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Cover photo: Psychological support for child disaster victims, North Africa © Sebastien Carliez/EC/ECHO

Medical assistance project: central Africa

Photo: © François Goemans/EC/ECHO

Health impacts in poor nations

Hannah Reid describes the range of direct and indirect impacts that climate change could have on health in poorer countries

It is becoming increasingly clear that climate change and global warming will seriously affect human health around the world. From heat stress, to food insecurity resulting from droughts, and from malaria to the education of schoolchildren, the range of potential health problems sensitive to climate change is enormous.

Direct health impacts

The effects of climate change on health will be both direct and indirect. Direct effects include heat stress and the impact of extreme weather events, including those that fall beneath the threshold for what is defined as a 'disaster'. Such events will result in more frequent humanitarian emergencies, which will particularly affect people in high-risk areas such as coastal zones, river valleys and cities. Even in wealthy France, an estimated 11,435 people above the seasonal average died when a record-breaking heatwave struck in the first two weeks of August 2003. Responding, Health Minister Jean-François Mattei, announced US$748 million in extra funding for hospital emergency services, a measure that would either be impossible or stretch government budgets to breaking point in much of Africa.

These direct effects will be especially powerful in the developing world, with its less-developed and poorly funded healthcare infrastructure. For example, floods in Bangladesh in 2004 caused about 800 deaths, while the cyclone of 1991 killed 138,000 people. Deaths caused by heat and cold extremes will rise in vulnerable groups, particularly those already suffering from heart and breathing problems, the very young, the elderly and the frail. According to the World Health Organisation (WHO), the United Nations Environment Programme and the World Meteorological Programme, at least 150,000 people die unnecessarily each year and there are 5.5 million 'disability-adjusted life years', (a standard WHO measure to compare disease burdens) as a direct result of global warming.

MAIN POINTS

- **The author describes** possible climate change impacts on health.
- **Direct impacts** include heat stress and the effects of disasters; indirect impacts include vector-borne diseases, like malaria, and food- and water-borne diseases.
- **Effects will be especially strong** in poor nations, where limited healthcare infrastructure, high disease burdens, regular droughts and floods, widespread poverty and a high dependence on natural resources compound vulnerability.

Indirect health impacts

Many indirect effects occur because of the close relationship between climatic conditions and insect and rodent populations. For example, climatic conditions strongly

VECTOR-BORNE DISEASES SENSITIVE TO CLIMATE FACTORS	
Vector	**Diseases**
Mosquitoes	Malaria, filariasis, dengue fever, yellow fever, West Nile fever
Sandflies	Leishmaniasis
Triatomines	Chagas' disease
Ixodes ticks	Lyme disease, tick-borne encephalitis
Tsetse flies	African trypanosomiasis
Blackflies	Onchocerciasis

influence the range of vector-borne parasitic diseases like malaria and leishmaniasis.

Malaria, which is already the second leading cause of death in the world for five to 14-year-olds, is expected to reach unprecedented levels because of climate change. There are already between 300 and 500 million cases of malaria in the world each year, and some estimate that between 260 and 320 million more people are likely to find themselves living in areas with malaria potential by the year 2080.

Malaria is of particular concern in Africa where the United Nations Environment Programme estimates that it already slows economic growth by up to 1.3 per cent each year. In one highland area of Rwanda, malaria incidence increased by 337 per cent in 1987. Some 80 per cent of this increase could be explained by changes in rainfall and temperature. Further changes in temperature and precipitation could trigger malaria epidemics at the current limits of the disease, both in altitude and latitude, where people lack immunity and the impact of the disease is, therefore, greater. In South Africa, it is estimated that the area suitable for malaria will double and that 7.2 million people will be at risk from the disease – an increase of 5.2 million. In addition, flooding, which is likely to increase as the climate changes, could help mosquitoes breed, thus spreading malaria to otherwise dry areas. The Sahel region, which has suffered from drought in the past 30 years and has experienced a reduction in malaria transmission as a result, could be at a renewed risk from a malaria epidemic.

> **"in one highland area of Rwanda, malaria incidence increased by 337 per cent in 1987"**

Food-borne diseases are likely to increase as a result of warmer temperatures. Water-borne diseases may also increase because of extra demands on diminished water supplies, which will in turn increase the risk of contaminated supplies reaching the public. This is particularly worrying for countries such as Bangladesh where water-borne diseases are already responsible for 24 per cent of all deaths. Diarrhoeal diseases, including cholera and typhoid, may increase as a result of more frequent and severe floods and drought. For example, flooding caused by Hurricane Mitch brought about a six-fold increase in cholera in Nicaragua.

Variations in extreme weather typically associated with the El Niño cycle are likely to become more common and more intense, and these will have a variety of knock-on health impacts. Spending on healthcare in Bolivia, Chile, Ecuador and Peru fell by ten per cent due to the fall in Gross National Product after the El Niño cycle in 1982–83, for

example, and Ecuador, Peru and Bolivia suffered serious malaria epidemics. Following excessive rainfall related to El Niño in 1997, some ten per cent of all Peruvian healthcare facilities were damaged and droughts in Brazil sparked forest fires, the smoke from which was a major public health problem leading to large numbers of patients with respiratory problems visiting already overstretched health facilities. Cholera had been absent from Latin America for nearly a century when the first cases appeared in Peru following the 1991 El Niño. These cases were spread out over a 1000 kilometre long stretch of coastline as a result of an El Niño-related bloom of algae in the rivers, estuaries and on the ocean coastline, combined with poor hygiene and contaminated foods.

The association between climate change and HIV/AIDS is by no means direct, but it is insidiously real. In Africa, for example, AIDS lowers productivity as more and more farmers are infected and affected. Survivors have to spend time attending funerals, looking after orphans, or managing the estates of the deceased. Absenteeism from school and work is common. At the same time, unreliable rain patterns, which are becoming a permanent feature in some areas of Africa, have led to crop failures of such magnitude as to lead to severe malnutrition, which accelerates the negative effects of the disease and poverty. Girls suffer disproportionately as many are forced into early marriage or prostitution to help their families survive. Many rural folk migrate to towns where they are more likely to get infected.

Population movements resulting from drought and environmental degradation can also provoke migration. People forced to leave their home and land may be faced with unsanitary refugee camps with a multitude of associated health problems.

