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International Institute for Environment and Development

CLACC Working Paper 2

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Capacity strengthening in the Least Developed Countries (LDCs) for Adaptation to Climate Change (CLACC)

Climate Change and Health in Zambia

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2008

The RING alliance of policy research organisations

FOREWORD

The health sector in Zambia has conspicuously exhibited its vulnerability to extremes in weather patterns. Droughts and floods are a common occurrence in Zambia and these climatic events have persistently resulted in increased morbidity and mortality levels amongst Zambians due outbreaks of diseases such as cholera, dysentery and malaria. Climate change is projected to exacerbate these types of vulnerabilities. Consequently, there is need to understand the nature and character of climate-health interactions so as to ensure effective climate change adaptation.

This study was undertaken with the aim of elucidating the impacts of climate change on human health in Zambia. However, due to technical and financial constraints, the study was confined to identifying climate-sensitive diseases in Zambia. The study was implemented under the auspices of the Energy and Environmental Concerns for Zambia in collaboration with officers from the Ministry of Health and the Meteorological Department of Zambia. Funding was provided by the International Institute for Environment and Development of the UK and the UK Department of International Development (DFID). It is hoped that in the future this study will serve as a basis for comprehensive and technically-robust studies on the impacts of climate change on human health in Zambia.

Executive Summary

This study addresses issues concerned with the vulnerability and adaptation of the health sector in Zambia to the impacts of climate variability and change. It constitutes the first step, which is to conduct a baseline analysis of the actual and potential adverse impacts on human health of climate variability/change and the coping strategies currently in place to respond to these impacts.

Zambia, with a population of about 11 million, is currently saddled with a large burden of disease. This burden is incessantly robbing the country of millions of productive hours, with over 8 million clinical cases per annum of malaria, diarrhoea, respiratory infections and other communicable but avoidable illnesses. The situation is further worsened by the increased frequency and magnitude of climate variability in recent years. The southern, eastern, and western parts of Zambia have had to endure three droughts, three floods and only one normal rainy season (2003/04) in the seven years since 2000. Of most concern, these climate anomalies are able to stifle or even reverse improvements in health by increasing illnesses and deaths in the affected populations. This study has found that floods and/or droughts can increase levels of diseases in some affected localities by as much as 50% or even 400%. It is unlikely that Zambia will meet most of the health-related Millennium Development Goals (MDG) targets by 2015 under these conditions.

The high vulnerability of the health sector in Zambia to the adverse impacts of climate variability/change is rooted in the widespread prevalence and proliferation of health risk factors within the population. These factors include inadequate health care facilities and personnel, extensive poverty, poor water supply and sanitation, and poor nutrition coupled with food insecurity.

Zambia can begin to reverse the deteriorating health trends in the population by implementing climate-informed policy interventions. This implies that investments are required to start the process of mainstreaming climate risk reduction and adaptation into plans and programmes of the health sector.

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ACRONYMS

CEEEZ	Centre for Energy, Environment and Engineering, Zambia Ltd
CFR	Case Fatality Rate
CMR	Crude Mortality Rate
CSO	Central Statistical Office
DALYs	Disability Adjusted Life Years
DFID	Department for International Development (UK)
GIS	Geographical Information Systems
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-tropical Convergence Zone
IUCN	The International Union for the Conservation of Nature
MARA	Malaria Risk in Africa
MDGs	Millennium Development Goals
MFNP	Ministry of Finance and National Planning
MoH	Ministry of Health
MTENR	Ministry of Tourism, Environment and Natural Resources
MUAC	Mid Upper Arm Circumference
NGOs	Non-governmental Organisations
NHSP	National Health Strategic Plan
PLWHA	People Living with HIV/AIDS
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change
VAC	Vulnerability Assessment Committee
WHO	World Health Organisation
YEC	Yachiyo Engineering Company
ZVAC	Zambia Vulnerability Assessment Committee

SECTION I

1 Introduction

Zambia signed the United Nations Framework Convention on Climate Change (UNFCCC) on 11th June 1992 in Rio de Janeiro during the United Nations Conference on Environment and Development (UNCED), and ratified it in March 1993. The UNFCCC calls on all parties to, among other things address global warming occurring because of human-induced climate change. This call is based on scientific assessments conducted by the Intergovernmental Panel on Climate Change (IPCC), which was established in1 988 under the auspices of the United Nations. The IPCC (2001) has estimated that average global surface temperature will rise by 1.4 – 5.8^{o}C during the 21st century. This global warming is expected to cause changes in average climate conditions (e.g. annual temperature), in inter-annual climate variability (e.g. drought spells), and in extreme weather events (e.g. wind storms and floods).

The impacts of climate change are expected to be more striking in developing countries like Zambia, because of their geographical location and current variability in climatic conditions. In these countries, the situation is further exacerbated by a high dependence on natural resources and limited economic, financial, human, and institutional capacity to effectively respond to the adverse impacts of climate change. The IPCC (2007) in its latest report has projected that climate change will negatively affect human health as follows:

- Increasing burden of malnutrition, diarrhoeal, cardio-respiratory and infectious diseases.
- Increased morbidity and mortality from heat waves, floods and droughts.
- Change distribution of some disease vectors.
- Contribute to a substantial burden on health services

In relation, Zambia is presently saddled with food shortages in some parts of the country and an outbreak of cholera due to a drought and heavy rains in the 2004/05 and 2006/07 farming seasons.

There are two practical response mechanisms for addressing the threat of climate change: mitigation and adaptation. Mitigation refers to actions that limit the amount and rate of climate change by constraining the emissions of greenhouse (heat-trapping) gases or enhancing their sinks. Adaptation, on the other hand, refers to the totality of actions that are undertaken to avoid, prepare for, or respond to the detrimental impacts of climate change and climate variability.

This report addresses issues concerned with the vulnerability and adaptation of the health sector in Zambia (Table 1) to the impacts of climate variability and change. It constitutes the first step, which is to conduct a baseline analysis of the actual and potential adverse impacts on human health of climate variability/change and the coping strategies currently in place to respond to these impacts.

Table 1: **Country Profile - Zambia**

Indicator	Estimate
Geographical Area	752,972 km^2
Population (2000 Census)	10.9 million
Mean Population Density	14 persons/ km^2
Population Growth Rate (1990 – 2000)	2.9%/annum
Altitude Range/Mean	350 – 2000m/1200m above sea level
Per capita income (2002)	US$351.00
% Living on less than $1/day (2004)	68%
Life expectancy at birth (2003)	39 years
Adult HIV/AIDS prevalence	16%
Human Development Index (World Ranking) in 2003	163 out of 175 countries
Annual Rainfall Range	700 – 1400 mm
Urban Population	40.1%
Main Export Commodities	Copper, Cobalt and Sugar

Source**:** MFNP (2006)

2 Climate variability and climate change in Zambia

2.1 Climatic Conditions

Zambia is a Southern African land-locked country lying in the wet and dry tropics. As such, its climate is influenced by the equatorial low and the Inter-Tropical Convergence Zone (ITCZ) as they move north and south over Africa in different months of the year. In January the ITCZ forms a Z-shape over Africa and it is at this time that it controls rainfall over Zambia.

In general, the year in Zambia can be divided into two distinct halves, a dry half from May to October and a wet half from November to April. The annual rainfall ranges from 700 mm in the extreme southwest to 1,400 mm in the north and is 1,001 mm on average (YEC, 1995). However, when temperature variations are included, the year can be divided into four seasons of unequal durations as shown in Table 2 below.

Table 2: **Seasons of the Year in Zambia**

Season	Duration
Winter	June – August
Pre-rainy	September – October
Rainy	November – March
Post-rainy	April – May

On a seasonal basis, more than 90% of annual rainfall is concentrated in the rainy season from November to March. The 8% of the residual 10% falls in October and April, while the remaining 2% occurs in September and May. On average, the monthly rainfall ranges from 100 to 250mm.

The average temperature for Zambia is 21.0^{o}C. July is the coldest month and the cold temperature range in Zambia is 3.6 – 12.0^{o}C with an average of 8.1^{o}C. The hottest month is October and the recorded hot temperature range is 27.7 – 36.5^{o}C with an average of 31.8^{o}C (YEC, 1995).

Geographically, the actual levels of temperature and rainfall pertaining to the seasons in Table 2 differ from location to location depending on the agro-ecological zone of the country. In this respect, Zambia is divided into three agro-ecological zones, namely zones I, II and III (Fig. 1). Zones I and II occupy 55.8% of Zambia's landmass and are located in the southern half of the country, while Zone III occupies the northern half.

