministry of Health could spend ten minutes with local congregations and classrooms across the country to explain ways to reduce malarial risk. These information-sharing sessions would be less formal than the media campaign, and offer individuals an opportunity to ask malaria-related questions of knowledgeable people. Moreover, such sessions might offer greater exposure to malaria education on a more personal basis. Any educational approach taken should be informed by the large amount of existing literature on social marketing.

Strengths

The initial capital investment into the KMED plan will be the most expensive part of the public health education option. As there are already existing structures within the Ministry of Health, such as the Kenyan Malaria Information Service (KMIS) and the National Malaria Strategy (KNMS), this initial expense will be somewhat offset. The initial investment would include media buying for air and print space in available forums, wages for information-sharing officers, as well as transportation and administrative costs. The maintenance costs for this option will require continuous media purchases to keep the message available to the public, however the training costs will recede over time.

As public health education plans are excellent avenues for expressing the policy of the government and for connecting the people with services and information, the program is highly feasible. A concern in

[77] CIA World Fact Book, March 2004.

creating a program is that it ought to be culturally sensitive to the target population. In the case of the KMED plan, this remains feasible as the specific program content can be crafted with cultural sensibilities in mind. Moreover political feasibility would not be an issue, as this program would be affiliated with the Ministry of Health and part of the Kenyan Malaria Information Service, both of which are responsible agencies of the Kenyan government. In terms of environmental feasibility, the education program would be highly feasible, as it has neither a negative nor a positive impact upon the environment.

Since there is a certain degree of flexibility in program content, as well as direct involvement of government agencies, many of the stakeholders have integral roles in the expression and implementation of the KMED plan, thereby meeting many of the stakeholder's interests. Program content will be specifically directed towards the target population of pregnant women and children that serves the interests of both the target and general populations as a whole. The government of Kenya, the international community, NGOs and neighboring states would all benefit from a public health education plan as this would better connect citizens with services and information pertinent to the reduction of malarial risk.

Weaknesses

Public health education campaigns are, by nature, not particularly speedy. Such campaigns take time to start up and even more time to become accepted into daily behaviors. Despite this drawback, the potential for impact and durability are relatively high. Once the media buys have become established, and the information-sharing avenues are implemented, the impact of the program could be widely felt throughout Kenya. Moreover, such a program has the capacity to be durable as it can be readapted to fit the evolving needs of the Kenyan people.

It is likely that KMED will save lives, although the implementation of the plan will mean that this will not be seen quickly. The degree to which the plan will translate into saved lives will depend upon how effective the program content and information-sharing activities are at altering public attitudes and behaviors.

Option 5: Eradication through Insecticides

Several types of insecticides exist that can be used to eradicate malaria carrying mosquitoes, including "knock-down" insecticides which are effective for a few days as well as "residual" insecticides which are effective for months.[78] However, of all insecticides, *Dichlorodiphenyltrichloroethane*, also known

[78] Teklehaimanot, A. & Herath, P.R.J., "The Mosquito: Public Enemy No. 1," *World Health*; Sep/Oct91, Vol. 44, Issue 5, p. 21[Academic Search Elite].

as *dicophane* or DDT, remains "the pesticide that's the cheapest, most efficient means of killing the mosquitoes that spread the disease" malaria.[79] For this reason the option of insecticide usage will focus on DDT.

DDT is a synthetic insecticide belonging to the family of organic halogens. In 1939, its toxicity in a wide variety of disease-carrying insects was discovered by Paul Hermann Müller and was used effectively to combat these diseases by eradicating the insects that carried them.[80] One disease vector in which DDT proved extremely effective was in battling malaria. Most of the Western world was able to eliminate any serious malaria threat through widespread DDT spraying in areas infested with malaria-infected mosquitoes. During the 1960s, fear of the environmental side effects of DDT led to a reduction of its use and tighter government control in many areas. However, as will be discussed shortly, many of the studies that built up this fear have recently been called into question either because of their methods or because subsequent studies have disproved their conclusions.

The Facts about DDT

We understand that DDT has a negative perception, due to past research which has come under recent criticism, as well as continuing concerns from recent research. The research that will now be presented will show the challenges to this perception of DDT. The debate over the use of DDT to eradicate malaria was specifically expressed by two of Kenya's leading research organizations, the Kenya Medical Research Institute (KEMRI) and the International Centre of Insect Physiology and Ecology (ICIPE), both based in Nairobi. Researchers from ICIPE along with other environmental experts argue that the health and environmental risks of reintroducing DDT are considerable, and that the East African region as a whole would suffer if the ban were lifted. But researchers from KEMRI, led by director Davy Koech, argue that the pesticide is needed to combat malaria, which kills 700 Kenyans a day.[81] "Anything that can reduce malaria deaths by 80 per cent should be given another thought," says Koech. The disease, which is transmitted by mosquitoes, currently accounts for up to half of all hospital admissions in Kenya. KEMRI researcher John Githure argues that Kenya's decision to ban DDT in 1990 was taken hurriedly and without adequate data.[82]

The assertions made against DDT have recently been proven false. At the time that the studies were released, the Assistant Attorney General, who would also become future director of the Environmental Protection Agency, William Ruckelshaus, stated that the studies were flawed. As Aaron Wildavsky

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[79] Doherty, Brian. "Mosquito Holocaust." *Reason*, Vol. 33 Issue 5 (Oct. 2001): 15. [Academic Search Elite]
[80] "DDT." *Encyclopedia Britannica Ready Reference*, 2003.
[81] Neondo, Henry, "DDT Row Splits Kenya's Scientific Community," *Science in Africa*, http://www.scienceinafrica.co.za/2003/september/ddt.htm, February 2004.
[82] Ibid

notes, "Ruckelshaus rejected all of the studies on humans, asserting that their sample sizes were too small, their duration was too short, and no completely unexposed human control group existed, given DDT's ubiquitousness. These are all valid points; the experiments were not ideal."[83]

After these studies condemned DDT, a stigma followed its usage. One explanation for the negative stigma towards DDT was the use of chemicals phased in to replace it after the flawed studies denounced it. The chemicals that replaced DDT, parathion and malathion, are much more dangerous, as they become lethal to humans at 1 gram and are easily absorbed into the skin.[84] Furthermore, in explaining the harm to the environment, parathion and malathion are stored in fat cells, or lipids, which cannot be broken down by water. Fish and other wildlife can then digest the contaminated lipids. Parathion and malathion replaced DDT in the early 1970s, and "1972 estimates of the number of deaths jumped to 118 for the first half of the year alone . . ."[85] Since DDT had only recently been phased out, public perception pointed to DDT as the cause of the damage to the environment even though the new chemicals that replaced DDT had actually caused the harm. Moreover, according to researcher Robert S. Desowitz, "it was the intemperate use [of DDT] by agriculturalists that caused the insecticides to spill over into the environment."[86]

In practical terms, DDT reduces the prevalence rate of Malaria, and "in the late 1990s, DDT-spraying Swaziland had a Malaria-infection rate of only 2%-4% a year. At the same time, South Africa, which had banned DDT, saw infection rates soar to 40% until DDT spraying was resumed."[87] Author Rachel Carson, one of the major critics of DDT in the 1960s, wrote *Silent Spring*, in which she made the accusation that use of the chemical caused soft-shells in birds and was carcinogenic. In contrast:

> Others say, however, that DDT need not be banned at all. Twelve scientific studies, including one where primates were given 33,000 times the average human daily exposure to DDT, found no direct link to cancer. And, contrary to the study cited in *Silent Spring*, 15 studies (including one published by the Canadian Wildlife Service) found no correlation between pesticides and eggshell thinning.[88]

Despite the evidence that proves the low toxicity of DDT, it will be challenging to present these facts to the public and to change the common myth that DDT is harmful. The public education program must show the facts and the myths about DDT use, so that the public will be comfortable with a Malaria

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[83] Wildavsky, Aaron. *But Is It True?; A Citizens' Guide To Environmental Health And Safety Issues*. Harvard University Press: Cambridge.1995. p.61
[84] Ibid, p. 73
[85] Ibid, p. 73
[86] Desowitz, Robert S. *The Malaria Capers: More Tales Of Parasites and People, Research and Reality*. W.W. Norton and Company: New York.1991. p. 214.
[87] Hiebert, Rick. "Technological Genocide". *Report Newsmagazine*. (Alberta Edition). Vol.29, Issue 15. July 22, 2002. p.60.
[88] Ibid

eradication program that employs DDT for household and outdoor spraying. DDT can cause harm, however this harm is minimal in consideration of the amount of lives that can be saved.

Strengths

The greatest strength of DDT is its ability to eliminate malaria infected mosquitoes and thereby halt the spread of the disease. In the ten years following the discovery of DDT "its widespread use reduced the number of malaria cases worldwide from 75 million annually to five million. In fact, the chemical has been so successful in killing malaria carrying mosquitoes that scientists estimate it has saved 500 million lives."[89] It is clear, that DDT would effectively reduce the number of deaths from malaria within a short timeframe.