Who is most vulnerable?

The Intergovernmental Panel on Climate Change is unequivocal: "The impacts of climate change will fall disproportionately upon developing countries and the poor persons within all countries, thereby exacerbating inequities in health status and access to adequate food, clean water and other resources." Climate change could also seriously undermine the health-related Millennium Development Goals to reduce child mortality, improve maternal health and combat HIV/AIDS, malaria and other diseases.

Poor communities in Africa are likely to be particularly vulnerable. Estimates by Christian Aid suggest that 182 million people in sub-Saharan Africa might die from diseases associated with climate change by the end of the century. Africa's high vulnerability to the impacts of climate change is compounded by widespread poverty. Ongoing drought and floods, and a dependence on natural resources for rural livelihoods, in turn, increase vulnerability. Also, Sub-Saharan Africa already supports a heavy disease burden including HIV/AIDS and malaria, cholera, dengue fever, yellow fever, encephalitis and haemorrhagic fever.

Finnish Red Cross emergency hospital, Pakistan Photos: © Yassine Gaba/EC/ECHO

Knowledge gaps

Health is often neglected in the assessment of vulnerability and adaptation to climate change, but understanding of the impacts of climate change on health in develop-

ing nations is steadily improving. Several countries have conducted national assessments to determine their vulnerability to the impacts of climate change and evaluate the capacity of their health infrastructure to adapt. Despite this, much more concrete information is required for informed health and climate change related decision making in poorer nations.

Much of the evidence gathered to date is anecdotal, and although clear trends are becoming increasingly apparent, it is difficult to isolate the influence that climate change might have on the spread of any one disease out of the multitude of other factors that will influence observed changes. Whilst counting the dead from a cyclone or heatwave can help give an indication of the scale of the direct impacts of climate change on health, assessing this is much more difficult for the indirect impacts, where many more factors that could influence disease transmission need to be considered. Predicting what will happen in the future is even harder, especially in regions where it remains unclear what climate change impacts are likely to occur.

Even harder to estimate, but perhaps no less important, are the knock-on health impacts that climate change will have on poor and vulnerable communities. Malnutrition could increase as a result of declining food yields as the health of those who need to work the land to provide food and income for their families is compromised and some areas of land become unsuitable for crop production. Will people be able to rebuild communities damaged by climate-driven disasters if their health is poor? What will be the impact on the provision of education when the pool of healthy prospective teachers and students is diminished? Healthcare infrastructure in poor countries is already over-stretched, but to what extent could climate change related disasters further drain public resources for healthcare? Climate change will not only affect people's health in all the direct and indirect ways described earlier, but in doing so it will also hamper people's ability to adapt to a changing, uncertain climate. ■

"malnutrition could increase as a result of declining food yields as the health of those who need to work the land to provide food and income for their families is compromised"

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NEWS

EMISSIONS

As the latest climate treaty negotiations got underway in Bonn during April, China, India and other developing nations combined to call on the industrialized nations to make much greater cuts in greenhouse gas emissions.

"We believe that by 2020 they should reduce their emissions by at least 40 per cent below 1990 levels," said Chinese delegate Xu Huaqing. To date, the European Union has adopted one of the more stringent targets for 2020, with a commitment to 20 per cent emissions reduction, deepening to 30 per cent if other nations come on board. No agreement regarding mid-term emissions targets was reached at the Bonn meeting.

Read more:
tinyurl.com/c5v8xt

MALDIVES

The Maldives intends to become carbon neutral within a decade. "Many politicians' response to the looming catastrophe... beggars belief," said Mohamed Nasheed, president of the Maldives.

"Playing a reckless game of chicken with Mother Nature, they prefer to deny, squabble and procrastinate rather than heed the words of those who know best," he continued. "In a grotesque Faustian pact, we have done a deal with the carbon devil: for untold fossil fuel consumption in our lifetime, we are trading our children's place in an earthly paradise. Today, the Maldives will opt out of that pact."

Read more:
tinyurl.com/c5v8xt

CHINESE WATER

The Chinese province of Xinjiang intends to construct 59 reservoirs to collect glacier water. The twin aims of the ten-year project are to adjust seasonal water levels and to compensate for the longer-term loss of water as the glaciers shrink.

"At the moment there is plenty of water in the big cities. But it is hard to say how long it will last," said He Yuanqing in Lanzhou. "On one hand, global warming is accelerating the melt. But on the other, it is increasing rainfall, so we need a way to store the extra water."

Read more:
tinyurl.com/dh2l8o

MALARIA

Southwestern Uganda, where temperatures have risen by 0.3 degrees [Celsius] in a decade, is one of the hardest-hit areas in terms of disease outbreaks, especially malaria," reports Philip Gwage of the Ministry of Water and Environment.

According to the National Adaptation Programme of Action (NAPA) for Uganda, a two-degree Celsius rise in temperature could see parts of the country losing cash crops, including coffee. Cassava and soya would be affected by new pests, despite being staple crops.

Read more:
tinyurl.com/ccrgvj

WORLD HUNGER

Ban Ki-moon, United Nations secretary-general, has called on rich nations to do more to ensure that the current economic crisis does not add to the already intolerable one billion people going hungry in the world.

"Continuing hunger is a deep stain on our world. The time has come to remove it forever. We have the wealth and know-how to do so," he said. According to the Food and Agriculture Organization, investment of US$30 billion a year in infrastructure and agricultural production could eliminate the root causes of hunger by the year 2025.

Read more:
tinyurl.com/c3twtc

Least Developed Country issues

Sari Kovats describes research and policy priorities needed to address links between climate change and health in the Least Developed Countries

Increasingly, health is used as a justification for taking action on climate change. The impacts of climate change on health are a prominent feature in Intergovernmental Panel on Climate Change (IPCC) reports, as well as in media coverage and political speeches.

IPCC authors working on the Fourth Assessment Report, however, found very little published literature from low-income countries on climate and health issues, particularly African countries. Health is also not well represented in the international policy agreements that address climate change, such as the United Nations Framework Convention on Climate Change. Practitioners have now begun to address how to integrate climate change into development planning, but very little work has been undertaken to address the specifics of incorporating climate change into health policy.