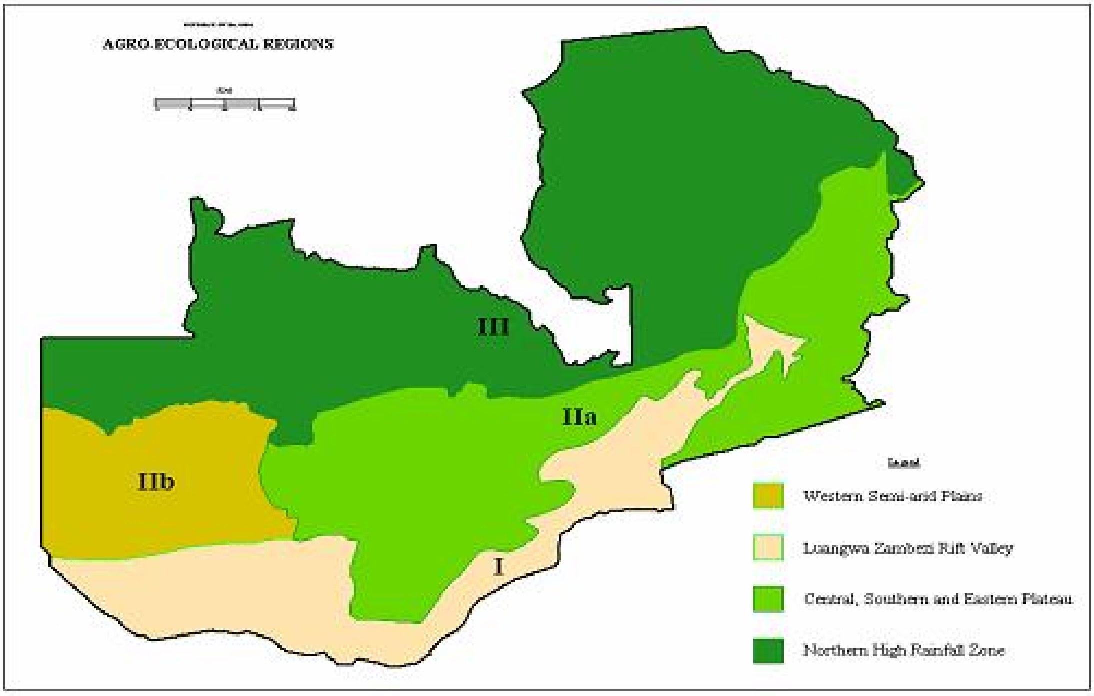

Fig.1: Agro-ecological Zones of Zambia (Source: YEC, 1995)

Zone I covers the southern and eastern rift valley areas of the Zambezi and Luangwa river basins. It also includes the southern parts of the Western and Southern provinces of Zambia. Zone II covers the sandveld plateau zone of Central, Eastern, Lusaka and Southern provinces, while Zone III is part of the Central African plateau covering Northern, Luapula, Copperbelt, and North-Western Provinces.

The main topographical and meteorological features of the three zones are presented in Table 3, where it is evident that the altitude and rainfall in Zambia increases from South to North as one moves from Zone I to Zone III. On the other hand, overall temperature decreases from the hot valleys of Zone I to the moderate plateau and mountain areas of Zones II and III.

Table 3: **Main Characteristics of Agro-ecological Zones of Zambia**

Agro-ecological Zone	Localities Covered (Provinces)	Mean Annual Rainfall	Altitude (m above sea level)	Annual Mean Temp. (^{O}C)	Temp. Range (^{O}C)
Zone I	Valleys of Luangwa (Eastern Province), Zambezi (Southern Province) and Western plains (Western province)	Less than 800mm	300 – 900	24.2	10.3 – 36.5
Zone II	Central, Eastern, Lusaka, Western and Southern Provinces	800 – 1,000mm	900 – 1300	21.2	6.3 – 33.7

Zone III	Copperbelt, Luapula, Northern and Northwestern Provinces	Above 1,200mm	1100-2000	20.7	5.7 – 32.1

Climate variability refers to deviations from the mean or average state of climatic parameters such as precipitation and temperature, sometimes resulting in the occurrence of extreme weather events over an area and for a period of time. Climate change is not expected to cause any new climatic events but rather to induce the long-term alteration of the frequency, magnitude and intensity of current climate variability.

Precipitation

The variability in rainfall in Zambia has been analysed by Chipeta and Mumba (2000) and the Centre for Energy, Environment and Engineering Ltd of Zambia (CEEEZ, 2006). The baseline or analysis period for these studies is 1970 – 2000. Rainfall variability has been studied at the scale of agro-ecological zones.

Two distinct rainfall periods were identified in Zone I in the duration of the baseline period. These were 1970–1980 and 1980-2000 according to rainfall trends. During the 1970–1980 decade there were five episodes of above average rainfall (684 mm) and five episodes of rainfall below average. A comparison of the two periods over the baseline period revealed that the 1980–2000 phase was relatively drier than the 1970 – 1980 decade. Overall, the rainfall pattern in Zone I revealed a tendency towards dryness over the 30-year period.

In Zone II, over the baseline period, 13 seasons had rainfall above the 30 year average (830 mm) while 15 had rainfall below average. The period of 1980–1990 experienced fewer occurrences of above average rainfall compared to the previous decade. The frequency and degree of below average rainfall increased in this period compared to the previous decade. The frequency and degree of dry episodes increased even further after the year 1990, with the most severe dry episode in 30 years experienced in the 1991/92 season.

Zone III exhibited a less variable annual rainfall compared to zone I and zone II. Overall, there were 16 occurrences of rainfall above average (1151 mm) and 13 occurrences below 30 year average. The abnormally wet seasons were 1997/98 and 2006/07, while the driest was 1996/97 in Zone III.

The two studies referred to above and the recent rainfall records have enabled the identification of the actual years of droughts and floods. The actual years of droughts and floods for Zones I and II are presented in Table 4 below.

Table 4: **Drought and Flood Years in Agro-ecological Zones I and II of Zambia**

Drought Years	Years of Heavy Precipitation
1972/73	1973/74
1981/82	1977/78
1986/87	1980/81
1991/92	1989/90
1994/95	-
1995/96	-
2000/01	1999/2000
2001/02	-
2004/05	2005/2006
-	2006/07

Drifts in Rainy Season Patterns

First rains used to fall in October or the first week of November, however in recent years the rain season in Zambia has tended to start in the second (11^{th} – 20^{th} day) or third (21^{st} – 31^{st} day) week of November in many areas of the country. In general there has been a tendency for late onset and early withdrawal of the rainy season since the early 1980s.

Temperature VariabilityError! Bookmark not defined.

Studies by CEEEZ (2006) and Chipeta and Mumba (2000) have also revealed that since the early 1970s, there has been a modest warming in the cool season (June – August) mean minimum temperature. Also considerable warming (by about $1^{o}C$) of the mean maximum temperature has been observed in the hot season (September – November), especially over the northern half of Zambia. A slight growing tendency of extreme temperatures was observed generally on all agro-ecological zones for the whole baseline period (1970–2000).

2.2 Future Climate Projections

Future climate projections for Zambia up to the year 2070 (CEEEZ, 2006) indicate the following:

- Zone I has become increasingly prone to droughts and this trend is projected to continue. There is also a slight growing tendency of extreme temperatures. It is more vulnerable to climate change/variability.
- Zone II is also subject to a trend of increasing climate variability and lower precipitation. There is a growing tendency of extreme temperatures
- Zone III rainfall has not historically declined and is projected to increase. It is less vulnerable to climate change/variability.

The Hadley Centre Coupled Model-Version 3 (HadCM3) has also projected increases in temperature and changes in rainfall amounts and patterns for the region of sub-Saharan Africa where Zambia is located. According to this model, Zambia is expected to experience a 5–20% decrease in length of growing (rainy) season by the year 2050 (DFID, 2006).

3 The current disease burden in Zambia

The adaptive capacity and vulnerability of the health sector in Zambia to the impacts of climate change can partially be gauged by the health status of the population, using the existing burden of disease in the country as an indicator. The burden of disease is measured by disease incidence and case fatality rates (CFRs). Disease incidence is the number of new cases that occur during a specified period in a defined population, while case fatality rate is the number of deaths from a particular illness out of reported cases resulting from that illness.

3.1 **Overall Disease Burden**

Table 5 below shows the first top ten causes of visitations to the health facilities in Zambia in 2005 (MoH, 2005). It is evident that the top three major causes of illnesses in Zambia in all age groups include malaria, respiratory infection (non-pneumonia) and diarrhoea (non-bloody).

Table 5: **Ten Major Causes of Visitation to Health Facilities, Zambia 2005**

Disease Name	Incidence Rate per 1,000 Population		
	Under 05 yrs	05 yrs and Over	Total
Malaria	1,108	197	373
Respiratory Infection: non-pneumonia	469	87	161
Diarrhoea: non-bloody	258	31	75
Eye Infections	145	14	40
Respiratory Infection: pneumonia	132	21	42
Skin Infections	111	26	42
Trauma	57	43	46
Ear/Nose/Throat Infections	57	16	24
Digestive System: not infectious	23	18	19
Muscular Skeletal	5	21	18
Source: MoH, Health Management Information System (HMIS), 2005			

Malaria is the highest cause of morbidity in the country and it remains a major public health problem in Zambia, accounting for nearly 40 percent of all outpatient attendances and 50 percent of cases among children under-five years of age. It is estimated that malaria is responsible for nearly 4 million clinical cases per year in Zambia.

Table 5 also indicates that with the exception of muscular skeletal illness, all the other diseases exhibit the highest incidences in children of less than 5 years of age. In fact, the incidence rates for children under 5 years of age for malaria, respiratory infections, diarrhoea and pneumonia were 5.6, 5.1, 8.4 and 6.5 times, respectively, more than for persons in the older age group. Children of less than five years of age are, therefore, the most vulnerable to the current burden of disease in Zambia.

3.2 **The Disease Burden at Provincial Level**

It has been shown above (Table 3) that the various administrative provinces of Zambia are located in various agro-ecological zones with different meteorological and topographical features. The effects of climate change impacts on health may, therefore, be discerned from the distribution and prevalence of the different diseases in the provinces. It is, therefore, necessary to examine the variations in morbidity and mortality levels at the provincial scale for the common diseases in Zambia.

Table 6 shows the morbidity and mortality rates for five climate-sensitive diseases in the urban and rural provinces of Zambia. The mortality data must be interpreted with caution as they only cover hospital admissions and all the deaths in health centres and communities are not included.