Another strength is that DDT is the most cost-effective means of controlling the spread of malaria. Using the following formula, a cost-benefit analysis of DDT can be carried which factors in an Ecological Risk-Benefit Analysis of DDT:

$$\Delta B = [\text{The population in this area}] \times US\$0.26$$

The population of Kenya is 31,639,091. Placing this value into the formula it is determined that ΔB = $8,226,163.60. This means that the benefit of using DDT spraying, factoring in the Ecological Risk-Benefit Analysis, is $8,226,163.60 compared to the next best alternative, in this case pyrethroid-impregnated bed nets.[90]

A further strength of DDT is that it can be implemented on a large-scale at a relatively low cost. As such, DDT would reduce the number of malaria-infected mosquitoes at a relatively fast rate, thereby reducing the number of new cases across the board. History has shown that DDT is not only an expedited means of addressing malaria but also meaningful in terms of its impact on the issue of malaria eradication through the use of control mechanisms.

Additionally, DDT is a feasible solution to the problem of malaria eradication due to its cost-effectiveness and efficiency, both of which make it politically feasible. Because it does not interfere with social and cultural constructs, it is socially and culturally feasible. In fact DDT has even become environmentally feasible despite increasing environmentalist criticism. As Arthur Robinson of the Oregon Institute of Science and Medicine explains, "The campaign against DDT is fuelled by "junk science" and little else…. There are other alternatives [to DDT], but they are not as effective, and many

[89] Heibert, "Technological Genocide" p.60.
[90] Ecological Risk-Benefit Analysis of DDT Regulation study done by: Crest, Japan Science and Technology Corporation, Department of Systems Engineering, Shizuoka University, Department of Biology, Faculty of Sciences, Fukui Prefectural University, Institute of Environmental Science and Technology.

of these countries can't afford it." He argues, "It simply does not make sense to ban DDT without replacement pesticides being readily available, especially when malaria does more damage than anything proven to be caused by the pesticide."[91] It is this opinion that has won over the international community, including the UN, who decided in 2001 not to ban the use of DDT for use in malaria related spraying.[92] Additionally, DDT use satisfies the interests of the stakeholders. Because of its cost-effectiveness, efficiency, feasibility, and ability to save lives, DDT will satisfy the interests of the government of Kenya as well as the general population. The international community as well as most NGOs and civil society have recently demonstrated their support for renewing the use of DDT to eradicate disease-carrying mosquitoes. Finally, if an effective DDT spraying plan is implemented in Kenya, (with subsequent surveillance, treatment, and re-spraying) neighboring states will be able to implement the same plan, allowing them to eliminate and eradicate malaria in the near future.

Weaknesses

DDT faces two weaknesses in durability: (1) mosquito can develop resistance to insecticides; and (2) there is no monitoring system to prevent re-infestation. The first issue would be difficult to mitigate in the case of Kenya because even if widespread spraying is successful in eradicating infected mosquitoes from these countries, re-infestation of chemical resistant mosquitoes from neighboring states could occur. The only way to address this issue is to focus on strengthening and morphing DDT, so that it remains a step ahead of resistant mosquitoes. The second issue is the lack of an effective monitoring system for areas deemed free of Malaria transmission. As J.A. Najera-Morrondo of the World Health Organization (WHO) explains, "Evidence began to accumulate that, although it was possible to reduce and even interrupt transmission by insecticide spraying over large areas, it was very difficult, if not impossible, to maintain efficient surveillance in the absence of a solid health infrastructure."93 In order to mitigate this issue, "close surveillance, designed according to the local situation, and preparedness for intervention with drugs for treatment and - if possible - insecticides for vector control are needed."94 This means that once an area is rid of Malaria infected mosquitoes, the region, and the various stakeholders involved, especially doctors, must remain vigilant. In this way, if a reemergence of Malaria were to occur, any persons infected by this disease could be treated with available medication and a re-spraying of the area could commence quickly. It is this surveillance component that has

[91] Hiebert, "Technological Genocide" p.60.
[92] Doherty, "Mosquito Holocaust." p. 15.
[93] Najera-Morrondo, J.A., "Malaria control: History shows it's possible." *World Health*. Vol. 44 Issue 5 (Sep/Oct 1991): p. 4. [Academic Search Elite]
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[94] Trigg, Peter. "Different strategies for different situations." *World Health*. Vol. 44 Issue 5 (Sep/Oct 1991): p. 10. [Academic Search Elite]

prevented DDT from successfully eradicating malaria on a worldwide basis in the past.95 An additional weakness is the difficulties that the negative perceptions of DDT will present in acquiring funding from international sources.

B. Particulars of The Policy:

After weighing the possible solutions to the endemic malaria problem in Kenya against the presented criteria, it seems that the optimum solution would be malarial eradication. To achieve this solution, malaria-carrying mosquitoes will be sprayed with DDT as part of a long-term program including a surveillance system to guard against re-infestation. In the short-term, it is recommended that mosquito nets be distributed, as it is an effective and low-cost option to reduce transmission. Both the long-term DDT program and the distribution of mosquito nets will be implemented alongside public health educational programs to assist in prevention of malaria and in informing the public.

Choosing Options That Will Work

As it is shown in the Dyna-Rank (see Appendix A), the DDT option ranks the highest in terms of cost-effectiveness, efficiency, feasibility, stakeholders interests, and in saving lives with the exception of only one subcategory – environmental feasibility.

Moreover, low initial capital and maintenance costs make DDT a realistic and effective measure as opposed to the financial commitment that the vaccination option would require. According to Marjorie Hecht, DDT can be spread twice a year in a household with a cost of $1.44.[96] Clearly, the government of Kenya, as one of the stakeholders, must come on board to provide availability of DDT and similar chemicals to households, as well as to execute federal eradication programs in high malarial zones (wetlands, lakes, rivers and so on).

DDT Surveillance, ITNs, and Public Health Education

Recommended surveillance is an essential component of DDT use. Government legislation should provide additional regulatory powers to control the transportation, storage, disposal and use of pest control products, taking into account regional conditions and concerns. Municipalities should control aspects of pesticide use and disposal. An epidemiological surveillance center should be created which would be responsible for overseeing DDT use in Kenya and reacting to any re-infestation of mosquitoes. A surveillance system must be structured in a way that ensures coordinated monitoring and control of all measures to fight malaria and other communicative diseases in the near future. The

[95] A more in-depth analysis of DDT as it relates to our specific Criteria can be found in Appendix 1.
[96] Hecht, Marjorie Mazel. "Bring Back DDT, and Science With It!" *21st Century Science and Technology*, Summer 2002.

surveillance center should work closely with NGOs and other bodies who are in the business of malaria eradication, prevention, and treatment by creating an extensive database of registered institutions and their ongoing projects, including efforts to prevent the misuse of DDT and other pesticides. The center should also monitor and control epicenters of malaria in East Africa and share information and expertise gained through experience with other nations and international organizations.

The Kenyan population has used insecticide treated nets for some time. However, our proposal is to make their use a part of the daily routine in the lives of at-risk individuals. The public must be educated on the effectiveness of using nets, including the ways to protect themselves from mosquito bites using the nets. For example, proper usage of mosquito nets means that they need to be retreated with chemicals on a regular basis and again after they have been washed.

A public health education program is another important measure in the fight against malaria. Educational outlets such as grade schools, universities, libraries, media, books, journals, and pamphlets must be employed to educate the general public about malaria's risks, means of transmission, and how it can be prevented and treated. Additionally, information-sharing officers, trained by the Ministry of Health, will seek out churches and other communal bodies to help educate the public about the benefits of DDT and the positive impact of mosquito nets.

III. Implementation and Conclusion

Implementation of any proposal will require a number of factors and obstacles to be taken into consideration. Ensuring that stakeholders are engaged and involved in the process is crucial to success. Ensuring that the relevant funding and political mechanisms are in place is also crucial, especially when proposing a course of action through the government. Furthermore, with any proposed recommendation a course of action must be established that will inevitably end in some unintended consequences. With the proposal of DDT spraying, the distribution of nets, and a public education campaign the following aspects of implementation are crucial for success.

How to Engage Stakeholders through Implementation

There are three major groups of stakeholders: the target population, the general population of Kenya with a primary focus on pregnant women and children, the government of Kenya, and other stakeholders (international community, NGOs, neighboring states) that will play crucial roles in the implementation of the proposed recommendation to the malaria problem.