The long-term impacts of climate change may be severe. Climate warming - and consequently water stress, disaster risk and food insecurity - is likely to affect the achievement of the Millennium Development Goals in 2015. Many countries in sub-Saharan Africa are not on track to meet these Goals and have very little capacity to address environmental risks and control infectious disease.

MAIN POINTS

- **The author explains** how little climate change has been incorporated into health policy and planning in the Least Developed Countries.
- **Focus is on immediate health threats** rather than the environmental determinants of ill health, and capacity to address the health impacts of climate change is low.
- **She describes future research** and planning priorities, stressing the need for evidence-based approaches and inter-agency collaboration on policy and planning.

Least Developed Country challenges

Awareness of the potential impact of climate change on human health is generally low within health sectors in the Least Developed Countries (LDCs), even in countries like Bangladesh where levels of climate change awareness across the environmental sectors and in civil society at large is relatively high. Very few national or local assessments of the impacts of climate change on key health determinants, such as food security, access to water and flood risks, have been undertaken. Such assessments would be of great value to health decision makers.

Health policy focuses on trying to address clear and urgent disease problems. Time horizons tend to be short-term rather than long-term. Both decision making and

research are undertaken in a compartmentalized way. Prevention activities such as public health and health protection are not given the attention they deserve. Environmental health issues are often a low priority even within prevention activities, and yet these concerns - water and sanitation, disaster preparedness, flood preparedness, housing and so on - are key for climate change. The problems of getting the health sector engaged in environmental problems should not be underestimated, let alone complex issues such as climate change.

Capacity in the LDCs

The LDCs already experience high burdens of climate-sensitive diseases and their capacity to address the health impacts of climate change is low. There is some evidence that climate change is already affecting health in the LDCs. Many people feel that changes in disease patterns can be attributed to observed climatic changes. It is clear, however, that LDCs currently have little capacity to detect changes in disease transmission and then to attribute these to anthropogenic climate change due to a multitude of other factors, such as drug resistance, population movement and changes in control measures that affect disease transmission. Considerable improvements in health surveillance systems are needed to achieve this. Few detailed epidemiological studies that would help directly attribute changes in disease patterns, particularly increases in malaria, to observed climate change have been undertaken.

Democratic Republic of Congo Photo: © François Goemans/EC/ECHO

The lack of health data is a major limiting factor in undertaking epidemiological studies and other research. Time series data are often only available for a few years due to changes in reporting systems over time, the loss of old data and data not being available in a digital format. Changes in the source populations over time, such as population growth and migration, also make the interpretation of trends very difficult. Data are frequently unavailable at the appropriate spatial resolution. For example, data are often only avail-

able at district level, making it impossible to obtain data for highland regions alone when studying highland malaria.

Research recommendations

Much research is needed to fill in the vast knowledge gaps pertaining to health issues associated with climate variability and change in the LDCs. It is only through better understanding of the interactions between climate and health that LDCs will be able to develop effective strategies, policies and measures for coping with and adapting to the many consequences of climate variability and change.

Robust climate-health models or methodologies must be used to quantify the relationships between climate variability and disease prevalence at local and national levels. Improved climate, disaster and disease mapping using Global Information System techniques are needed to improve preparedness activities.

At the local level, community-based vulnerability and adaptation assessments of the health impacts of droughts and floods are essential. Information on whether some demographic or occupational groups of people are more or less vulnerable to disease outbreaks during periods of climate extremes is needed. Interdisciplinary research to understand the ways in which floods and droughts affect human health and wellbeing must improve. For example, the impacts of floods and droughts on infectious diseases, particularly HIV/AIDS and tuberculosis, and mental health problems need quantifying. The impact of climate-change-related events such as floods, droughts and heatwaves on the health-related Millennium Development Goals also needs to be determined.

Democratic Republic of Congo

Photo: © François Goemans/EC/ECHO

Studies on the influence of climate variability on malaria and respiratory, diarrhoeal and livestock diseases are needed. Livestock diseases have implications for human health, particularly in East Africa where livestock is a major contributor to community wealth and wellbeing and in recent years there have been numerous outbreaks of livestock diseases, especially in drought-prone areas. Links between climate variability, air pollution and the occurrence of respiratory infections need exploring, as does the impact of salinization and water scarcity in areas such as coastal Bangladesh.

Policy and planning priorities

Although capacity for short-term and long-term preparedness strategies is limited in the LDCs, there is scope to improve the mainstreaming of climate change responses into national and local policies and planning. This response relies on better assessment of future health risks and clear evidence for the effectiveness of particular policies, strategies and measures. The adverse impacts of climate variability and climate change on human health are real, however, so clear policies and strategies are needed to deal with these impacts. Health ministries must integrate climate risk management and adaptation measures into national health policies and strategic plans. Cross-sectoral approaches to strengthen the implementation of these policies are a priority.

Vulnerability to climate change could also be reduced by an inter-agency approach to implementing community-based activities aimed at improving incomes, water supply and sanitation and food security. Local

government must lead on climate-proofing sanitation facilities and domestic water supplies. Health ministries, local governments and non-government organizations must work together to support malaria control programmes, for example, by improving the uptake of insecticide-treated nets. Environment ministries could engage more closely with disaster management agencies to mainstream adaptation into national development planning. Government, non-government organizations and the media must also work together to inform the general public about climate change and health issues. For example, education ministries could incorporate climate change issues into school curricula, and climate change could be given more attention in the training of doctors, nurses and other health professionals.

Disease surveillance programmes must improve, for malaria and other vector-borne diseases. Climate-informed interventions should not focus on malaria alone but must also include other climate-sensitive diseases. Better climate-based early warning systems for climate-sensitive epidemic diseases, such as malaria and meningitis, would be of great benefit, but are currently limited by the low capacity of health systems to deliver an effective response. Such warning systems have been shown to be cost-effective.

The economic implications of climate variability and change on health must be quantified. This will facilitate the mainstreaming of climate change adaptation activities into national health sector programmes. Future development pathways are also important, and the IPCC stresses that the manner in which economic growth occurs will be critically important for future vulnerability.

In terms of assessments, links with National Communications on climate change should be ensured so that health issues are addressed appropriately in future National Communications. Links are also needed with the National Adaptation Programmes of Action (NAPA) process, where consideration of health issues is highly variable. The Bhutan NAPA, for example, considers health impacts as a priority for adaptation. ■

“better climate-based early warning systems for climate-sensitive epidemic diseases, such as malaria and meningitis, would be of great benefit, but are currently limited by the low capacity of health systems to deliver an effective response”

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FURTHER INFORMATION

● **On the Web:** World Health Organization publications on climate change and health are listed at tinyurl.com/c8y3ps.