Table 6: **Morbidity and Mortality Rates for the Provinces of Zambia in 2005**

	Incidence of Diseases per 1,000 Population								
	Urban Provinces				Rural Provinces				
	Lusaka	**Copper-belt**	**Central**	**Southern**	**Luapula**	**Northern**	**North-Western**	**Eastern**	**Western**
Malaria	313	377	331	344	407	331	439	447	430
Respiratory	157	192	160	212	125	126	190	140	134
Diarrhoea	114	78	65	77	73	50	81	67	59
Pneumonia	63	47	30	25	60	30	41	47	32
Dysentery	4	5	7	12	6	4	4	9	7
Case Fatality Rates (CFRs) per 1,000 Hospital Admissions									
Malaria	50	51	50	55	51	32	24	68	36
Respiratory	14	41	55	71	23	6	35	48	38
Diarrhoea	63	103	81	131	62	27	52	93	85
Pneumonia	96	129	125	125	100	73	76	107	99
Dysentery	-	28	44	152	0.0	28	62	82	67

Malaria

The National Health Strategic Plan (NHSP) of the Ministry of Health of 2001–2005 set the target to reduce the incidence rate of malaria to 300 per 1,000 population by the year 2005. However, this target is yet to be achieved at both the national and provincial levels, as shown by the data presented in Table 6. The only provinces that appear to be closing on this target are those in urban areas. This may be due to the fact that urban provinces have had relatively higher access levels to national malaria treatment and control measures which include the following:

- Substitution of chloroquine (due to parasite resistance) with the relatively expensive coartem for malaria treatment.
- Distribution of insecticide treated mosquito nets to various vulnerable groups including pregnant women and children, and
- Indoor residual spraying of households for mosquito control

Table 6 also shows that out of the rural provinces, Northern has the lowest morbidity rates for malaria. This province experiences relatively lower temperatures as it is located in the high-altitude segment of agro-ecological zone III. This may impede the widespread transmission of malaria.

The fatality rates due to malaria in urban and rural areas were highest for Southern and Eastern provinces, respectively. Incidentally, these two provinces are located in agro-ecological zones I and II which have in recent years been prone to extreme climatic events of droughts and floods (Table 4). The impacts of these climatic extremes on malaria in Zambia have yet to be determined.

Malaria is currently a national health disaster in Zambia accounting for about 50,000 deaths annually, including up to 20 percent of maternal mortality. According to Kapelwa (2001), it also accounts for the greatest number of Disability Adjusted Life Years (DALYs) lost (6.8 million). The most vulnerable population groups include children, pregnant women and people living with HIV/AIDS.

Respiratory and Pneumonia Infections
Table 6 points to the fact that the provinces with the highest incidence rates for respiratory infections are the Copperbelt and Southern for urban areas, and the North-western for rural provinces. The actual risk factors responsible for the proliferation of these infections in the given provinces have not yet been studied and explained. Suffice to mention that all these provinces are currently major mining areas and the air pollution effects of ore mining and processing are well-known and visible in this country. The provinces with relatively high CFRs were Southern, Central and Eastern which incidentally are all located in the drought-prone areas of Zones I and II.

Pneumonia morbidity was highest in Lusaka and Luapula while fatality cases were highest in all the urban provinces except Lusaka. On the other hand, the rural provinces with relatively high fatality rates were Luapula and Eastern. In fact pneumonia is currently the deadliest disease in Zambia even though its morbidity levels are relatively low.

Diarrhoea and Dysentery
Table 6 indicates that there are more people suffering and dying from diarrhoea in urban than in rural areas. In fact the highest incidence rates were recorded for Lusaka province which is dominated by the capital city (Lusaka) of Zambia. The other urban provinces of Copperbelt and Southern topped the list with CFRs of more than 100 deaths per 1,000 hospital admissions. This may be attributed to overcrowding and poor sanitation in urban areas. For example, the population density in Lusaka province is 63.5 persons/km^2 while that for North-Western province is a mere 4.6 persons/km^2 (CSO, 2001a).

In 2005, the morbidity and fatality rates for dysentery were highest in the Southern and Eastern provinces (Table 6). It has been indicated above that these two provinces are the drought-prone areas of Zambia. However, it still remains to be investigated as to whether climate variability is a major risk factor in the epidemiology of dysentery in Zambia.

3.3 **Health Aspects of the Millennium Development Goals**

It has been shown in the sections above that the current disease burden in the country is quite high and consequently, achievement of the health-related Millennium Development Goals (MDG)-targets will require drastic shifts in health policy and investment. The MDG framework is a global attempt to operationalize a multi-dimensional approach to poverty reduction and improvement of human welfare.

The MDGs that directly address or have a significant bearing on human health in Zambia are presented in Table 7. From this, it is very evident that the current health and welfare statuses of Zambians are extremely poor and that there is a large gap between the 2015 MDG-targets and the existing human health indices.

According to the 2005 MDG report on Zambia (United Nations, 2005) five targets are perceived as likely to be achieved by 2015. These are: halving the proportion of people living in extreme poverty and those suffering from hunger; ensuring that children everywhere, boys and girls alike, will complete a full course of primary schooling; eliminating gender disparities in all levels of education; and having halted and began reversing the spread of HIV and AIDS. Similarly, three targets were perceived to be potentially achieved by 2015 although with lesser optimism: reducing under-five mortality by two thirds, halting and reversing the incidence of malaria and other major diseases and halving the proportion without sustainable access to safe drinking water and sanitation. On the other hand, two targets: reducing the maternal mortality ratio by three-quarters and reversing the loss of environmental resources, are unlikely to be achieved by 2015.

Table 7: **MDG Target-indicators of human health and welfare in Zambia**

INDICATOR	1990/1992	2002/2003	2015 MDG-TARGET
Proportion of people living in extreme poverty	58%	46%	29%
Proportion of people living in extreme hunger	25%	28%	12.5%
Under-five mortality ratio(per 1,000 births)	191 (1992)	168	63
Infant mortality ratio (per 1,000 births)	107	95	36
Maternal mortality ratio (per 100,000 live births)	649	729	162
Epidemiological Sentinel Surveillance System (ESS) trends in HIV infection among Antenatal Clinic Attendees	20% (1994)	40%	19%
New malaria cases per 1,000 population	255	383 (2004)	<121

Source: United Nations, 2005

In fact the National Health Strategic Plan 2006–2010 (MoH, 2006) concludes that despite discrete and sustained improvements in some indicators, it is unlikely that Zambia will meet most of the MDG targets by 2015. The high disease burden in Zambia is compounded by several factors, including the impact of the HIV/AIDS epidemic, high poverty levels, inadequate health care facilities and providers, low access to safe water supplies and sanitation, chronic food insecurity and the general poor macroeconomic situation. There is also the additional burden of the existing risks from climate variability that can substantially impede progress towards meeting the MDG-targets.

SECTION II

4.0 **CASE STUDY**

The postulated interactions between climate and health are presented in Fig.2 (WHO, 2003a) below. Broadly, a change in climatic conditions can affect human health directly either by impacts of thermal stress or death/injury occasioned by floods or storms. The indirect effects include changes in the prevalence and ranges of disease vectors (e.g., mosquitoes), water/food/rodent-borne pathogens, water/air quality, and food availability and quality. The actual health impacts will be strongly influenced by local environmental conditions and socio-economic circumstances. Conceptually Fig. 2 shows that climate variability/change has the potential to erode the assets and livelihoods of a given population through its adverse effects on human health.

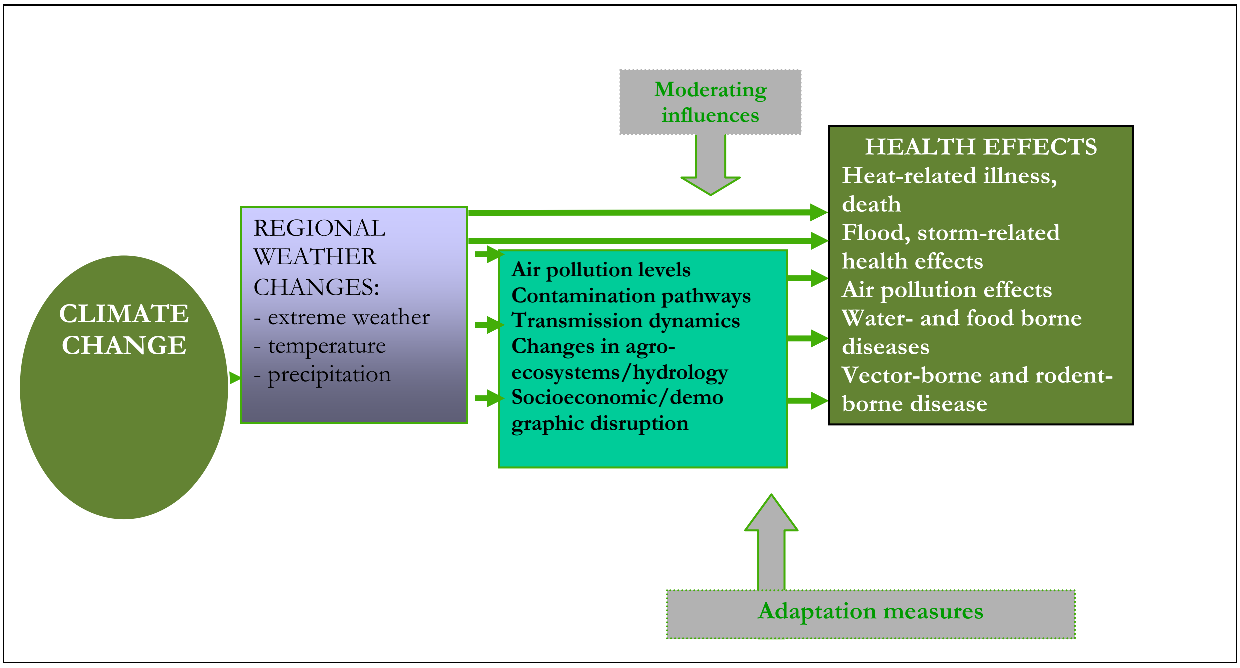

Fig.2: **How climate change affects health**

It has been shown above (Section 2) and through field surveys conducted under the National Adaptation Programme of Action on Climate Change (MTENR, 2007) and the IUCN (Riché, 2007) that Zambia is vulnerable to climatic hazards in the form of droughts, floods, extreme heat and shifts in length of rainy season (Table 8). It is evident from Table 8 that almost all the prevailing climatic hazards in Zambia have a negative effect on health, either through increased outbreaks of diseases or actual loss of life. However, despite the increased frequency of these hazards in the last decade, Zambia has not yet developed any climate-informed policies for the health sector. This might be due to the paucity and actual unavailability of information on climate-disease interactions in Zambia.