Efficient use of DDT, insecticide treated nets and public health education will depend upon public involvement to ensure the success of the proposed measures. As the target population is pregnant women and children, it is recommended that this group, as they are most vulnerable to malaria, must be protected. While DDT chemical treatment of affected areas is the most effective measure in the long run, the target population as well as general population must be educated on the use of this chemical inside households, the potential hazards and side effects, and the importance of DDT in the eradication of malaria. In the short-term, the public must be encouraged to use mosquito nets as a preventative measure. Public health education programs are intertwined with other measures, as Kenya residents need to be well-informed, not only about malaria and how it can be spread, but also on proposed measures for eradicating and preventing this disease.

The Kenyan government is another key player in the process of implementation of the proposed program. The first measure that must be executed by the government is to lift the ban on DDT in Kenya. This will require government involvement with other key players such as the general public (their constituents), neighboring states, environmental organizations, NGOs and international bodies. The government role requires not only the legalization of DDT, but also ensuring its availability to the public through distribution schemes and monitoring the eradication process in both urban and rural areas.

The biggest obstacle will be acquiring the support of environmental groups and NGOs in the use of DDT as it has a negative public perception. Research suggests that it is the most cost-effective and efficient way to fight the disease in the region. Although, the environment should be an appropriate concern, saving the lives of many people must be paramount. Careful implementation and monitored use of DDT combined with mosquito nets and strong educational programs can provide the desired outcome with the support of the international community, NGOs, and other stakeholders.

Paying for the Program

To effectively implement our recommendation of the Kenyan government pursuing a program that includes DDT, insecticide treated nets and a public health education plan, funding must be discussed. Funding sources must be examined as well as how this funding will be allocated between the three components of the program.

Funding Sources

There are essentially two primary sources of funds for the Ministry of Health: (1) Kenyan government; and (2) foreign aid. The domestic funds will come from traditional funding mechanisms such as existing taxes and other forms of government revenue. The external aid can come from a range of sources including bilateral and international institutions, foreign governments, NGOs and other forms of civil society.

Prospects for a Domestically Funded Initiative: According to the World Health Organization, the total health expenditure in Kenya as a percentage of GDP is 8.3%.[97] Those funds are generally allocated into the Ministry of Health, which is charged with implementation of government health policy and health initiatives. As mentioned earlier, this includes the Kenyan Malaria Information Service as well as the National Malaria Strategy and many other programs. The recommendation that the Kenyan government undertake a malaria program including DDT, insecticide mosquito nets, and the public health education program will all fall under the jurisdiction of the Ministry of Health. The funding for this recommendation ought to be included in the next fiscal year budget as part of the budget for the Ministry of Health. This would mean that the funds would probably be taken from other health programs, as there is a scarcity of funds. The capacity might exist for some programs related to malaria treatment or prevention to be collapsed into the recommended plan. Of course this may also pose institutional problems related to reorganizing agencies within the Ministry of Health, but these issues can be addressed as part of organizing and addressing the interests of stakeholders.

[97] World Health Organization [online]: www3.who.int/whosis/country/indicators.cfm?country=ken&language=en, February 2004.

Foreign Aid. Kenya receives bilateral aid as well as multilateral aid, some of which is structured for specific programs and some of which is less structured. International sources of funding come from international organizations like the United Nations, the World Health Organization, and the International Monetary Fund. There are also initiatives and nongovernmental sources of funding such as the Roll Back Malaria Initiative, the Make Pregnancy Safer Initiative, the Global Fund, Doctors Without Borders, the International Committee of the Red Cross/Red Crescent Societies, and the Bill and Melissa Gates Foundation, among many others. These sources of funding offer further means of expanding or augmenting the three-pronged approach of the recommended plan.

Allocation of Funds

As the exact budget numbers may be difficult to project, it is proposed for clarity that the allocation of funds for our recommendation be dealt with as guidelines that the Kenyan government should commit to the plan from domestic and international sources.

The DDT component of the recommendation is a long-term program, requiring regular spraying and surveillance. The government of Kenya will cover the cost of spraying DDT in rural and highly endemic areas. The costs of spraying DDT around the country, especially in poorer, rural areas and areas highly endemic will require accounting for the costs of the substance, its transportation into Kenya, distribution, as well as labor, requiring a team to "transport, mix, and apply the insecticide."[98] Additionally equipment costs will account for transporting the material in trucks as well as compression sprayers, fan-jet nozzles or other instruments for spraying. There will additionally be costs of maintenance and repair, especially as DDT is used over the long-term. Costs for spraying across the country in endemic, particularly rural areas will, undoubtedly, come out to higher totals, as costs for personnel, transportation, and equipment must be factored in. Therefore, the Ministry of Health needs to spend the majority of the new funds on the DDT component. Once this priority has been met, then the Kenyan government ought to put resources towards the distribution, and in some cases subsidization of the insecticide treated nets. The ITN's are given a lesser priority than the spraying of DDT because it is a temporary measure that does not actually eradicate the malaria mosquito population, which is the aim of our proposal. To mitigate costs and provide more effective distribution of DDT or ITN's, the Ministry of Health should work with NGOs that have existing networks of operation in endemic rural areas. The Kenya Malaria Education plan (KMED) will be the primary vehicle of the government to convey information about DDT, ITNs, and about malarial symptoms and

[98] Walker, Kathleen, "Cost Comparison of DDT and Alternative Insecticides for Malaria Control," *Medical and Veterinary Entomology* (2000) 14, p. 345-354.

treatment options. Since public health education is, by nature, a long-term investment, it is recommended that the Kenyan government allocate funds to this end as the last priority.

Funding allocation clearly expresses the priorities of the recommendation. As DDT, the long-term component of the program, receives the largest allocation of funds to firmly establish DDT spraying as an effective program with substantial reduction of malarial risk. The other two components of the program, KMED and insecticide treated nets are also important components, but they are primarily supplements to the major focus of our DDT program. Mosquito nets are also currently available to the public and do not require as much government funding as a widespread DDT spraying campaign and on-going surveillance system. Since financial resources are limited, prioritization ought to be given to high-density areas where individuals do not possess the means to purchase nets or pay for household DDT spraying.

Actual Costs of Recommendation

Although it is recommended that the exact amount allocated be decided by the Kenyan Parliament, there is a minimum amount of money that should be allocated to make the program viable and effective in eradicating malaria. We recommend that the program focus on highly endemic areas, which tend to be in the western part of Kenya and are also largely rural. According to a 2001 estimate, 66% of the Kenyan population lives in rural areas, which are 20.4 million people. It is further stated that some 2.7 million Kenyans live in the 5 largest cities: Nairobi (1,810,000 1995 est.), Mombasa (465,000 1989 est.), Kisumu (185,100 1989 est.), Nakuru (150,000 1991 est.), and Eldoret (104,900 1989 est.).[99] The immediate urban population and the rural population is approximately 23.1 million Kenyans, which does not include semi-urban and semi-rural populations nor does it include refugees, out of an official population of 31 million. Since it is recommended that the government spray DDT primarily in rural areas, where people typically do not have the means to afford protections against malaria, and where malarial mosquitoes are most prevalent, it is necessary to calculate the approximate cost of spraying DDT in the rural areas of the country.

The cost of spraying DDT is $4.37/person/year; [100] the base from which we will multiply the rural Kenyan population to achieve the minimum number of dollars needed for allocation to successfully eradicate malaria in the most endemic areas of the country. If only the rural population is considered in this calculation, then the minimum that the Parliament must allocate for DDT spraying is $89.4 million.

[99] Encarta, "Kenya" [Online]: http://au.encarta.msn.com/text_761564507__6/kenya.html, February 2004.
[100] Ecological Risk-Benefit Analysis of DDT Regulation

This sum would be the equivalent of 10% of the Kenyan government's current total expenditures on health, according to the World Health Organization.[101]

In the case of Insecticide Treated Nets, if the government were to provide nets for the entire 20.4 million rural Kenyans, the cost would be $122.7 million, or 14% of the current total expenditures on health by the government. But since it is recommended that the major focus of malarial eradication should be DDT spraying, the provision of nets and distribution assistance should account for no more than 7% of the total health expenditures or $61.3 million. Therefore, in total, the spending level that the Parliament should allocate for DDT spraying and ITNs is $150.8 million, or 17% of the total health expenditures of the government. Clearly it is not realistic for the Kenyan government to allocate this percentage of their budget to malaria interdiction, and so outside funding will become important.