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Adaptation and health in Zambia

George Kasali describes key factors that make Zambia's health sector vulnerable to climate change, focusing on malaria and the impacts of floods and droughts

Zambia is already saddled with a huge disease burden with over eight million clinical cases of malaria, diarrhoea, respiratory infections and other communicable but avoidable illnesses robbing the country of millions of productive hours each year. Zambia's infant mortality rate is an enormous 112 per 1000 live births. In 2003, the average life expectancy was 39 years and Zambia ranked 163 out of 175 in the Human Development Index.

Climate change impacts are expected to be greater in developing countries like Zambia because of their geographical location, high dependence on natural resources and limited economic, financial, human and institutional capacity to effectively respond. Food shortages, drought and heavy rains are already commonplace in Zambia, and this situation has been worsened by the increased frequency and magnitude of climate variability in recent years.

Climate and climate change in Zambia

Zambia is a land-locked country in Southern Africa. In general, the year can be divided into two distinct halves, a dry half from May to October and a wet half from November to April. Average annual rainfall is 1001 millimetres, more than 90 per cent of which falls in the rainy season from November to March.

MAIN POINTS

- **The author describes** Zambia's existing disease burden and key climate change vulnerabilities.
- **He explores disease sensitivity** to rainfall and temperature, focusing on malaria, and describes the health impacts of floods and droughts.
- **He concludes that sustainable solutions** to climate-related hazards, the mainstreaming of climate risk reduction and adaptation into national health plans, and research to fill the vast health and climate change knowledge gaps are essential.

July is the coldest month and October is the hottest.

Climate change is not expected to cause any new climatic events in Zambia, but rather to alter the long-term frequency, magnitude and intensity of current climate variability. Rainfall in the south and central parts of the country between 1970 and 2000 has tended to decrease, although floods have also been common. The first rain used to fall in October or the first week of November, but in recent years, the rainy season has tended to start a week or two later. Since the early 1980s, there has been a tendency towards the late onset and early withdrawal of the rainy season.

Since the early 1970s, there has been a modest warming in the cool season (June to August), with considerable warming (by about one degree Celsius) of the mean maximum temperature in the hot season (September to November), especially in northern areas. A tendency towards more extreme tempera-

tures between 1970 and 2000 was observed throughout the country.

Future climate projections for Zambia up to the year 2070 predict more droughts and extreme temperatures in southern and central areas, and increasing rainfall in northern parts of the country. One climate model predicts a five to twenty per cent decrease in the length of the growing (rainy) season by the year 2050.

Zambia's disease burden

Existing disease burdens provide some measure of the adaptive capacity and vulnerability of the health sector in Zambia to the impacts of climate change. The top three reasons for visiting health facilities in Zambia in all age groups are malaria, respiratory infections (excluding pneumonia) and non-bloody diarrhoea.

Malaria is the largest cause of morbidity in Zambia and is a major public health problem accounting for nearly 40 per cent of all outpatient attendances at health facilities. The attendance figure rises to 50 per cent for children under five years. There are roughly four million clinical cases of malaria per year in Zambia and 50,000 deaths, including up to 20 per cent maternal mortality. The National Health Strategic Plan (2001 to 2005) aimed to reduce malaria incidence rates to 300 per 1000 people by the year 2005. This target has not yet been achieved, although levels are lower in urban areas with better access to treatment and control measures. Out of the rural areas, those in the north with higher altitudes and lower temperatures have the lowest morbidity rates.

Conversely, more people suffer and die from diarrhoea in urban than rural areas, with the highest incidence rates recorded for Lusaka Province, which houses Zambia's capital city Lusaka. This may be attributed to overcrowding and poor sanitation.

Children under five years old carry much of the disease burden in Zambia. Incidence rates for malaria, respiratory infections, diarrhoea and pneumonia are 5.6, 5.1, 8.4 and 6.5 times higher, respectively, than rates for older people.

Zambia's current disease burden is quite high, and achievement of the health-related Millennium Development Goal targets will require a drastic shift in health policy and investment. The table above shows the huge gap between the 2015 targets and existing human health indices. The National Health Strategic Plan (2006 to 2010) concludes that despite discrete and sustained improvements in some areas, Zambia is unlikely to meet most of the Millennium Development Goal targets by 2015.

HEALTH-RELATED TARGETS AND INDICATORS IN ZAMBIA

Indicator	1990/1992	2002/2003	2015 target
Proportion of people living in extreme poverty (%)	58	46	29
Proportion of people living with extreme hunger (%)	25	28	12.5
Under-five mortality rate per 1000 births	191 (1992)	168	63
Infant mortality rate per 1000 births	107	95	36
Maternal mortality rate per 100,000 live births	649	729	162
Trends in HIV infection among antenatal clinic attendees (%)	20 (1994)	40	19

Climate change impacts on health

Field surveys conducted under the National Adaptation Programme of Action on Climate Change show that Zambia is vulnerable to droughts, floods, extreme heat and shifts in rainy season length. Almost all of these climate hazards will have a negative effect on health. Despite the increased frequency of

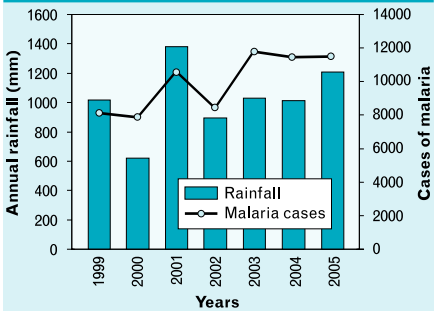
these hazards in the past decade, Zambia has not yet developed any climate-informed policies for the health sector. This may in part be because of the limited available information on interactions between climate and disease in Zambia.

Disease sensitivity to rainfall

Some diseases are more sensitive to weather or climatic factors than others. Data on morbidity and mortality levels for various diseases in Chadiza and Mazabuka Districts in the Eastern and Southern Provinces, respectively, were collected from the Ministry of Health and the District Health Office in Mazabuka. These were then correlated with rainfall data for both districts collected from the Department of Meteorology in Lusaka. Daily or weekly health data were not accessible so monthly or three-monthly health data were used.