Table 8: **Main Impacts of Climate Hazards in Zambia**

Drought	Floods	Extreme Heat	Shorter Rainy Season
• Crop damage/loss, leading to food scarcity and hunger • Water shortages • Reduced fish stocks • Income loss • Reduced charcoal business • Increase in diseases (affecting humans and animals) • Decreased water quality • Increased soil erosion • Decreased soil fertility • Increased honey production (if drought is not too severe)	• Crop damage/loss, leading to food scarcity and hunger • Loss of crop land and grazing ground • Decline in fish catches • Increase in diseases (malaria, dysentery, cholera, etc.) • Destruction of infrastructures (houses, roads) • Life loss (humans and livestock)	• Increase in diseases affecting animals, crops and humans (especially malaria) • Decreased human capacity to do work • Loss of life (animals and humans) • Crop damage/loss • Reduced fish stocks • Decreased livestock feed • Reduced water quality	• Decreased crop yields • Crop damage/loss • Decreased income from crop selling • Crop seeds do not reach maturity (which negatively affects the next crop generation) • Reduced charcoal production and business

Source: Riché, 2007

This case study attempts to shed some light on climate-disease interactions in Zambia. This will be achieved by identifying climate-sensitive diseases through simple correlations between climate and disease variables, and by documenting ill health outcomes associated with occurrences of extreme climatic events.

4.1 The Sensitivity of Diseases to Climate in Zambia

A climate-sensitive disease is an illness that is sensitive to weather or climate factors, with the current spatial distribution and seasonal transmission being affected. In an attempt to identify climate-sensitive diseases in Zambia, data on morbidity and fatality levels for various diseases in Chadiza and Mazabuka districts were collected from the Ministry of Health (Health Management Information Section) headquarters in Lusaka and the District Health Office in Mazabuka, respectively. Monthly temperature and rainfall data for both districts were collected from the Department of Meteorology in Lusaka.

Under standard procedures, the relationship between climate and disease variables is determined using various types of models. For best results, it is recommended to use daily or weekly time-series data. However, these models and daily/weekly health data were not accessible in this study, hence monthly or tri-monthly health data and simple statistical correlations were used.

4.1.1 Effect of Rainfall on Disease Patterns

In order to assess the effect of rainfall on disease manifestations in the population, simple correlations were made between health and climate data for Mazabuka District of the Southern Province and Chadiza District of Eastern Province. Mazabuka and Chadiza districts had populations of 240,000 and 82,400 persons in 2000 (CSO, 2001a). These two districts are located in the climate variability-prone areas of agro-ecological zone II.

Table 9: **Variation in Cases of Diseases with Rainfall in Mazabuka District**

	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005
Rainfall (mm)	840.6	851.6	759.4	617.6	825.7	748.5	583.7
Rainfall Distribution (mm)	771.4	596.3	606.3	356.1	593.0	427.2	322.3
Malaria (cases)	81,732	50,792	76,145	63,175	94,157	64,308	59,533
Diarrhoea (cases)	11,986	13,764	14,783	14,351	16,211	14,388	15,605
Non-Pneumonia (cases)	25,737	23,196	26,558	25,880	32,861	29,490	38,653
Pneumonia (cases)	-	3342	6105	3,768	4,919	4,083	3,074
Dysentery (cases)	2,879	2,758	3,606	3,659	2,294	2000	2,183

The cases of diseases in Table 9 represent the totals (under 5 and over 5 year olds) but covering only the months of the rainy season (4^{th}, 1^{st} and 2^{nd} quarters of the years). The rainfall data is presented as both rainfall and rainfall distribution in Table 9. Rainfall is the total rainfall for the particular season, while **rainfall distribution** is total rainfall for the particular season but adjusted for the number of rainy days according to the formula of Gilles :

Total rainfall x Number of rainy days/Number of rainy days in month

Rainfall distribution is considered to be a better indicator than total rainfall in assessments of malaria prevalence (Kapelwa, 2001). The mean (1980–2006) seasonal rainfall for Mazabuka was calculated to be 706.4mm.

One cannot expect a direct dose-response effect between rainfall and disease, as the relationship is non-linear due to various confounding factors such as temperature, socio-economic conditions, levels of population immunity, cultural habits and impacts of existing intervention measures. Sophisticated models are required to determine the exact relationship. However, for our purposes, simple linear regression was used to simply determine the general qualitative direction of the dose-response relationship between rainfall distribution and disease occurrence (Table 10). The correlations were significant at the $P< 0.05$ level.

Table 10: **Rainfall Distributuion-Disease Correlation Matrix (1980 -2006)**

Disease	Correlation Coefficient
Malaria	0.56
Diarrhoea	-0.47
Respiratory infection: Non-pneumonia	-0.13
Respiratory infection: Pneumonia	0.70
Dysentery	-0.09

The response of the manifestations of disease to rainfall is varied and very disease-specific. Table 10 indicates that malaria increased as rainfall increased. Cases of malaria showed increased sensitivity to rainfall distribution compared to total rainfall. In fact, the correlation coefficient increased by 47% when rainfall distribution was used instead of total rainfall. The correlation matrix also shows a positive correlation between rainfall and malaria (Table 10). Scrutiny of Table 9 suggests the presence of some quantitative thresholds with regard to the effect of rainfall on malaria and these can only be better determined with further research.

The responses of diarrhoea and non-pneumonia respiratory infections to rainfall are not very clear-cut. In 2002/2003 both diseases respond positively to increased rainfall after the drought year of 2001/2002. However, in the drought year of 2004/2005 the cases also increase after the normal rainy season of 2003/2004 (Table 9). In fact they both correlate negatively with rainfall (Table 10). In the case of diarrhoea, this might be explained by the fact that in rural settings droughts lead to reduced supplies of water. These diminished water sources can result in poor personal hygiene and reduced dilution capacity for dangerous pathogens, resulting in an overall increase in diarrhoea cases. In comparison, in urban settings increased rainfall carries pathogens to humans as poor sanitation facilities begin to overflow or break down. Dysentery also appears to increase with drought conditions (Table 9) and is negatively correlated with rainfall (Table 10). Pneumonia has a relatively higher positive correlation with rainfall and the trends are similar to those of malaria.

The purpose of this section is to demonstrate that climatic variables can influence significant changes in the incidence of diseases. Calculation of the data in Table 9 indicated that malaria cases increased by 49% in just one year from the drought season of 2001/02 to the normal rainy season of 2002/2003. The National Malaria Control Centre of Zambia (1999) also found that in Lundazi district of the Eastern province, the malaria incidence rate in the wet year of 1996 was 885.7 cases/per 1000 people but fell to 215.8 cases/per 1000 people in the drought year of 1998. This is also evident in the data from Chadiza as presented in Fig. 3, where it is shown that malaria cases rose with increased rainfall in the area. Particularly notable are the reductions in malaria cases during the drought year of 2002.

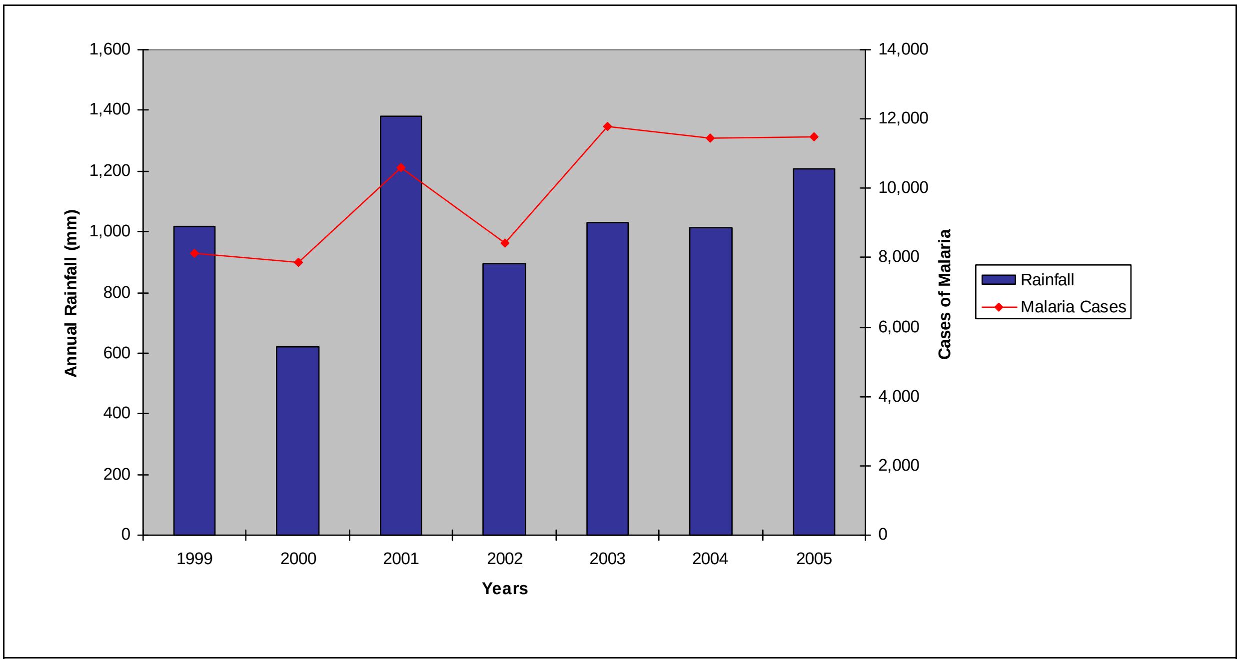

Fig.3: **Variation of Malaria Cases with Annual Rainfall in Chadiza**

Monthly data collected from Itebe clinic of Mazabuka district also confirmed the observation that increased rainfall can influence malaria epidemics even in malaria endemic areas. In Itebe clinic catchment area the cases of malaria quadrupled from the drought year of 2004/05 to the flood year of 2005/06 (Fig.4). Surprisingly, contrary to the national pattern, this riverine (Kafue River flood plain) community of fisherfolk and herdsmen of Itebe, had malaria incidence rate for children under 5 years two times lower than older persons in 2005/06. The impact of epidemics has been noted to be particularly severe when they follow prolonged periods of drought and famine (WHO, 2005).