Where the National Rainbow Coalition Stands: Legislative/Executive Obstacles to DDT

NARC's environmental policies stand in strong contrast to those of KANU, which is alleged to have illegally sold state forests and issued illegal logging permits to those friendly with the regime.[102] Under Newton Kulundi, NARC's Minister of Environment, Natural Resources & Wildlife, and Assistant Minister Wangari Maathi, a former activist who former President Daniel Moi once decried as a "mad woman" for her pro-environment stance, have taken major steps towards conservationism. This includes a move to suspend the operations of a Canadian mining company that threatened to destroy thousands of acres of farms near the coastline.[103]

NARC's approach to public health is an ambitious one, with free, universal health care at the forefront of its plans. Though Kenya's struggling economy has led to a reduction in government revenues, this is expected to change with the government's normalization of relationships with IMF and the World Bank (which had been damaged during the previous regime) and the subsequent influx of donor funds. This is expected to bolster spending in the private sector and give a boost to the economy as a whole.[104]

The commitment to a free public health care system, coupled with Kenya's flourishing pharmaceutical market (with a surplus output, Kenya has the strongest pharmaceutical industry in East Africa), seems to indicate that the Kenyan government is in favor of dealing with tropical diseases such as malaria by

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[101] WHO, http://www3.who.int/whosis/country/indicators.cfm?country=ken&language=en, March 2004.
[102] One World Africa. "Kenya's Green Role Model" [online]: http://africa.oneworld.net/article/view/71536/1/., February 2004.
[103] World Rainforest Movement. "Kenya: Mangroves Threatened by Canadian Mining Company" [online]: http://www.wrm.org.uy/bulletin/38/Kenya.html, February 2004.
[104] World's Market Analysis [online]: http://www.worldmarketsanalysis.com/wma_sample_pages/site_pages/WMHSampKenya1.html, February 2004.

way of prevention and treatment. With environmental activists holding high positions in Kibaki's cabinet, a measure to combat malaria with DDT – posing potentially harmful effects on the environment and on wildlife – could be a tough sell.

Advocacy and Information Sharing

The need to foster advocacy and information sharing among the players in Kenya's health sector and other sectors will be critical to the implementation of these policy recommendations. Furthermore, such a program will require substantial funding from various sources. The Ministry of Health and other related ministries like the Ministry of Rural Development and the Agricultural Ministry will be of major importance here as well as international organizations which are active in Kenya such as the World Health Organization (WHO), United States Agency for International Development (USAID), German Development Service, United Nations Children's Fund, United Nations Development Fund for Women, and non-governmental organizations like CARE International, Adventist Relief Agency, and Family Care International. Community-based groups and organizations will also have a role to play.

Advocacy is especially important in recommending the use of DDT in order to overcome people's wariness of using DDT, as it has long been thought to pose health and environmental risks. Advocating for widespread DDT use will require much education and counter arguments to prevailing, exaggerated criticism. In addition, in order to win people over, it will require demonstrations showing where the chemical is being used and the positive results that are generated.

Mosquito net advocacy will need to be concentrated in areas where women and children congregate such as churches, market places, and schools since they are the most affected part of the target population. Maternal and child welfare clinics, for example, will provide a good forum for advocating the use of mosquito nets. Doctors, nurses and midwives will be of great help in this instance. Information sharing will be extremely important to the successful implementation of the recommendation because it will be essential in identifying areas with the greatest prevalence of malaria and hence which areas will require priority.

Information sharing is also necessary in order to enhance the efforts of agencies that are already active in the field such as the WHO with its Roll Back Malaria Program, and will also help prevent the duplication of efforts and hence conserve resources. In this way it would be helpful for the government to establish a database where all relevant agencies can connect with each other.

In order to increase the transparency in communication between all NGOs, IGOs, and government agencies engaged in the fight against malaria, the government should create a database. The government would then make it a stipulation that any NGO or IGO that is granted permission to enter

Kenya would have to report activities and research findings related to malaria to the database. For example, if an NGO enters Kenya to distribute mosquito nets, they will have to report to the database where they are distributing the nets and how many. At the same time, if an NGO entered Kenya to conduct medical research on health issues that relate to malaria, they would have to report their findings to the database. The government of Kenya should furnish them with whatever material assistance they can provide to help track the mosquitoes. Coordinating with the international community, they will be able to draw upon the resources of some of the best scientists and researchers in the world, allowing for a greater likelihood of controlling the endemic.

Field officers will be sent out along with scientists and researchers, domestic and foreign, who will track the populations and continually report their findings to a central agency in charge of the database and coordinating DDT spraying. The agency will likely be part of the Ministry of Health and will consist of a team of staff members who will coordinate DDT spraying, provide education, update the databases, providing information to NGOs and other government agencies, and will further facilitate communication among the various actors involved. Their funding will likely come from Parliament and will require a long-term commitment if DDT spraying is to be effectively administered over many years. The Kenyan government, through the Ministry of Health or Parliament, will need to develop the infrastructure to process this information and the scientific facilities to successfully monitor the spread of malarial infecting mosquitoes.

In return for reporting information to the database, not only will the NGOs and IGOs be able to enter Kenya, but they will also have access to all database information. This would allow for a central channel of communication for all NGOs, IGOs, and government agencies, cutting out inefficiencies and overlap. This database would create a clear system of communication and in cutting down on the inefficiencies would save money. NGOs and IGOs would assist in mosquito net distribution as well as assisting in the DDT surveillance component of our recommendation Medical teams doing research would have to report a re-infestation or malaria outbreak, allowing the government and other NGOs and international civil society members to rapidly deploy resources to spray the vector for mosquitoes and get aid and treatment to those infected.

With regards to widespread spraying of DDT, information sharing will help to identify areas that need extra surveillance as health workers; NGOs and other agencies working on the ground will be the knowledgeable of areas where there are major incidences of malaria. Information sharing amongst all of the key players will also help identify which areas require more concentrated educational campaigns regarding the use of DDT and mosquito nets.

A couple of ways in which information sharing could be achieved would be through the introduction of a malaria newsletter that would be published either monthly or bimonthly to which government and the various NGOS and international organizations could submit information regarding the efforts they have been making in the fight against malaria. Furthermore, conferences could be organized that would bring all the various actors involved together to discuss successes and challenges that they have faced in the field. The establishment of a good environment of information sharing will be beneficial to all stakeholders, and ultimately the success of the recommendation.

Sequencing of the Recommendation

A culture of ITN use must be established. Currently, many Kenyans are improperly using mosquito nets. Use and ownership of mosquito nets varies from urban to rural areas in Kenya. Use of mosquito nets is higher in urban than in rural areas where the majority of housing do not have mosquito nets. In addition, nets often do not fully cover a bed or area where an individual is sleeping, leaving openings for mosquitoes. Nets are often torn but are still used. Frequently ITNs are also used without reapplication of insecticides, such as when they are washed. While studies have shown untreated nets to be effective at preventing mosquito bites, treatment of nets can provide additional protection to individuals and can even form a zone of protection that repels mosquitoes. This can form buffer zones and areas of safety that are not even under nettings. To create such an area, it is necessary to have many nets in close proximity. [105] Net usage, especially with the required reapplication of insecticide, renders them less effective obstacles to mosquitoes if they are not re-treated. Therefore, it is important to ensure proper usage and a high concentration of ITNs in endemic areas. Communities and individuals, particularly in rural areas, need to be educated about the realities of using mosquito netting. It does not have to be confining and limiting. It can also provide zones of protection that enhance the ability of villagers and urban residents to conduct their daily affairs and sleep at night in protection.

NGOs already distribute netting to some areas of Kenya, including providing free nets to pregnant women who come for medical checkups.[106] In coordination with these NGOs, through the proposed inter-agency newsletter, the government can target the poorest and most endemic areas where there is a lack of netting, especially in rural communities. It can then purchase ITNs from producers and distribute them to NGOs according to the areas that they service. If there are areas where NGO servicing is minimal, then the government should directly distribute ITNs to these areas. While the

[105] Crampton, Thomas, "In Africa Netting Brings New Hope to Fight Malaria," *International Herald Tribune,* 18 Sept. 2003, [online]: http://www.iht.com/articles/110312.html, February 2004.
[106] African Medical Research Foundation (www.amref.org), Reuters AlertNet – "Malaria and mothers in western Kenya" [online]: www.alertnet.org/printable.htm?URL=/thenews/fromthefield/107123193010.htm, February 2004.

ultimate amount of funding allocated will be at the discretion of the Kenyan government, it is recommended that as many as possible be provided to those in highly endemic areas who are unable to afford them.

Additionally, the government must stay abreast of the development of LLINs. When these become available for mass purchase and at a reasonable price, the government should provide these nets free of charge as well. As LLINs last longer and do not require the frequent re-application of traditional ITNs, their potential for impact is far greater.[107] Production has begun and some forms of the netting have yet to be approved by the WHO Pesticide Evaluation Scheme.[108] Once costs are down and the netting is adequately tested, the government should begin distributing LLINs.

The government must undertake proper steps to ensure that DDT is readily accessible in a usable concentration or can be easily mixed, is available in reasonable amounts, and with tools necessary for its use. The proper tools could include pumps, spray nozzles, and other means of easy application. In addition, the government will be spraying in highly endemic areas, particularly rural areas. Outside spraying will require a concerted analysis of the most endemic areas of Kenya.