A simple linear relationship between rainfall and malaria is unlikely to occur due to confounding factors such as temperature, socioeconomic conditions, population immunity levels, cultural habits and the impacts of existing interventions. A simple linear regression reveals, however, that between 1998 and 2005, malaria increased as rainfall increased in Chadiza and Mazabuka Districts. Rainfall distribution (which measures the total rainfall for a particular season adjusted for the number of rainy days) provided a better indicator of malaria prevalence than total rainfall. Studies from elsewhere in Zambia also found that malaria incidence in wet years was considerably higher than in dry years. Particularly notable are the reductions in malaria during the 2002 drought.

MALARIA PREVALENCE AND RAINFALL IN CHADIZA DISTRICT



The responses of diarrhoea and respiratory infections (that are not pneumonia) to rainfall are less clear. In the case of diarrhoea, this may be because in rural settings droughts reduce water supplies resulting in poor hygiene and less dilution of pathogens in water supplies resulting in more diarrhoea. In urban settings, however, more rainfall causes inadequate sanitation facilities to overflow or collapse thus carrying more pathogens to humans. Dysentery appears to increase with drought conditions, and pneumonia correlates with rainfall with similar trends to those of malaria.

Disease sensitivity to temperature

In order to explore the sensitivity of various diseases to temperature, monthly data on morbidity and mortality levels for Chikankata Hospital in Mazabuka District were collected from 1998 to 2002. Climate data were collected from Magoye meteorological station in the same district. Health data were analysed with respect to the three distinctive seasons in Zambia.

Data confirm that there is increased morbidity (measured in terms of mean hospital admissions per month) from malaria and pneumonia during the hot rainy season. On the other hand, hot dry conditions favoured diarrhoea, non-pneumonia respiratory infections and dysentery. Morbidity due to HIV/AIDS is spread almost evenly over the three seasons (with slight increases seen during the cold dry season), perhaps because many infections can hospitalize a person with HIV/AIDS.

In the cases of malaria and diarrhoea, increased mortality accompanied increased morbidity according to season. In the cases of dysentery, pneumonia and respiratory infections that are not pneumonia, however, mortality peaked during the cool dry season, whilst morbidity peaked in other seasons. In short, cool dry conditions appear to stimulate death from these diseases.

The effect of temperature on malaria

Temperature, humidity and rainfall are the three main climatic factors that affect ma-

laria transmission. The Malaria Risk in Africa (MARA) project has demonstrated that malaria is sensitive to temperature. Malaria parasites cease to develop in the mosquito vector when the temperature is below 16°C and the best conditions are when the mean temperature is between 20°C and 30°C, with a relative humidity of at least 60 per cent.

Areas such as Nyimba and Luangwa have a suitable climate for malaria and are classified as endemic by the MARA project. Here, malaria incidence rates are high and peak in the first quarter of the year.

In MARA areas designated as marginal and epidemic, malaria incidences are relatively low. In marginal areas, incidences are perennially low with morbidity remaining fairly stable because contact between humans and the mosquito vector is minimal throughout the year. In epidemic-prone areas, such as Mpika in the Northern Province, malaria incidence is low for most of the year when climatic conditions do not favour mosquitoes. This lowers population immunity, which means epidemics can occur. In the first quarter of the year, malaria outbreaks begin to occur and incidence rates practically double. Climatic conditions and population immunity are both crucial factors in the genesis of epidemics.

It is evident that in Zambia the distribution and transmission of malaria are functions of both temperature and altitude. High-altitude areas above 1200 metres with mild temperatures constitute the marginal and epidemic malaria areas, while the hot low-lying areas provide suitable climatic conditions for malaria to be endemic. Generally, malaria is stable in the valleys and unstable on the plateaus and higher grounds, which are mostly in central and northern parts of the country.

Health impacts of droughts

Climate disasters are now an annual occurrence in Zambia, ravaging livelihoods and disrupting the economy. Zambia and the entire southern African region experienced drought during the 2004/2005 agricultural season. Two thirds of Zambia, mainly the Southern, Eastern and Western provinces, experienced prolonged dry spells resulting in irreversible damage to most crops, including drought-tolerant crops such as cotton and tobacco. In areas affected by drought, cereal (staple food) production losses ranged from 30 to 80 per cent with an average of 56 per cent. Some 1,232,661 people needed food assistance in affected districts. Some of the affected districts continued receiving food aid until June 2006.

> **“climate disasters are now an annual occurrence in Zambia, ravaging livelihoods and disrupting the economy”**

The prevalence of child malnutrition, as measured by a child’s mid/upper arm circumference, was an average of 15.5 per cent. Between 3.2 and 6.9 per cent of children were at a high risk of mortality, and 51 per cent of children had an inappropriate diet diversity score. These areas historically suffer from chronic food shortages and poor dietary intake, with stunting (an indicator of chronic malnutrition) levels of between 40 and 59 per cent. More climatic extremes will worsen people’s existing poor nutritional status.

In one survey in a drought-affected area, 43 per cent, 62.6 per cent and 48.8 per cent of children had suffered from diarrhoea, a fever or a cough, respectively, in the week prior to the survey. About 20.7 per cent of adults in the survey area had been chronically ill for more than three months during the 12 months prior to the survey. Amongst these, 6.4 per cent were household heads. Some 51 per cent of those surveyed had experienced the drying up of water sources. Water supplies for livestock was also a key concern. Additional hazards to which the people in drought-affected areas were subjected included increases in conflict between humans and wild animals and increases in crop and livestock diseases. More climatic extremes will act as an additional burden on the health and livelihoods of those affected.

Health impacts of floods

Zambia experienced excessive rainfall during the 2005/2006 and 2006/2007 rainy seasons that caused widespread flooding in most parts of the country. These floods had many health-related impacts. A total of 1,443,583 people in 41 districts were affected by floods and required assistance in the form of rehabilitation of their houses, latrines, water wells, schools, clinics, roads and other infrastructure over the following year. The lives and livelihoods of 295,148 people were directly threatened, all of whom required urgent help, especially with emergency food relief.