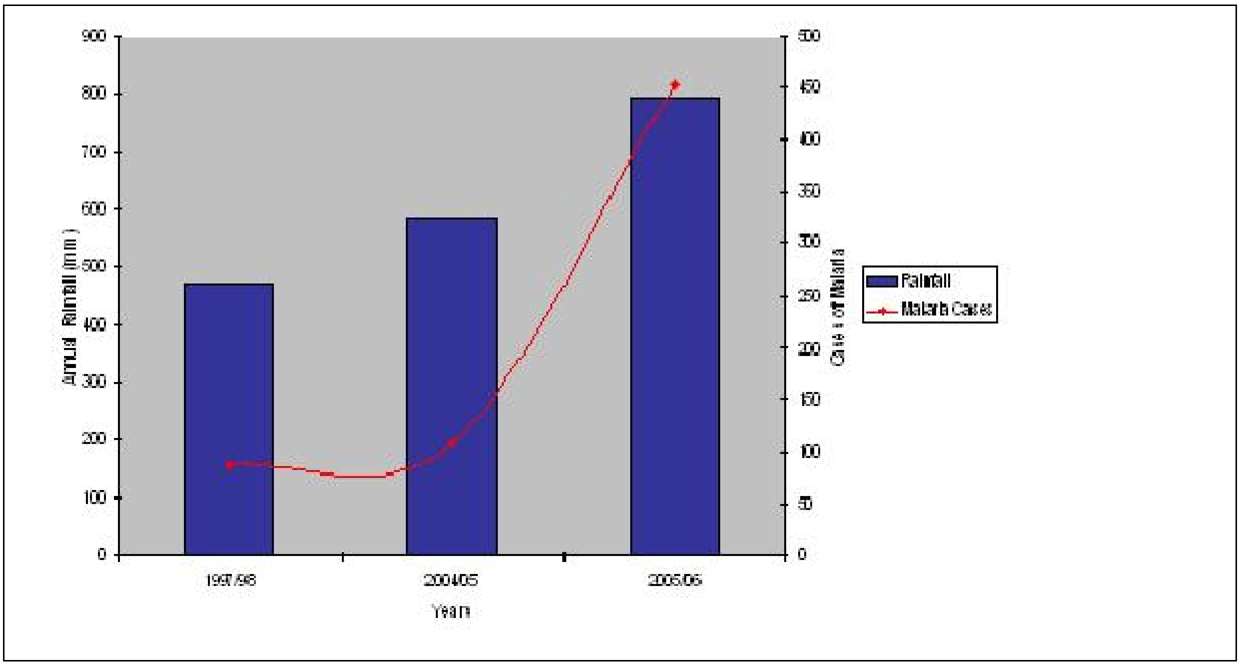

Fig. 4: **Rainfall effects on Malaria at Itebe clinic**

4.1.2 **Effect of Temperature on Disease Patterns in Zambia**
In order to explore the sensitivity of the various diseases to temperature, monthly data on morbidity and mortality levels for Chikankata Hospital of Mazabuka District was collected for the period of 1998–2002. The climate data used was for Magoye meteorological station of Mazabuka. Health data was analysed with respect to the three distinctive seasons in Zambia. The idea was to use the seasons as proxy indicators for the transitional changes in temperature.

The analysed data is presented in Table 11 below. These data confirm the results presented in Tables 9 and 10 above, in that there is increased morbidity (mean admissions/month) from malaria and pneumonia during the rainy and hot season. On the other hand, hot and dry conditions favour the preponderance of diarrhoea, non-pneumonia respiratory infections and dysentery. Morbidity due to HIV/AIDS is nearly almost evenly spread throughout the three seasons. This may be attributable to the multiplicity of opportunistic infections that can cause hospitalisation of HIV-infected persons. However, there is a slight increase in hospital admissions for HIV/AIDS patients during the cold-dry season.

Table 11 further confirms that of the diseases analysed, HIV/AIDS is the deadliest infection with CFRs of about 500/per 1000 admissions, implying that half of the persons hospitalised during that time (1998–2002) never returned home. In this respect and in decreasing order of CFR values, HIV/AIDS is followed by diarrhoea, pneumonia, non-pneumonia and malaria.

In the case of malaria and diarrhoea, increased morbidity is accompanied by increased mortality within the same seasons, i.e., during the rainy-hot and hot-dry seasons, respectively. However, in the cases of dysentery, pneumonia and non-pneumonia, the highest mortality levels occur during the cool-dry season, while their highest morbidity levels occur in other seasons. In short, cool-dry conditions appear to influence death from these diseases (Table 11).

Table 11**: Seasonal variations in the occurrence of diseases at Chikankata Hospital**.

Disease	**Indicator**	**Rainy-Hot Season** Nov - April (Temp. range: 13.7-33.5^{o}C; Mean Temp: 24.1^{o}C)	**Cool-Dry Season** May - July (Temp. range: 6.1 – 29^{o}C; Mean Temp: 17.5^{o}C)	**Hot-Dry Season** Aug – October (Temp. range: 10.8 – 35.3^{o}C; Mean Temp: 23.0^{o}C)
HIV/AIDS	Mean Admissions Per Month	25	26	21
	Mean Deaths per Month	12	13	10
	CFR/1000 Admissions	464	506	500
Dysentery	Mean Admissions Per Month	11	6	19
	Mean Deaths per Month	0.2	0.7	0.0
	CFR/1000 Admissions	14	105	0.0
Diarrhoea	Mean Admissions Per Month	43	57	68
	Mean Deaths per Month	3	5	9
	CFR/1000 Admissions	61	94	132
Malaria	Mean Admissions Per Month	428	337	252
	Mean Deaths per Month	16	9	8
	CFR/1000 Admissions	36	28	34
Pneumonia	Mean Admissions Per Month	55	48	49
	Mean Deaths per Month	2	5	4
	CFR/1000 Admissions	42	111	96
Non-pneumonia	Mean Admissions Per Month	48	56	75
	Mean Deaths per Month	0.8	5	3
	CFR/1000 Admissions	17	83	40

4.1.2.1 **Effect of Temperature on Malaria Distribution in Zambia**

The sensitivity of malaria to climate in Zambia has actually been demonstrated by the Malaria Risk in Africa (MARA) project that used a climate-driven model (WHO, 2003b) to develop a climate-suitability map of malaria for Zambia (Fig.5). Kapelwa (2001) has noted that temperature, humidity, and rainfall are the three main climate factors that influence the transmission of malaria. Malaria parasites cease to develop in the mosquito when the temperature is below 16^{o}C. The best conditions for the development of *Plasmodia* (parasites) in the *Anopheles* mosquito is when the mean temperature is within the range of 20 – 30^{o}C, while the relative humidity is at least 60%.

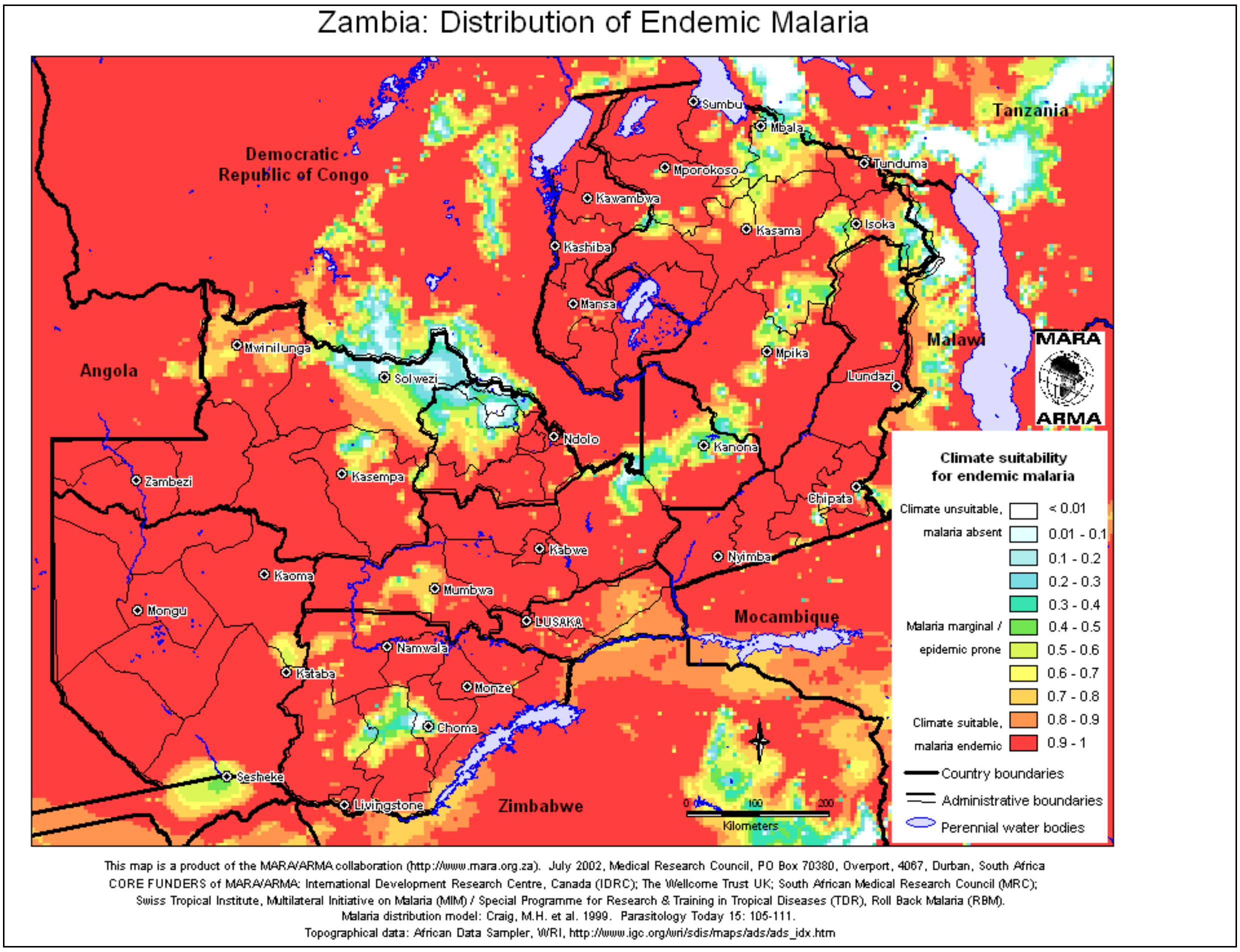

Fig.5: **Climate Suitability for Malaria in Zambia**

In an attempt to validate and understand the epidemiological utility of the MARA map (Fig.5), locations with different climate suitability indices were selected and their actual malaria incidences were compared to the 2002-2003 malaria data obtained from the Ministry of Health. The results are given in Fig. 6 below.