Because DDT can be washed away and because mosquitoes are not present during the rainy season, outdoor DDT spraying conducted by the government should take place at the conclusion of the rainy season. In addition to spraying at the conclusion of the rainy season, it will be necessary to spray again, within 6 and perhaps 4-5 months. Similarly, indoor residual spraying should occur twice a year. ITNs, if exposed to rain, may not need to be re-treated during the rainy season but should be re-treated at the end of the season when mosquito infestation is greatest.

As agricultural spraying in the past had led to concerns about the toxicity of DDT toward humans and toward the environment, it will be necessary to have governmental oversight of its use. It will be necessary for the government to ensure by random testing whether or not misuse of DDT is occurring. A government official can periodically investigate and test the DDT levels in different areas of the country that have been designated for spraying. Upon determination of overuse, government inspectors should notify regional or local authorities that would conduct an investigation. While DDT has been verified by numerous studies to be non-toxic when used correctly, it may still be used incorrectly and result in some health risks. As one researcher has stated, "Although the safety precautions described earlier should reduce acute health risks, poisoning accidents may persist in areas where proper training and supervision are not provided."[109] Therefore, in order to ensure the proper use of DDT, rural village

[107] Crampton, Thomas, "In Africa Netting", February 2004.
[108] Ibid.
[109] Walker, "Cost-Comparison."

inhabitants must be educated on safety procedures for using DDT, including how to mix the chemicals, where and how often to spray and in what amount.

A successful education campaign will require direct contact with rural villagers and farming communities. Representatives of the government or of respected and recognized NGOs will need to interact with villagers face to face and teach them the proper procedures for DDT use. Additionally, advocacy may be best accomplished through existing civic and social organizations, including religious institutions or informal social hierarchies. Churches and civic organizations are an important tool in urban areas, as these institutions possess legitimacy in the eyes of the people and can be effective at changing the misconceptions about DDT. Local leadership in rural villages can similarly provide legitimacy in changing the understanding of DDT spraying in rural communities. Other times, NGOs with ties to rural areas or government agencies may be best able to transmit this information and be credibly accepted. It is very important that a credible source be transmitting this information as DDT has been taboo in Kenya and in many other nations for decades.

Even well educated members of society in many African nations are still skeptical about the use of DDT despite the new evidence that disproves its toxicity. It will require a concerted effort by the Kenyan government and by local NGOs to re-establish a culture that accepts DDT spraying. Once education and proper training occurs and information travels throughout society, the dangers of DDT use will be minimized and a culture of acceptance will develop. Further, the government can educate through the public schools about the effectiveness and low toxicity of DDT. A culture of using DDT and ITNs properly will be created in the next generation who will be fully educated about the uses of DDT and will be able to provide their parents with this information.

Overcoming Specific Challenges

As with the implementation of any major policy, there are stakeholders who cannot be completely satisfied. In the case of the policy recommendations being made, the major stakeholders who may be dissatisfied are the environmentalists, especially with regards to DDT use. To address the concerns of this group, the evidence showing that DDT has been falsely shown to have an adverse effect on the environment has been provided in this recommendation, and will be prominent in the public education program. Furthermore, widespread DDT spraying will be restricted to highly endemic areas. Government will also monitor the spraying and use of DDT in order to avoid abusive use, which without monitoring may cause environmental harm as well as possible harm to humans.

Environmental experts will be consulted before each spraying episode in order to verify that the procedure is being done according to protocol so as not to affect the environment. They will also be

called in from time to time to conduct surveys within areas of DDT spraying to provide independent verification of any adverse effects to the environment that may be developing.

Unintended Consequences

The recommendation set forth is one that meets the stated criteria by effectively and efficiently contributing to the eradication of malaria in Kenya. However, it might be argued that the plan to use the measures of DDT spraying, mosquito nets, and public awareness campaigns could produce certain unintended effects. The decision to spray DDT is motivated by an intention to ultimately eradicate malaria in Kenya, and the insecticide has been proven effective many times over. The controversy surrounding its use is a cause for apprehension but not a deterrent; the overwhelming evidence presented in numerous recent studies has shown that DDT is not nearly as harmful to the environment or the human population as had been previously thought. Nevertheless, the use of DDT could produce unintended consequences, and it is crucial that these issues are addressed:

Environmental Impact. Though numerous scientific studies in the recent past have dismissed the purportedly harmful effects on DDT on the environment, Kenya is a biologically diverse nation that depends on its natural beauty and unique wildlife to attract tourist dollars. Thus any harm to the environment and its ecosystem is potentially catastrophic. If DDT does not harm humans directly, it could arguably do so economically.

Technical Issues with the Spraying of Insecticide. Determining where and how the insecticide will be sprayed presents another major challenge in itself, and failure to distribute the DDT properly, or to use it improperly, will reduce its effectiveness in combating malaria.

The Possibility of Re-infestation. Even with surveillance measures in place, the permanence of eradication is challenged by a possibility for re-infestation, such as by mosquito migration from neighboring countries. If the focus of the recommended approach is to eradicate the disease rather than simply slow its spread or treat those who are already afflicted, this possibility must be considered.

Emphasis on Eradication Could Cause Complacency. The recommended approach is intended to operate in concert with, rather than in place of those measures that are currently used to combat malaria. If the approach to eradicate the disease creates a false sense of security and people stop taking the drugs used to prevent malaria, the recommended plan will not achieve the desired results.

Potential for Political Strife. The National Rainbow Coalition is a loose conglomerate of different political parties that joined together to expel from power the corrupt regime under President Daniel Moi and the Kenya African National Union. If DDT becomes a hot-button issue, as it most certainly will be

with people such as the Assistant Minister of the Environment, Wangari Maathai, it could drive a wedge through the party and pave the way for Moi's return to power.

Impoverished People Could Be Left Behind. The reach of several aspects of the recommendation could be limited by the reality that many Kenyans are living in poverty in remote areas of the country. For example, many of those living outside the major urban centers are illiterate, and this brings into question how effective public education could be in reducing malaria in these populations. Additionally, though DDT would be sprayed outdoors in areas where malaria occurs most frequently, the recommended usage of insecticides indoors is limited by the fact that those living in poverty simply cannot afford to buy it for themselves.

Public Education Might Not Be Effective. Illiteracy is a major hurdle, and with malaria most prevalent in the country's poorest regions, the cost-effectiveness of public education could become questionable; the result of ineffectiveness is that it would be seen as a misallocation of resources.

Improper Use of Mosquito Nets. Even with some education on the use of mosquito nets, people might use them improperly, or not use them at all. In the past, people have used the mosquito nets in place of proper bedding, or have hung them in such a way as to render them ineffective. Without proper instruction, mosquito nets will not be fully effective in preventing the spread of malaria.

Mosquito Resistance to ITNs. Mosquitoes may develop resistance to pyrethroids. The pyrethroids have three main effects on mosquitoes; mortality, repellency and exiting behavior; and resistance can develop against each of these.[110] In Africa, pyrethroid resistance in different species of the anopheles mosquito has been found in different regions of the continent. Though evidence on how this resistance has occurred is not quite certain it is believed that it may have resulted from the use of pyrethroids as agrochemicals.[111] Thus making resistance resulting from the use of ITNs highly unlikely and even in areas where pyrethroid resistance has been reported, ITNs may still be effective because the reduced excito-repellency caused by the resistance leads to a longer period of contact with the insecticide (this is cited by Takken from Chandre *et al*. 2000) and so the mosquitoes are still killed.[112]

ITNs may change the biting time of mosquitoes, in studies in Papua New Guinea and Kenya it was found that mosquitoes shifted to outdoor biting and biting occurred earlier in the evening.[113] Use of ITNs may also cause mosquitoes to change their host, this was observed in studies in Papua New

[110] Takken, "Do insecticide-treated."
[111] Ibid
[112] Ibid
[113] Ibid

Guinea and Tanzania where the mosquitoes shifted from human hosts to pigs, dogs for Papua New Guinea and cattle for Tanzania.[114]

Mosquitoes Could Develop a Resistance to DDT. DDT has been proven effective in eliminating the disease-carrying insects, but over a long period of time, the parasites could develop a resistance to DDT in much the same way as the disease itself has become increasingly resistant to certain drugs. If and when this happens, mankind will be forced to develop stronger pesticides to combat the threat.

Some Concluding Remarks

Malaria is a disease that works in cycles; spread through the bite of the female mosquito in order to nourish its eggs, it strikes hardest in the tropical regions of sub-Saharan Africa, and in addition to posing a mortal threat to those who are afflicted, its prevalence can also have a strong negative impact on the greater community by hindering economic growth and education; contributing to a cycle of poverty in many African nations. Current measures of prevention have served to alleviate these problems to some extent, but in order for the cycle to be broken, there must be an enduring, effective solution. The recommendation that has been offered in this study approaches the problem of malaria in Kenya in a way that recognizes the urgent need for disease awareness and preventative measures, but at the same time it seeks to address a lasting solution through eradication of the disease.