The floods destroyed 10,954 houses leaving 17,172 people needing emergency shelter. There was a high risk of water contamination, especially from faecal matter, in 78 per cent of affected areas because the floods led to the collapse of toilets and flooding of unprotected shallow wells. This affected 1,012,540 people. Some 14 districts (or 288,532 people) were at high risk of malaria outbreaks. Over 5000 cases of and 137 deaths due to cholera were recorded in Lusaka, and outbreaks of rabies, the plague and trypanosomiasis occurred in some areas.

The floods negatively affected the education sector, with damage to classroom blocks, staff houses and toilets of up to 160 schools disrupting the education of about 150,000 children. On the other hand, receding water left enough moisture and nutrients to allow dry season crop cultivation in some areas.

Zambia's key vulnerabilities

Zambia's health sector is very vulnerable to climate change. Several factors influence the extent to which vulnerable populations are exposed to climate-change-related health risks. These factors include the state of healthcare delivery systems, provision of water supplies and sanitation, and chronic poverty, food insecurity and nutrition.

The healthcare system in Zambia comprises of government, mission (churches), industrial and private sector health facilities. In 2002, the availability of these facilities was an average of one hospital per 100,000 people, one health centre per 8000 people and one health post per 500,000 people. This shortage of health facilities poses a serious constraint to accessing health services in Zambia.

In urban areas, 99 per cent of households are within five kilometres of a health facility while this figure is only 50 per cent for rural areas. Flood damage to roads and bridges and illness itself can seriously limit people's ability to reach distant health facilities.

Health institutions are grossly understaffed. With a projected population of 11,297,304 (for 2006), the average doctor to person ratio is about 1:16,000 while the average nurse to person ratio is about 1:1900. The World Health Organization recommends ratios of 1:5000 and 1:700 for doctors and nurses respectively.

Supplies of essential drugs and medical equipment pose another challenge to Zambia's health system. Over the past four years, supplies have been erratic with as much as 50 per cent of essential drugs being out of stock.

Lisutu, Zambia Photo: © Richard Lord / UMCOR

Access to safe water supplies in Zambia in 2000 was estimated at 86 and 37 per cent for urban and rural populations, respectively. For sanitation, these estimates were 33 and four per cent for urban and rural areas, respectively. However, in shanty compounds, which house 50 to 70 per cent of urban inhabitants, at least 56 per cent of the population do

not have access to safe water supplies and as much as 90 per cent of people have no access to satisfactory sanitation facilities. Water shortages during droughts dramatically reduce personal hygiene while floods overwhelm pit-latrines and contaminate water sources. Under such conditions, the proliferation of disease is unavoidable.

Poverty levels also serve to increase risk. In 2004, 68 per cent of Zambia's 10.9 million people (as recorded by the 2000 census) lived on less than US$1 per day. Amongst these, 53 per cent were extremely poor. In rural areas, the overall poverty rate was 78 per cent with 52 per cent living in extreme poverty. In 2001, about 72 per cent of women in rural areas reported a lack of money for treatment or transport to a health facility. Total government expenditure on healthcare as percentage of Gross Domestic Product also fell from six per cent in 1997 to 1.5 per cent in 2005.

Some 70 per cent of Zambia's population is food insecure. Their poor nutritional status has been attributed to unaffordable food prices, unsteady availability, livelihoods instability and inadequate diet diversity amongst other causes. Floods and droughts exacerbate food insecurity and malnutrition.

Vulnerability to extreme climatic events is a function of geographical and socioeconomic factors. For example, malaria affects people in valley areas, the eastern provinces and wetland areas most. Vulnerable groups include children, pregnant women, those living with HIV/AIDS, riverine communities and fisherfolk. In riverine areas, for example, government programmes provide subsidized insecticide-treated nets to prevent malaria, but many fisherfolk use the nets for catching fish.

Conclusions

Zambia is currently saddled with a heavy burden of communicable climate-sensitive diseases. It is also very vulnerable to the impacts of climate variability and extreme weather events like droughts and floods. Climate models have projected that these extreme conditions will persist in the future. This study has shown that floods and droughts can increase disease levels in some affected areas by as much as 400 per cent. Zambia clearly needs to find sustainable solutions to hazards associated with extreme climatic events and must start now to mainstream climate risk reduction and adaptation into national health strategic plans and programmes. Vulnerable populations and localities must be targeted. If this does not occur immediately, the health targets of the Millennium Development Goals will not be met.

Research is also needed to fill the vast knowledge gaps relating to health issues associated with climate variability and change in Zambia. It is only through a better understanding of the interactions between climate and health that effective strategies, policies and measures for coping with climate variability and change can develop. ■

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ACKNOWLEDGEMENT

● This research was conducted under the Capacity building in the Least Developed Countries on Adaptation to Climate Change Programme. See www.clacc.net for more information.

Malaria in Cotonou, Benin

Krystel Dossou describes how climate change could affect malaria prevalence in the city of Cotonou in Benin

Benin usually experiences alternating dry and wet periods, but global warming could modify rainfall patterns with dry periods lasting one to two months longer than in the past, particularly in northern areas. Agriculture, which is largely dependant on rain, will be affected. Forestry, water resources, health, the energy sector and the costal zone are also vulnerable. The government of Benin has identified droughts, floods, sea-level rise and late and violent rains as the main climatic risks.

Cotonou is the economic capital of Benin as well as its largest city. Its official population count was 761,137 in 2006, although some estimates suggest the population may now be as high as 1.2 million. The city lies in the southeast of the country, between the Atlantic Ocean and Nokoué Lake. It is a low-lying city, vulnerable to increases in sea level, floods and coastal erosion. Numbers of people without access to clean water in Cotonou are estimated to be 13,000, whereas nearly 219,000 inhabitants are defined as poor, with an income of less than 165,000 Franc CFA a year. Environmental conditions, particularly the presence of important swamps, strongly influence public health.

Considerable volumes of soiled water drain into Nokoué Lake through the main city sewers. Oil pollution also goes in the lake along with waste from the Dantokpa Market. The Ouemé River pollutes the lake still further by bringing in pesticides, heavy metals and lots of organic matter and chemical and microbiological pollutants.

MAIN POINTS

- **The author describes** the social and economic impacts of malaria in Benin explaining how poor women and children are most vulnerable.
- **He explains how** climate change could affect malaria prevalence in the city of Cotonou, describing two possible future scenarios.
- **Key measures** to prevent the spread of malaria and recommendations for city officials and researchers are detailed.