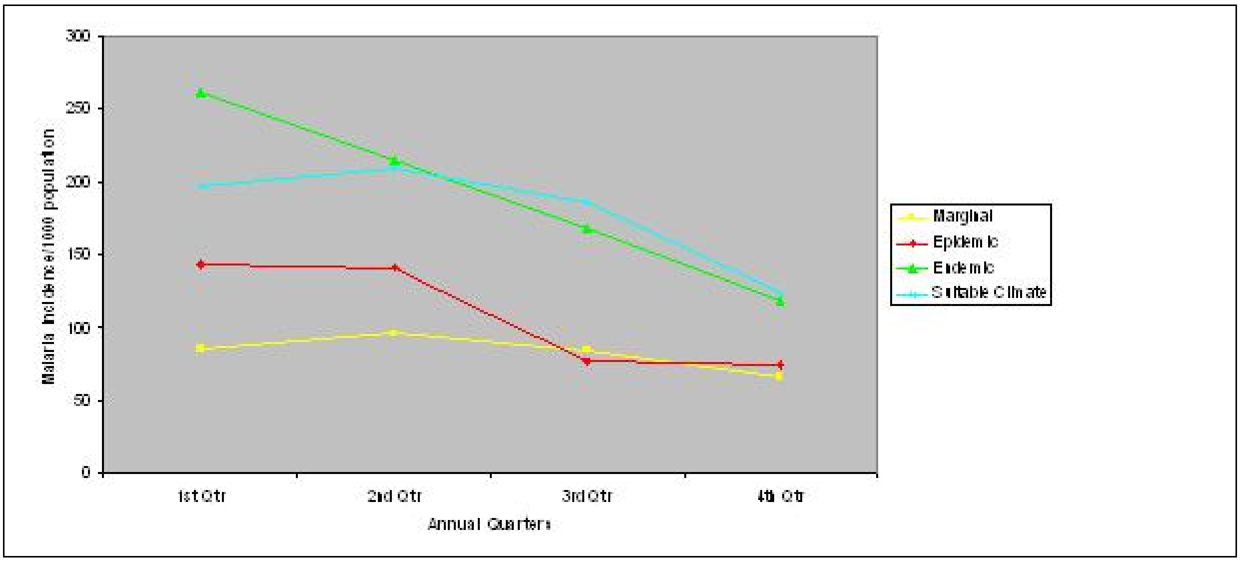

Fig. 6: **Patterns of Malaria Prevalence in the Climatic Zones Defined by MARA Map for Zambia**

In the zones designated as marginal and epidemic areas, the incidences of malaria are relatively low. However, in marginal areas the incidences are perennially low with almost a stable morbidity level through out the year. In the case of epidemic-prone areas, the incidence rates maintain low levels in the 3rd and 4th quarters of the year and by the 1st quarter (peak transmission period) malaria outbreaks begin to occur, with incidence rates practically doubling. This condition persists up to the 2nd quarter of the year. According to Kapelwa (2001), climatic conditions and population immunity are crucial factors in the genesis of epidemics. In epidemic-prone areas, climatic conditions are unfavourable for the malaria vector (mosquitoes) during certain periods of the year and this lowers the entomological inoculation rates, resulting in low immunity of the population. Epidemics are most likely to occur in areas where the collective immunity of the population is low (Macdonald, 1957). Apparently, in marginal areas the conditions are such that the contact between humans and the A*nopheles* vector is maintained within comparatively minimum levels throughout the year, without any sudden increases of the number of vectors in particular seasons. The representative districts used in this study for marginal and epidemic-prone zones were Mpika (Northern Province) and Mumbwa (Central Province).

In zones classified as endemic and climate-suitable, the malaria incidence rates are relatively very high (Fig. 6). In endemic areas, the malaria incidence rates peak in the first quarter (malaria season) and then start to drop linearly until the fourth quarter when they are almost halved. On the other hand, in climate-suitable areas, the high incidence rates tend towards stability for almost the entire year until the fourth quarter when they exhibit some level of decline. The representative districts identified in this study were Nyimba and Luangwa for endemic and climate-suitable areas.

The selected localities (Luangwa, Nyimba, Mumbwa and Mpika) were further analysed by comparing their average annual malaria incidence rates with their location-specific altitude and average minimum temperatures, the results are presented in Fig.7. It is evident again here that the distribution and transmission of malaria are functions of temperature and altitude. High-altitude (above 1200m) areas with their usually mild temperatures constitute the marginal and epidemic malaria zones, while the hot low-lying areas provide suitable climatic conditions for endemic malaria. The selected high-altitude districts of Mumbwa and Mpika at elevations of 1218m and 1402m above sea level actually experience frost conditions, especially during the cold season, while the low-lying districts of Luangwa and Nyimba at elevations of between 300 and 900m do not.

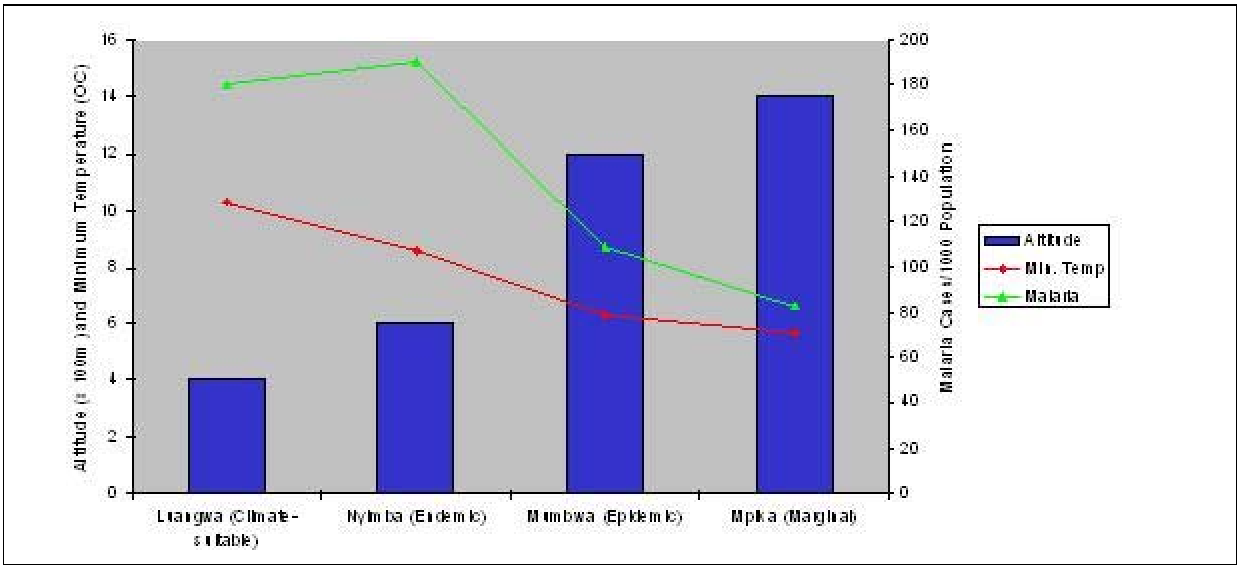

Fig. 7: **Temperature and altitude effects on Malaria distribution in Zambia**

According to Kapelwa (2001), in Zambia, malaria is hyper- to hypo-endemic in hot river valleys with perennial transmission. The plateaus are generally meso- to hyper-endemic while urban areas on the plateau are hypo- to meso-endemic. The rural plateaus of Zambia are epidemic-prone areas. Generally, malaria is stable in the valleys and unstable on the plateaus and higher grounds.

In the context of Zambia, therefore, the MARA map can be interpreted to indicate that the valley areas of agro-ecological zone I constitute the climate-suitable and endemic areas for malaria transmission. The marginal and epidemic-prone areas can be found in the plateau and mountain regions of agro-ecological zones II and III.

4.2 **Observed Health Effects of Droughts and Floods in Zambia**

It has been shown and documented above that climate disasters have now become an annual feature, ravaging livelihoods and disrupting Zambia's socio-economic plans and programmes. Consequently, the government has formed the Vulnerability Assessment Committee (VAC) under the auspices of the Disaster Management and Mitigation Unit in the Office of the Vice-President. The mandate of the VAC is to assess the impacts of climatic hazards on household livelihoods, determine the food and other relief requirements of the affected areas and recommend appropriate immediate and long-term interventions. The facts presented below were extracted from the VAC reports and observations of the author.