Summary of Proposal

The proposal offered in this study is that Kenya should implement a policy of eradication in its approach to the problem of malaria. Wide-scale outdoor spraying of DDT should be undertaken in those areas where the disease is most prevalent, and indoor spraying for homes and offices should be encouraged. Additionally, the government should implement an aggressive campaign to educate its people about the disease as well as preventative measures. Insecticide-treated nets (ITNs) should be distributed to at-risk populations. The proposal calls for increased funding in these areas, and does not seek to move funding away from other measures that are currently being used to combat the disease.

The use of the insecticide DDT has been found to be the most cost-effective and feasible means by which the ultimate goal of total eradication will be realized. More importantly, it will save thousands of lives. Its great successes in other places around the world have shown it to be an effective and highly efficient insecticide, and despite its controversial name, it has been proven to be relatively harmless to both humans and the environment. Combined with a recommendation for the distribution of mosquito nets and the implementation of a disease awareness program, the recommendation serves to address the

[114] Ibid

needs at hand and looks to a future in which the nation of Kenya is finally completely free from the curse of malaria.

Appendix 1: Dynarank Solution to Policy Problem

Dynarank is a software program that allows its user to quantitatively analyze various options as they relate to each other and the criteria for the success of a project. Through this program a scorecard which produces a matrix where the options are in the right hand rows, and are weighed against the criteria (the top columns). Each option is then ranked according to its ability to satisfy each criterion. The program, through various formulas, then ranks all options as they compare against the criteria as a whole allowing the user to see were it stands in relation to all options. Finally the scorecard can be colored which allows the user to visually see each options strengths and weakness as they relate to each individual criteria as well as the criterion as a whole, and as it relates to other options.

There are two steps to ranking and weighting criterion in Dynarank. First, you decide what level of measure (top-level measure, mid level measure, or base level measure); second, you decide what weight each measure or criteria should be given. Following is a breakdown of how we weighted each of our measures.

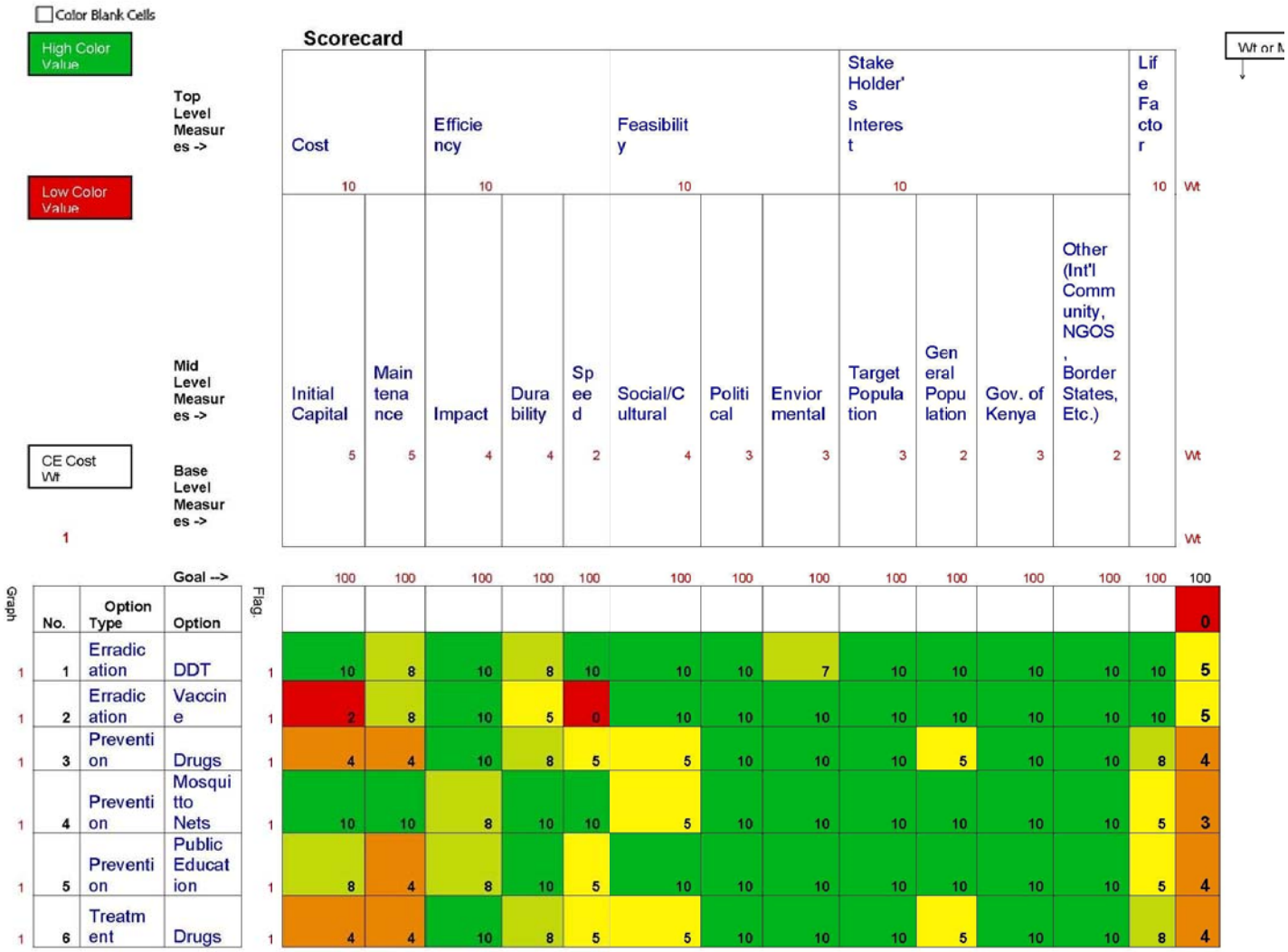
- Cost-effectiveness as a top level measure was weighted a 10. The two mid level measures for cost-effectiveness, capital cost and maintenance cost, were weighted as follows:
    - Capital Cost – 5,
    - Maintenance Cost – 5,
- Efficiency as a top level measure was weighted a 10. The three mid level measures for efficiency, impact, durability, and speed, were weighted as follows:
    - Speed – 2,
    - Impact – 4,
    - Durability – 4.
- Feasibility as a top level measure was also weighted a 10. The three mid level measures for feasibility, social and cultural, environmental, and political, were weighted as follows:
    - Social/Cultural – 4
    - Political – 3
    - Environment – 3
- Stakeholders as a top level measure was also weighted a 10. The four stakeholders were weighted as follows:
    - Target population – pregnant women, children – 3
    - Government of Kenya – 3
    - General population – 2

- And Other which includes the international community (UN, WHO), NGOs and Civil Society, and neighboring states – 2

- Finally, we gave the Saving Lives category a weighting of 10 because at the center of our work is the need to reduce the number of lives being lost to malaria in Kenya.

After weighting each measure the user then ranks each option as to how well that option meets the measure. We set Dynarank to a scale of 1-10, although it can be set on any scale from 1-100. As we have already explained our evaluation of our options as they meet our criterion (measure) we will not go into detail here.

Finally Dynarank allows you to color in the scorecard allowing for a visual representation of the strengths of each option as it relates to the measures as well as an overall representation of how each option relates to the measures on a whole, and as they rank in relation to each other. From this we determined that DDT met our criterion the best. (The next closest option was seeking a vaccine, which we determined had some severe weaknesses, colored in red that DDT did not). We decided to combine the DDT option with the next best option that could realistically be combined, for a hybrid approach that would assist in preventing malaria spread while the DDT option was being set up. For this we decided on mosquito nets because it fell between our second highest options, but, unlike preventative drugs, treatment drugs, or education could be combined with DDT spraying and remain a cost effective approach. The Mosquito nets option would allow the Government of Kenya to begin addressing the problem immediately, while the DDT spraying would allow them to potentially eradicate the problem as a whole. Below is a copy of the colored Dynarank scorecard.


Color Blank Cells
High Color Value
Low Color Value
CE Cost Wt
1
Scorecard
Top Level Measures ->
Mid Level Measures ->
Base Level Measures ->
Goal -->
Wt or M
Cost
Efficiency
Feasibility
Stakeholder's Interest
Life Factor
Wt
Initial Capital
Maintenance
Impact
Durability
Speed
Social/Cultural
Political
Enviormental
Target Population
General Population
Gov. of Kenya
Other (Int'l Community, NGOS, Border States, Etc.)
Graph
No.
Option Type
Option
Flag
1 Eradication DDT 10 8 10 8 10 10 10 7 10 10 10 10 10 5
2 Eradication Vaccine 2 8 10 5 0 10 10 10 10 10 10 10 10 5
3 Prevention Drugs 4 4 10 8 5 5 10 10 10 5 10 10 8 4
4 Prevention Mosquitto Nets 10 10 8 10 10 5 10 10 10 10 10 10 5 3
5 Prevention Public Education 8 4 8 10 5 10 10 10 10 10 10 10 5 4
6 Treatment Drugs 4 4 10 8 5 5 10 10 10 5 10 10 8 4

Appendix 2: Options Weighed Against Criteria

Weighing the aforementioned criteria we established the recommendation of DDT spraying, at home and outdoors, ITN distribution, and education. The list of policy options along with how they relate to each criteria are listed below. While each criterion was considered and used in establishing strengths and weaknesses, a full explanation and explication of each in reference to the options was not included.