The importance of malaria in Benin

Malaria constitutes a major public health problem in Africa, particularly in Benin where the disease occurs all year round. Malaria is particularly prevalent in areas subject to flooding and one immediate consequence of an increase in flood frequency is the increase in mortality due to malaria. Malaria is the reason for 34 per cent of medical consultations and 20 per cent of hospital admissions. It is the principal cause of mortality in Benin, causing more than 1000 deaths per year.

The economic implications of this are enormous. Severe malaria requires admission to hospital, but those less sick still require help,

MALARIA CASES IN COTONOU FROM 1996 TO 2004

Commune	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Cotonou I	7,169	6,936	5,754	6,574	5,214	5,138	6,759	6,756	5,896	**56,196**
Cotonou II	7,532	8,232	5,804	7,995	9,062	8,219	10,983	13,895	9,221	**80,943**
Cotonou III	1,814	3,130	2,389	11,973	15,770	14,474	17,339	20,251	17,297	**104,437**
Cotonou IV	2,206	2,131	1,548	2,808	3,103	5,651	7,108	7,789	5,258	**37,602**
Cotonou V	15,260	14,051	13,317	27,270	23,098	24,939	34,067	30,521	16,199	**198,722**
Cotonou VI	47,050	48,468	40,139	30,002	32,492	32,935	30,777	33,653	33,546	**329,062**
The whole of Cotonou	**81,031**	**82,948**	**68,951**	**86,622**	**88,739**	**91,356**	**107,033**	**112,865**	**87,417**	**806,962**

usually to the detriment of their own or their helpers' income generating activities. An individual can contract malaria on average three to six times per year depending on how effective his strategies are to fight or prevent the disease. The costs of treatment are considerable. Thus the direct and indirect costs relating to the disease are huge.

Malaria's main victims are women and children under five years old from poor families for whom treatment is too expensive. In 2001, some 118 out of every 1000 inhabitants had the disease. This incidence was higher for children, with 459 out of 1000 children under one year and 218 out of 1000 children between one and four years having the disease. Children are particularly vulnerable to malaria because they easily become weakened by diarrhoea and vomiting.

Malaria is endemic in Cotonou. More than 800,000 cases of malaria were treated between 1996 and 2004. The years 2002 and 2003 showed the highest number of malaria cases while 1998 showed the lowest. Times of high prevalence tend to coincide with particularly rainy periods. Indeed, precipitation in Cotonou seems to increase the number of recorded malaria cases. After periods of rain, locals notice a remarkable increase in the number of malaria cases, perhaps because conditions for the spread of mosquitoes that cause malaria are more favourable. Morbidity tends to peak one to two months after peak rains. This knowledge can be used to plan optimal strategies to fight the disease.

Some parts of Conotou are more vulnerable than others. For example, areas bordering Nokoué Lake in the north of Cotonou have more cases of malaria. Locals observe storms of mosquitoes rising from Nokoué Lake and moving to Cotonou and Abomey-Calavi at about seven o'clock every evening once the city lights are on. There are also swamps in the north of Cotonou that affect vulnerability to malaria and where population density is high due to cheap house rental costs.

Concerns about malaria led the government to start a five-year programme (from 2001 to 2005) to 'roll back malaria' in Benin. This aimed to half the mortality and morbidity due to malaria. Unfortunately, the 'roll back malaria' programme did not integrate climate change into its planning, so all efforts made could be wasted.

Malaria and climate change in Benin

Climate change predictions suggest temperature increases of between one and 2.5 degrees Celsius by the year 2100. An increase in temperature could lead to the expansion of ecological zones suitable for the *Anopheles* mosquitoes that carry malaria. Average temperatures of higher than 16°C and 18°C are also favourable for the malaria-causing parasites *Plasmodium vivax* and *Plasmodium falciparum,* respectively. Climate change could,

Cotonou, Benin

Photo: © mrfs.net

therefore, exert considerable influence on the number of malaria cases, especially when higher temperatures are maintained over long periods.

Other factors such as the length of the wet season or rates of evapotranspiration could also be important. Models predicting changes to the length of the wet season vary. Some suggest the dry season will increase from six to seven months in length each year, whereas others suggest it could decrease to five months each year with the wet season increasing in length. In addition, a temperature increase of one degree Celsius could increase evapotranspiration rates from six to eight per cent. Higher temperature increases will increase evapotranspiration still further.

Conditions favourable for the spread of mosquitoes are increasing, and combined with increasing population numbers, this is likely to lead to continuing increases in cases of malaria unless public awareness increases and living conditions improve. Illiteracy is a key problem in this context.

Scenarios for climate change health impacts in Cotonou

Cotonou's population is estimated to reach 1.2 million by 2025. Much could happen in this time. The worst-case scenario sees bad management and corruption leading to the failure of strategies implemented to tackle epidemics. There could be an increase in suitable sites for mosquito larva in areas prone to flooding and child morbidity rates could increase. Inadequate provision of health centres, poor hygiene, poor sanitation system provision and privatisation of medical services could all help increase the prevalence of malaria.

A more optimistic scenario is that the strategies used to fight or prevent epidemics are more successful. Activities planned under the environment ministry and city officials prove effective. Mosquito larva breeding sites are controlled, swamps are eradicated and fewer chemicals are needed to control mosquito populations. Impregnated mosquito nets are commonly used and treatment costs fall. As a result, malaria infection rates are reduced and child morbidity rates fall.

Measures to prevent or reduce malaria

Although mosquito nets are an extremely efficient way to prevent mosquito bites, they are not commonly used. Many parents can-

not afford to buy mosquito nets for all their children, so children share nets and thus find themselves lying with their skin up against the nets and, therefore, exposed to mosquito bites. Many children in Cotonou's poorest areas just sleep on mats without nets, and where nets are used they are often badly maintained and perforated so no longer offer protection against mosquitoes. Acquiring nets is costly, though mothers with children under five years old are helped in this regard.

Self-medication is commonly used to fight malaria but it isn't very efficient because it tends to treat symptoms rather than help with a cure. Many people take pills imported from Nigeria, which are often stored and handled in bad conditions. Removing sanitation structures can help, as can using sanitation structures in homes or nearby when malaria risks increase.