4.2.1 **Impact of Drought on Human Health in Zambia**

Zambia and the entire southern African sub-region experienced drought during the 2004/05 agricultural season. Two thirds of Zambia, mainly the Southern, Eastern and Western provinces of Zambia, experienced prolonged dry spells resulting in irreversible agronomic damage to most crops, including drought tolerant crops such as cotton and tobacco. The health-related outcomes of the 2004/05 drought are presented below.

Food Security

In the drought-affected areas of the country that were visited by the VAC (ZVAC, 2005), cereal (staple food) production losses ranged from 30 to 80% with an average of 56%. Using a food gap analysis, it was established that a total population of 1,232,661 persons were in need of food assistance in the drought-hit districts. A total of 118,335 MT of cereal was required for a period of 8 months, from July 2005 to February 2006. In actuality, some of the affected districts continued to receive food aid until June 2006 when the year's harvests began to stabilize local food supplies.

Nutrition

Overall, the prevalence of child malnutrition during the drought, as measured by child's Mid Upper Arm Circumference (MUAC), was 15.5% with a range of 16.7 – 26.6%, while oedema was at 1.9% with a range of 2.3 -3.8%. Malnutrition was more prevalent in male children (mean of 21.2%) than in female children (mean of 9.5%). The children with high risk of mortality (MUAC less than 11 cm) ranged from 3.2% to 6.9%. It was established that 51% of the children had inappropriate diet diversity score. Although the ZVAC assessment used the MUAC, other assessments (CSO, 2003) used weight and height measurements to determine malnutrition. They concluded that these areas historically suffer from a chronic shortage of food and poor dietary intake, with stunting (indicator of chronic malnutrition) levels of between 40 and 59%. The impact of climatic extremes is, therefore, to worsen the already existing poor nutritional status of the people.

Health

The ZVAC study additionally revealed that for children in the drought affected areas, 43% had diarrhoea, 62.6% had fevers, and 48.8% had coughs within a week prior to the survey. A similar high proportion was seen in children with acute malnutrition during the same survey period. Proportions of diarrhoea, fever, cough and difficulties in breathing among under-five children was the highest among children aged 6–23 months.

Among members of households who got sick during the two weeks prior to the survey, 7.7% did not seek health care. Around 57.2% sought care from formal health facilities, 5.1% got home-based cared (own medication), 3.2% from a pharmacy or dispensary, 2.7% from private care, and 2.6% from a traditional healer.

The overall mortality rate (CMR) for the six months prior to the survey was 0.7 deaths per 10,000 per day. However, some areas had unacceptably high CMRs of up to 1.3. Among the household members who died during the 6 months prior to the survey, 17 percent had been chronically ill for more than 3 months. About 20.7 percent of the adults in the study area have been chronically ill for more than 3 months during the 12 months prior to the study. Amongst them, 6.4% were heads of households. This situation has a potential to adversely impact food and income sources for the directly affected households. It is clear that climatic extremes act as additional socio-economic burdens that further erode the health and livelihoods of the affected people.

Water

The main sources of drinking water in the communities surveyed were unprotected shallow wells, unprotected spring, unprotected deep wells, protected deep wells, and village boreholes. About two thirds of households in all assessed areas did not treat water (ZVAC, 2005). Among the areas covered, there were special cases with at least 51% having experienced drying up of water sources. Water supply for livestock in many areas was a source of concern and the situation was likely to worsen later on in the year.

Potential Hazards in Drought-Affected Areas

The ZVAC study also identified chronic and periodic hazards to which the people in the drought-affected areas were usually subjected. There were two main chronic hazards in the areas visited: mainly human-wild animal conflict and crop/livestock diseases. The periodic hazards common across all zones were erratic rainfall, floods, poor crop marketing and input distribution, and limited water sources especially for livestock. The main periodic hazard in the zones visited was erratic rainfall. This most often meant long dry spells, which are few rainy days with sufficient rainfall amounts or generally inadequate rainfall. Such events tended to create transitory food insecurity in most zones.

4.2.2 The Health impacts of the 2005/06 and 2006/07 Floods

Zambia experienced excessive rainfall during the rainy seasons of 2005/06 and 2006/07 that caused widespread flooding in most parts of the country (ZVAC, 2006/2007).
In 2005/06 the most affected regions were those of agro-ecological zone I, while the floods of 2006/07 covered all the three agro-ecological zones of Zambia. The health-related impacts of these floods can be summarised as follows below.

- A total of 1,443,583 people in 41 districts were affected by floods and required assistance in the rehabilitation of their houses, latrines, water wells, schools, clinics, roads and other infrastructure over the next year.
- The lives and livelihoods of 295,148 people were directly threatened, demanding an urgent response to their needs, especially of emergency food relief.
- 10,954 houses were destroyed by floods, leaving 17,172 people in need of emergency shelter.
- There was a high risk of water contamination, especially from faecal matter, in 78% of the affected areas, affecting 1,012,540 people. This originated from the floods collapsing toilets and flooding unprotected shallow wells.
- 14 districts were at the highest risk for malaria outbreaks. The total number of flood-affected people in these districts was estimated at 288,532.

- The floods negatively affected the education sector, with damage to classroom blocks, staff houses and toilets of up to 160 schools in 31 districts of six provinces, disrupting the education of about 150,000 children.
- Over 5,000 cases of cholera and 137 deaths were recorded in Lusaka. Outbreaks of rabies,
  plague, and trypanosomiasis also occurred in some localities.
- Conversely, floods also presented an opportunity to promote dry season cropping, as the receding floods left sufficient moisture and nutrients in the affected wetland areas to allow cultivation of crops.

It has been demonstrated above that Zambia is very vulnerable to impacts of climate variability and that extreme weather events of this nature cause devastating public health and developmental problems for the country. Climate models (section 2.2.4 above) have also projected that these extreme conditions will persist in the future. There is, therefore, the need for Zambia to find sustainable solutions to hazards associated with extreme climatic events and variability.

SECTION III

5.0 **KEY VULNERABILITIES**

It is evident from the preceding sections that the health sector in Zambia is very vulnerable to the impacts of the changing climate. To reduce this vulnerability and improve the adaptive capacity of the sector, Zambia must address the health risk factors and target the interventions to the vulnerable populations and localities. This section of the report, therefore, examines some of the prevailing risk factors or determinants of health and the vulnerable population segments and localities in Zambia.

5.1 **Health Risk Factors in Zambia**

The main determinants of health in Zambia have not yet been explicitly identified and their contribution to the overall disease burden has yet to be assessed and quantified. However, these risk factors can include the state of the health care delivery systems, water supply and sanitation, poverty and nutrition.

5.1.1 **Health Care Facilities**

The health care system in Zambia comprises of government, mission (churches), industrial, and private sector health facilities. The structure of public health facilities operated in Zambia is composed of hospitals, health centres, and health posts. The actual number of health facilities in 2002 is presented in Table 12 below.

Table 12: **Summary of Existing Health Facilities in Zambia**

Type/Level	Government	Mission	Private	Total
Hospitals	53	27	17	97
Health Centres	1,052	61	97	1,210
Health Posts	19	0	1	20
Total	1,124	88	115	1,327

Given a population of Zambia of around 10 million in 2002 (9,885,591 in 2000), the availability of these facilities translates on average into one hospital per 100,000 persons, one health centre per 8,000 individuals, and one health post per 500,000 persons. The shortage of health facilities poses a serious constraint to access of health services in Zambia. In urban areas, 99% of households are within 5km of a health facility, while only 50 percent of households are within 5km of a health facility in rural areas. A survey (CSO, 2001b) found that almost sixty percent of respondents cited the distance from a facility as a problem in securing access to health care. Hunger during droughts and floods also lowers peoples' ability to seek health services at distant health centres. Floods further restrict access to health services by flooding and/or damaging roads, bridges and health facilities.

5.1.2 **Health Personnel and Supply of Medical Drugs**

The human resource situation for the health sector in Zambia is very close to being a disaster. In February 2005, Zambia had a total of 703 medical doctors and of these only 391 were Zambians. Given a projected population of 11, 297,304 in 2006 (MoH, 2006), the average doctor to population ratio is about 1:16,000 while the nurse to population ratio is currently around 1: 1,900. The World Health Organization has recommended the Staff/Population ratios for Africa of 1:5,000 and 1:700 for doctors and nurses respectively. Consequently, health institutions are grossly understaffed resulting in severe deterioration of service delivery, especially during periods of disease outbreaks caused by either floods or drought.

Essential drugs and medical supplies still pose vexing challenges to the health system in Zambia. Over the past 4 years, the bulk supply of essential drugs and medical supplies was erratic, with as much as 50 percent of essential drugs being out of stock. However, the availability of basic medicines in rural health centres has been reported (MFNP, 2006) to be fairly steady.

5.1.3 **Water Supply and Sanitation**
Based on constructed and rehabilitated facilities, access to safe water supplies in Zambia in 2000 was estimated at 86% of the urban population and 37% of the rural population. With regard to sanitation, the estimated coverage was 33% and 4% for urban and rural areas, respectively. In shanty compounds where 50% to 70% of the urban population live, at least 56% of the population do not have access to safe water supply, and as much as 90% do not have access to satisfactory sanitation facilities (MFNP, 2006). Water shortages during droughts dramatically reduce personal hygiene, while floods overwhelm pit-latrines and contaminate water sources. Under such poor environmental health conditions, the proliferation of infectious diseases is almost unavoidable.

5.1.4 **Poverty Levels in Zambia**
In 2004, 68% of Zambians were living below the World Bank-defined poverty line of US$1 per day. Amongst these, 53 percent were extremely poor. The overall poverty rate in 2004 was 78% in rural areas, with 52% living below the extreme poverty line. In 2001, about 72% percent of women in rural areas reported lack of money for treatment or transport to a health facility (CSO, 2001b). Total government expenditure on health as percent of GDP has fallen from 6.0% in 1997 to 1.5% in 2005. Similarly, Zambia's annual per capita expenditure on health has fallen from US$24.0 in 1997 to US$18.0 in 2005. This level of spending contrasts sharply with that of middle income economies such as Malaysia's spending of US$88 per capita. The infant mortality rate for Zambia is 112/1,000 live births compared to that for Malaysia of 08/1,000 live births. As should be evident, the provision of quality health care has declined in Zambia (MFNP, 2006). Droughts and floods also deepen and entrench poverty with disastrous consequences for human health and welfare.