Option 1: Preventative Malarial Drugs

Malarial drugs are the primary method that the government currently uses to treat malaria. Since treatment does not actually eradicate malaria, this approach was ultimately discarded, but that is not to suggest that preventative malarial drugs should not have a continued role in the public health system.

Saving Lives:

Intermittent treatment with preventative drugs is proven to save lives, and for pregnant women, it is proven to prevent complications at birth. Some preventative drugs can have harmful side effects, but the more popular drugs (i.e. sulphadoxine-pyrimethamine) are very safe.

Cost-Effectiveness:

Intermittent preventative treatment is considered to be a relatively cost-effective approach to fighting malaria. The increasing demand for medicines to combat malaria and other tropical diseases has caused a steady expansion in the Kenyan pharmaceutical market, and Kenya's pharmaceutical manufacturing industry stands as one of the strongest in East Africa. The unit cost of sulphadoxine-pyrimethamine is $0.14, though some of the more effective drugs currently on the market have a higher per unit cost (about $3.00)115. According to a study by Emory University, "When only antenatal clinic costs are considered, the two-dose and monthly SP strategies cost US $11 and $14, respectively, well within the range considered cost effective."116

[115] Business Day [online]: "Deadly Cost of WHO's Malaria Flops" http://www.businessday.co.za/bday/content/direct/1,3523,1522353-6096-0,00.html, February 2004.
[116] Wolfe, Elisabeth B. and others, "Cost-effectiveness of sulfadoxine-pyrimethamine for the prevention of malaria-associated low birth weight," *American Journal of Tropical Medicine and Hygiene*, 64 (3-4) 2001, p. 178-186, [online, PubMed]: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11442215&dopt=Abstract, February 2004.

Efficiency:

On a case-by-case basis, preventative drugs would stop the onset of malaria before it even starts. On the wider scale, implementing a program for the widespread distribution of preventative drugs could be done rather quickly, considering that Kenya manufactures many drugs on its own, but some of the more rural regions of the country are short on doctors and medical facilities. The infrastructure is severely lacking in some areas, and this could delay implementation of a preventative drug program.

Feasibility:

A preventative drugs program is both culturally and politically feasible, as preventative medications are already widely used in Kenya. Kenya is a member of the global partnership Roll Back Malaria and the WHO, and in the past it has followed that organization's recommended strategy of providing intermittent preventative drug treatment in addition to the use of mosquito nets. The use of preventative drugs is not a novel concept in Kenya, and any strategy that includes further use would be socially feasible. Politically speaking, it is a safe choice.

Stakeholders' Interests:

The people of Kenya, their government, and private pharmaceutical manufacturers all stand to benefit from a preventative drug program. Preventative drugs have been proven to save lives and reduce the likeliness of complications at birth; and at a relatively low cost, provision of these drugs is a cheap, politically safe option for the government. For the new administration under the National Rainbow Coalition, using a strategy for preventative drug treatment would to some extent represent a continuation of what has already been done, which makes it more politically attractive than some other options, and wider distribution will reaffirm the administration's aggressive approach to dealing with public health issues. Kenyan pharmaceutical companies, already producing great amounts of drugs aimed at preventing and treating tropical diseases, will benefit financially from the program.

Option 2: Malaria Vaccines, Cautious Optimism

Malarial vaccine usage was considered as a policy option because of its vast potential, but its weaknesses were too strong to merit a recommendation. As it was discarded, its standing with regards to each criterion is listed here.

Cost-effectiveness:

Developing a malaria vaccine is not cost-effective in the short-term - while long-term costs would be made up with an effective vaccine that prevents infection and consequently costs of control and treatment programs implemented by the government. Currently, funding for vaccine development

comes largely from private sources such as the Bill and Melinda Gates Foundation. In addition to the costs of developing any vaccine, as this paper has discussed, developing a malaria vaccine will be especially difficult and especially costly, as many vaccines may need to be developed to effectively inoculate the entire population. The initial capital outlays, which are already significant, will need to be even greater if a successful vaccine is to be developed. While it could prove to be cost-effective in the long-term in offsetting costs, the pay-off for a vaccine would be far into the future. With the slow development of a vaccine it is difficult to justify encouraging the Kenyan government to spend limited resources on an uncertain technology.

Efficiency:

The efficiency of a malaria vaccine in the short-run will be limited. Research and development continues and will likely be necessary for a few more years. Scientists have been working on developing a vaccine for decades and have been unsuccessful. A malaria vaccine or series of vaccines could be extremely successful if vaccine development proceeds flawlessly. The likelihood is that successful vaccines will be developed that can temporarily immunize, requiring annual or frequent re-administrations, or that may be successful in combating malaria at certain stages of development.

As has already been discussed, the proteins developed by the malaria infections are polymorphic, changing continually and although the different stages of development are broadly known, the protozoan malaria can release a variety of antigens as well at different stages in its development. If scientists overcome these hurdles and develop a successful vaccine, the impact could be enormous, with the potentiality to eliminate malarial infections. This potentiality, though, must again be tempered, as past efforts have only been partly fruitful. Therefore, the speed, the impact, and even the durability, of successful vaccines, which have been inoculated on an irregular basis and for short periods of time, should be called into question.

Political Feasibility:

The Kenyan government should have no objections to implementing a vaccine program if such a program is successful. The government has already begun working with the international community, including the United States Army in developing a vaccine. It may be difficult to convince the Ministry of Health or the Parliament to provide funding or assistance for a vaccination initiative with limited success. The Parliament will likely provide assistance with any implementation programs once a successful vaccine is developed. It will be unlikely, however, to pay development costs. Kenya already has a significant pharmaceutical industry and the Parliament has in the past, in dealing with other diseases, given significant funding for developing drugs. They will likely focus their limited resources on other treatment and prevention mechanisms with the potential for greater success.

Social/Cultural Feasibility:

Vaccines for other diseases, including yellow fever and hepatitis B, are currently in use in Kenya and in Eastern Africa. With no inherent concerns over vaccine usage, cultural practices embrace using vaccines. Its cultural/social feasibility, once developed, should be of no concern. Civil society would pose no objections to vaccinations, including religious bodies and cultural associations. Vaccines produce no toxins, or in any other way, adversely harm the environment. Its environmental feasibility, therefore, should be unquestioned. Environmental groups, including international NGOs with strong environmental concerns will not object to the use of vaccines to treat malaria as they may with the use of DDT or other pesticides.

International Stakeholders:

The UN and its agency the WHO, as well as international NGOs including the Malaria Vaccine Initiative and foreign governments have already begun putting significant resources, research and development, into developing a vaccine. Many multi-lateral efforts involving these actors, and companies such as GlaxoSmithKline, and universities around the world, are in the midst of a number of projects aimed at different population groups and different stages of malaria protozoan development. While a vaccine may be far off into the future, its potential is significant and could lead to the eradication of the disease

Option 3: Insecticide Treated Nets as Effective Prevention Tools

Insecticide treated nets are available in sub-Saharan Africa, but are also relatively expensive for many people at risk of contracting malaria. To properly assess the value of ITN's as an approach to malaria interdiction, the following discussion evaluates ITN's impact on specific issues of concern.

Saving Lives:

Though ITNs may not be very efficient in saving lives, the reality that it is a means of preventing mosquito bites, and therefore reduces the infection rate of malaria transmission, means that it will continue to play a substantial role in reducing the potential number of malaria deaths, as long as it is used correctly and on a regular basis.

Cost-effectiveness

Insecticide treated mosquito nets are relatively inexpensive to other forms of prevention. The netting costs $5 and the cost of insecticide per treatment costs $0.50. Treatment is required about twice a year.

As a result, this brings the cost of ITNs to about $6. Though this is not within the reach of most people in sub-Saharan Africa, it is a cheaper means of prevention than prophylaxis drugs.

Efficiency

Insecticide treated mosquito nets are a durable solution in respect to the prevention of malaria. If they are habitually used, they reduce exposure to mosquito bites, and thus infection. The impact of ITNs will not be a widespread practice unless individuals made it a habit to use the nets in their proper manner. ITN use can be introduced in a relatively short amount of time. On the whole, ITNs may prove to be quite inefficient in the face of current cultural traditions.

Feasibility

The use ITNs would be politically and environmentally feasible since they have no adverse impact on the environment and politics. With regards to socio-cultural feasibility, ITN usage may not easily catch on, as its use may be completely foreign to the practices and traditions of the people of Kenya. Extensive education will be required in order to convince people to adopt the practice of correct usage.

Stakeholders

The use of ITNs will be favorable to all stakeholders involved here since it is an effective and inexpensive way to prevent malaria infection. Pregnant women and children, in particular, will benefit substantially from its use.

Option 4: Public Health Education On Malaria Risks And Options

Public health programs such as KMED are best paired with other options in order to make the most of the educational message. As such, this option received the lowest priority in our recommendation behind DDT and ITNs. Each of the criteria below is addressed specifically in terms of how KMED meets our objectives.

Saving Lives

It is likely that KMED will save the lives of pregnant women and children, although the implementation of the plan will mean that this will not be seen quickly. The degree to which the plan will translate into saved lives will depend upon how effective the program content and information-sharing activities are at altering public attitudes and behaviors.

Cost-Effectiveness

The initial capital investment into the KMED plan will be the most expensive part of the public health education option. As there are already existing structures within the Ministry of Health, such as the

Kenyan Malaria Information Service (KMIS) and the National Malaria Strategy (KNMS), this initial expense will be somewhat offset. The initial investment would include media buying for air and print space in available forums, wages for information-sharing officers, as well as administrative costs. The maintenance costs for this option will require continuous media purchases to keep the message available to the public, however the training costs will recede over time.

Efficiency

Public health education campaigns are, by nature, not particularly speedy. Such campaigns take time to start up and even more time to become accepted into daily behaviors. Despite the drawback to the public health option in terms of speed, the potential for impact and durability are relatively high. Once the media buys have become established, and the information-sharing avenues are implemented, the impact of the program could be widely felt throughout Kenya. Moreover, such a program has the capacity to be durable as it can be readapted to fit the evolving needs of the Kenyan people.

Feasibility

As public health education plans are excellent avenues for expressing the policy of the government and for connecting the people with services and information, the program is highly feasible. A concern in creating a program is that it ought to be culturally sensitive to the target population. In the case of the KMED plan, this remains feasible as the specific program content can be crafted with cultural sensibilities in mind. Moreover political feasibility would not be an issue, as this program would be affiliated with the Ministry of Health and part of the Kenyan Malaria Information Service, both of which are responsible agencies of the Kenyan government. In terms of environmental feasibility, the education program would be highly feasible, as it has neither a negative nor a positive impact upon the environment.

Stakeholders' Interests

Since there is a certain degree of flexibility in program content, as well as direct involvement of government agencies, many of the stakeholders have integral roles in the expression and implementation of the KMED plan, thereby meeting many of the stakeholders' interests. Program content will be specifically directed towards the target population of pregnant women and children that serves the interests of both the target and general populations as a whole. The government of Kenya, the international community, NGOs and neighboring states would all benefit from a public health education plan as this would better connect citizens with services and information pertinent to the reduction of malarial risk.

Option 5: Eradication through Insecticides

DDT is recommended as the primary approach that Kenya should take to eradicate malaria. In consideration of the negative perceptions that surround DDT, a detailed discussion of the advantages and disadvantages of DDT are given below.

Saving Lives

Any recommendation put forward must reduce the number of deaths from malaria. In the ten years following the discovery of DDT "its widespread use reduced the number of malaria cases worldwide from 75 million annually to five million. In fact, the chemical has been so successful in killing the mosquitoes that carry malaria that scientists estimate it has saved 500 million lives."117 It is clear, that DDT would effectively reduce the number of deaths from malaria within a given timeframe.

Cost-effectiveness

As already cited, DDT is the most cost-effective pesticide. The use of DDT spraying as a means of controlling the infestation of malaria infected mosquitoes would allow Kenya to combat the spread of malaria at a low cost. Because of the lower cost of DDT it is possible for Kenya to spread available funds further in the fight against malaria. They will not only be able to make a greater impact with the funds they have available but additional funds, made available by the inexpensiveness of DDT, can be put towards additional methods of fighting and treating this parasitic disease.

Efficiency

Because of the nature of DDT, spraying of the chemical can be implemented on a large-scale at relatively low cost. As such, DDT would significantly begin to reduce the number of malaria-infected mosquitoes at a relatively fast pace; thereby reducing the number of malaria infections across the board. History has shown that DDT is not only an expedited means of addressing malaria, but also meaningful in terms of its impact on the issue of malaria eradication through the use of control mechanisms. The effectiveness of DDT spraying, which is evident in the areas where this method of malaria control has been implemented (such as America and Western Europe), proves that it has the ability to make a large scale rapid impact on malaria. However, while DDT is an extremely efficient means of combating malaria in terms of speed and impact, it has one drawback - its durability.

DDT faces two issues of durability: (1) mosquito resistance to insecticides; and (2) lack of a monitoring system to prevent re-infestation. The first issue would be difficult to mitigate in the case of Kenya because even if widespread spraying is successful in eradicating infected mosquitoes from these

[117] Hiebert, "Technological Genocide."

countries, re-infestation of chemical resistant mosquitoes from neighboring states could occur. The only way to address this issue is to focus on strengthening and morphing DDT so that it remains a step ahead of DDT resistant mosquitoes. The second issue is a lack of an effective monitoring system for areas that have been deemed free of malaria transmission. As J.A. Najera-Morrondo of the World Health Organization (WHO) explains, "Evidence began to accumulate that, although it was possible to reduce and even interrupt transmission by insecticide spraying over large areas, it was very difficult, if not impossible, to maintain efficient surveillance in the absence of a solid health infrastructure."[118] In order to mitigate this issue "close surveillance, designed according to the local situation, and preparedness for intervention with drugs for treatment and - if possible - insecticides for vector control are needed."[119] This would mean that once an area is rid of malaria infected mosquitoes, the region, and the various stakeholders involved, especially doctors, would still need to be vigilant; so that if a reemergence of malaria were to occur, any persons infected by this parasitic disease could be treated by available medication and a re-spraying of the area could commence. It is this surveillance component that has prevented DDT from successfully eradicating malaria on a worldwide basis in the past.

Feasibility

DDT is a feasible solution to the problem of malaria eradication due to its cost-effectiveness and efficiency, which are both politically feasible. Additionally, because it does not interfere with social and cultural constructs it is socially and culturally feasible. In fact DDT has even become environmentally feasible in light of increasing environmentalist criticism.

As Rick Hiebert explains, "Twelve scientific studies, including one where primates were given 33,000 times the average human daily exposure to DDT, found no direct link to cancer…15 studies (including one published by the Canadian Wildlife Service) found no correlation between pesticides and egg shell thinning."[120] As Arthur Robinson of the Oregon Institute of Science and Medicine further explains, "the campaign against DDT is fuelled by "junk science" and little else…. There are other alternatives [to DDT], but they are not as effective, and many of these countries can't afford it." He argues "it simply does not make sense to ban DDT without replacement pesticides being readily available, especially when malaria does more damage than anything proven to be caused by the pesticide."[121] It is this opinion that has won over the international community, including the UN, who decided in 2001 not to ban the use of DDT for use in malaria related spraying.[122]

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[118] Najera-Morrondo, "Malaria control," p. 4.
[119] Trigg, "Different strategies" p. 10.
[120] Hiebert, "Technological genocide."
[121] Hiebert, "Technological Genocide."
[122] Doherty, "Mosquito Holocaust".

Stakeholders' Interest:

Stakeholder interests ought to be examined in terms of DDT. As a result of its cost-effectiveness, efficiency, feasibility, and ability to save lives (which will be discussed shortly) DDT will satisfy the interest of the government of Kenya as well as our target population and the general population. The international community, as well as most NGOs and civil society, have recently demonstrated their support, in of the use of DDT as a means of addressing the malaria crisis. Thus, it may be sufficiently possible that their interests will be satisfied as long as the spraying of DDT within the region is done so in a feasible and eco-friendly manner. Finally, if an effective DDT spraying plan is implemented in Kenya, (with subsequent surveillance, treatment, and re-spraying) neighboring states would be able to implement the same plan in their states allowing them to eliminate and eventually eradicate malaria in the near future. In other words, the Kenya experience would serve as a test situation for neighboring states that could ultimately satisfy their interest in managing malaria. If Kenya is successful in its attempt to eradicate malaria while improving the overall situation of its malaria infected population, other states may seek to follow and implement similar measures.[123]

[123] "Ecological Risk-Benefit Analysis of DDT Regulation" Crest, Japan Science and Technology Corporation, Department of Systems Engineering, Shizuoka University, Department of Biology, Faculty of Sciences, Fukui Prefectural University, Institute of Environmental Science and Technology.

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