5.1.5 **Food and Nutrition**
Zambia's Fifth National Development Plan (MFNP, 2006) has noted that 70 percent of the population is food insecure. The poor nutritional status has been attributed to a number of factors which include: inadequate access to food, unaffordable food prices, unsteady food availability, instability of income sources, and inadequate diet diversity. Other causes of poor nutrition relate to the high prevalence of infectious diseases, including HIV/AIDS and poor environmental, economic, and social conditions. Among the major nutrition problems in Zambia are protein-energy malnutrition, iron deficiency-anaemia and vitamin A deficiency, which affect the vulnerable groups of women, children, the disabled, and the poor. Floods and droughts sadly exacerbate food insecurity and malnutrition in the country.

5.2 **Vulnerable Localities and Populations**
It has been shown in the preceding sections that the vulnerability of Zambia to the ravages of extreme climatic events is a function of both the geographical and socio-economic disposition of the country. This identifies the resultant effects of the interactions between climate variability and vulnerability as location specific. Table 13 shows the most vulnerable segments of the population and localities to some of the climate-sensitive diseases in Zambia. It is curious in Table 13 that respiratory infections of the non-pneumonia and pneumonia types both cause more illness in the under-fives than in the over-fives, yet fatalities occur more often in the over-five group.

Table 13: **Vulnerability Matrix for Climate-sensitive Diseases in Zambia**

Climate-sensitive Di	Most Vulnerable Population	Most Vulnerable Locality
Malaria	Children, pregnant women, people living with HIV/AIDS (PLWHA), riverine communities and fisherfolk.	Valley areas, Eastern province and Wetland areas.
Diarrhoea	Children and urban dwellers	Urban areas, Lusaka, Copperbelt and Southern provinces
Respiratory Infection	Under 5 year olds (morbidity) and Over 5 year olds (fatality).	Mining areas, North-western and Southern provinces
Pneumonia	Under 5 year olds (morbidity) and Over 5 year olds (fatality).	Provinces of Luapula, Lusaka and Copperbelt
Dysentery	Children	Southern province
Cholera	Shanty compound dwellers and riverine communities	Urban areas and Luapula province
Malnutrition	Children and rural dwellers	Rural areas

Although Table 13 identifies some localities as being the most vulnerable, it is important to note that the entire country is badly affected by the current burden of disease. Droughts and floods act to worsen the already bad situation. In this regard, the regions that are most vulnerable to climate variability are those located in agro-ecological zones I and II. Extreme heat (heat waves) has in recent years become a factor in the Zambian climate, even though its impact on health in this country has yet to be studied.

5.3 **Coping Strategies**

When climatic and/or other hazards cause outbreaks of diseases, the response strategies employed by households include the following.

- Going to the medical clinic
- Seeking traditional healers for herbal medicine
- Using medicinal plants to treat diseases
- Boiling water or treating it with chlorine
- Buying and using mosquito nets and repellents
- Burying ditches to eliminate stagnant water and prevent waterborne diseases
- Getting support from NGOs and the government

According to Riché (2007), most survey respondents considered the above-mentioned strategies not to be very efficient. It is therefore necessary to assist the affected populations in building sustainable livelihoods that can reduce their vulnerability to the adverse health impacts of the changing climate.

6.0 **POLICY RECOMMENDATIONS**

Based upon the information presented and the ensuing discussion of this study by stakeholders at the workshop, it has become quite clear that Zambia is currently saddled with a heavy burden of communicable climate-sensitive diseases. Further, these diseases are persistently robbing the country of much needed human capital. This situation is also worsened by the fact that Zambia itself is currently extremely prone to climate anomalies in the form of droughts and floods. It is therefore necessary that Zambia undertakes the following measures:

- The adverse impacts of climate variability/change on human health in Zambia are real and consequently there is need for the Ministry of Health to urgently integrate climate risk management and adaptation measures into the national health strategic plan.
- The National Malaria Control Centre should start working with the Meteorological Department and other stakeholders to develop an early warning system for malaria in Zambia.
- The supply and delivery of medical drugs by the Ministry of Health to health facilities should be synchronised with the seasonal fluctuations of diseases. This will eliminate stock-outs of drugs during peak transmission periods when they are critically needed.
- The climate-informed interventions should not focus on malaria only but must also include other climate-sensitive diseases that are exerting a significant death toll on the Zambian population.
- The Ministry of Health, local governments, NGOs and other stakeholders must urgently embark on vigorous information and education campaigns on the utility of insecticide treated nets for malaria prevention. This should occur in riverine communities where these subsidised nets are being wrongly diverted for catching fish.
- Zambia requires a multi-disciplinary capacity for research on the effects of climate change on human health. The Ministry of Health can incorporate this capacity-building component into its current Integrated Disease Surveillance and Response programme.
- Local governments must promote the climate-proofing of sanitation facilities in their communities, especially in urban areas.
- The government, cooperating partners, NGOs and other stakeholders must take a multi-pronged approach to improving rural health by implementing community-based activities aimed at improving incomes, water supply/sanitation, and food security simultaneously.
- The Ministry of Tourism, Environment and Natural Resources must work closely with the Disaster Management and Mitigation Unit to ensure that Zambia mainstreams adaptation to climate change/variability into its national development planning. This will certainly speed up the pace for meeting the MDG targets.
- The government must explore the integration of traditional medicine into current official health care delivery systems in Zambia.
- Funding of climate change activities in Zambia should not be a prerogative of external development partners only but must be supported with allocations from the national budget.
- Government, NGOs and the Mass Media must work together to inform the general public on issues of climate change adaptation. Additionally, the Ministry of Education should incorporate climate change issues into educational curricula at primary, secondary, and tertiary levels.

7.0 **RESEARCH RECOMMENDATIONS**

There is need for research to fill in the vast knowledge gaps pertaining to health issues associated with climate variability and change in Zambia. Only better understanding of the interactions between climate and health that can enable the development of effective strategies, policies, and measures for coping with and adapting to the many consequences of climate variability and change. In the context of Zambia, the following research areas can significantly contribute to the required knowledge base:

- There is need to use robust climate-health models or methodologies for quantifying the relationships between climate variability and disease prevalence in Zambia. This should assist in developing climate-informed preventive measures and establishing early warning systems for the various infectious diseases.
- It is essential to conduct community-based vulnerability and adaptation assessments of the health impacts of droughts and floods.
- There is need for specific studies focussing on the influence of climate variability and other health risk factors on morbidity and fatality rates associated with malaria, respiratory illness, and diarrhoeal diseases (including dysentery and cholera) in Zambia.
- There is need for multi-disciplinary research to understand the various pathways by which floods and droughts affect human health and well-being.
- There is a high incidence of chronic diseases, such as HIV/AIDS and Tuberculosis, in Zambia. The socio-economic and health outcomes associated with chronic disability in the face of droughts and floods must be determined and elucidated.
- Livestock is a major contributor to the wealth and well-being of many Zambian communities. However in recent years, there have been numerous outbreaks of livestock diseases, especially in the drought-prone areas. The role of climate variability in veterinary disease outbreaks must be determined.
- The economic implications of climate variability and health interactions must be quantified to facilitate the mainstreaming of climate change adaptation activities into the national health sector programmes.
- Investigation are needed into the role of climate variability in the relatively high incidences of respiratory infections and dysentery in Southern province and of malaria in the Eastern province.
- Investigation is needed on the impacts of the interaction between climate variability and air pollution and the occurrence of respiratory infections in the mining provinces of the Copperbelt, Southern and North-western.
- Assessment is required on the demographic and occupational vulnerability of communities to disease outbreaks during periods of climate extremes in Itebe and other areas of Zambia.
- There is need to determine the impacts of floods, droughts, heat waves, and seasonal shifts on the health-related indicators of MDG targets.
- Climate disaster-disease mapping using GIS techniques must be conducted for urban and rural regions of Zambia to enable targeting of interventions.

8.0 **CONCLUSION**

This study has demonstrated that the health sector in Zambia is very vulnerable to the vagaries of climate variability and hence immediate and urgent adaptation measures are needed if the health targets of the MDGs are to be met on time. This implies that Zambia must start immediately to mainstream climate risk reduction and adaptation into national health strategic plans and programmes.

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10.0 **ANNEX**

LIST OF PARTICIPANTS AT EECZ WORKSHOP HELD ON 24 JULY 2007, ENVIRONMENTAL MANAGEMENT INSTITUTE, KITWE.

Name	**Organisation**
Dr. M. Maseka	Copperbelt University
Mr. F. Ntengwe	Copperbelt University
Ms. L. Mbozi	District Disaster Management and Mitigation Unit
Ms. P. Chitalu	District Health Management Board
Mr. G. Kasapo	Regional Meteorological Office
Dr. R. Chongwe	Tropical Diseases Research Centre
Dr. C. Mumba	Tropical Diseases Research Centre
Ms. S. Zimba	Copperbelt University
Mr. J. Phiri	Ministry Agriculture and Cooperatives
Mr. G. Kapala	Forestry Department
Ms. R. Chanda	Copperbelt Environment Project
Mr. J. Mubanga	Churches Association of Zambia
Mr. H. Musonda	Hope for Orphaned and Vulnerable Children
Mr. E. Sombe	Kwacha Health Centre
Mr. O. Kayumba	District Public Health Office
Mr. K. Nyirenda	Kitwe City Council
Mr. S. Sosala	Copperbelt University
Dr. G. Kasali	Copperbelt University