Many other health issues can aggravate malaria, including anaemia, severe respiratory infections, diarrhoeal diseases, skin infections and malnutrition. Environmental factors, such as how waste is managed, are also important. This includes the management of solid waste, biomedical waste and sewage in addition to drainage systems for rainwater. Cotonou produces nearly 400 tons of waste a day, some of which fills up swampy areas which can then be built on, but 61 per cent of which is badly buried or incinerated.

Suggestions

The long-term consequences of malaria will be greater if no adequate prevention measures are taken to limit malaria risks. Better awareness amongst national actors on the links between climate change and human health is necessary.

National authorities in charge of the public health system must plan ahead, taking knowledge of traditional medicine into account and following up on existing epidemiological and meteorological data in order to plan better. The district authorities of Cotonou and civil society must put extra effort into waste elimination and cleaning the environment of those most vulnerable to malaria. This includes improving management of rainwater and other waste and waste water. Environmental education needs to get better and the use of mosquito nets impregnated with insecticides must be promoted throughout the year. The capacity of non-government organizations working on climate change adaptation and development issues needs building. Adaptation projects to reduce social vulnerability to climate variability and climate change must be implemented.

Research capacity and the supply of equipment needs improving, including research capacity on traditional medicines. Researchers must work to improve and share their understanding of climate change impacts on malaria and other diseases, and adaptation measures appropriate for the Benin context. ■

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CONFERENCES

EVENTS

12th European Forum on Urban Forestry
Arnhem, The Netherlands:
27-05-2009 to 30-05-2009
This year's working theme for the forum is "Working together for green city values". Aimed at providing a venue for dialogue and networking between urban forestry professionals, scientists and policy makers. The Forum is associated with the International Union of Forest Research Organizations (IUFRO) as well as various other European and Nordic networks for urban forestry.
Details: European Forum Organizer, IUFRO Headquarters, Mariabrunn (BFW), Hauptstrasse 7, A-1140 Vienna, Austria.
Fax: +43-1-8770151
Email: info@efuf.org
Web: www.efuf.org

ICLEI World Congress 2009
Edmonton, Canada:
14-06-2009 to 18-06-2009
Working theme for the ICLEI-Local Governments for Sustainability congress is "Connecting Leaders - Advancing Local Action for Sustainability". Aims to facilitate exchange and promote capacity building among local governments and other stakeholders who play leading roles in the path towards sustainability. Will include keynote presentations, reports, debates, workshops, networking events, site visits and an exhibition.
Details: Conference Organizer, ICLEI International Training Centre, Leopoldring 3, 79098 Freiburg, Germany.
Fax: +49-761-3689229
Email: world.congress@iclei.org
Web: www.iclei.org/worldcongress

2009 International Energy Workshop
Venice, Italy:
17-06-2009 to 19-06-2009
Organized with the International Center for Climate Governance and the Euro-Mediterranean Centre for Climate Change. The workshop will provide a venue for researchers, analysts and practitioners to network and compare energy projections and analyse the interrelationship between climate change and energy.
Details: Angela Marigo, Fondazione Eni Enrico Mattei, Palazzo Querini Stampalia, Castello 5252, I-30122 Venice, Italy.
Fax: +39-41-2711461
Email: angela.marigo@feem.it
Web: www.iccgov.org/iew2009

8th World Wind Energy Conference & Exhibition
Jeju Island, South Korea:
23-06-2009 to 25-06-2009
Working title of the conference is "Wind Power for Islands - Offshore and Onshore". South Korea is one of the founding members of the newly formed International Renewable Energy Agency (IRENA). Conference will take place on Jeju Island which holds South Korea's first wind farm. Participants will discuss all issues related to development, grid integration and mechanisms for wind farm energy.
Details: WWEC2009 Conference Organizer, WWEA Head Office, Charles de Gaulle Str 5, 53113 Bonn, Germany.
Fax: +49-228-3694084
Email: secretariat@wwindea.org
Web: papers@2009wwec.com

2009 ACEEE Summer Study on Energy Efficiency in Industry
New York, USA:
28-07-2009 to 31-07-2009
Working theme of the 2009 study course is "Timing is Everything: Moving Investment Decisions to Energy-Efficient Solutions". Main panel areas of work will include: investing in energy-saving technologies; energy efficiency as a co-benefit; selling energy efficiency in your organization; energy efficiency: investing in a time of uncertainty; and, regulatory aspects and incentives to energy-efficient investments.
Details: Rebecca Lunetta, ACEEE Summer Study Office, PO Box 7588, Newark, DE 19714-7588, USA.
Fax: +1-302-2923965
Email: rlunetta@verizon.net
Web: www.aceee.org

10th International Congress of Ecology
Brisbane, Australia:
16-08-2009 to 21-08-2009
Co-hosted by the Ecological Society of Australia and the New Zealand Ecological Society. Theme is "Ecology in a Changing Climate: Two Hemispheres - One Globe". Ecological research and its implementation for managing environmental systems and the successes thereof will be main issues for discussion and dialogue.
Details: INTECOL2009 Congress Managers, c/- Tour Hosts Pty Ltd, GPO Box 128, Sydney, NSW 2001, Australia.
Fax: +61-2-92675443
Email: intecol10@tourhosts.com.au
Web: www.intecol10.org

SER International 2009 World Conference on Ecological Restoration
Perth, Australia:
23-08-2009 to 27-08-2009
The 19th in a series of conferences organized by the Society for Ecological Restoration (SER). More information is available in pdf form via the SER website.
Details: Society for Ecological Restoration International, 285 W 18th Street, Suite 1, Tucson, Arizona 85701, USA.
Fax: +1-270-6265485
Email: seri2009@bgpa.wa.gov.au
Web: www.ser.org/events.asp?EventID=219

5th Australia-New Zealand Climate Change & Business Conference
Melbourne, Australia:
24-08-2009 to 26-08-2009
Co-organized by the Climate Change and Business Centre and Point Carbon. Conference will include an expo of climate change and carbon market service providers offering the opportunity for delegates to obtain specific information on how to implement a re-

sponse to climate change.
Details: Conference Organizer, Climate Change & Business Centre, PO Box 375, Collaroy, NSW 2097, Australia.
Email: secretariat@ climateandbusiness.com
Web: www.climateandbusiness.com

World Climate Conference-3 2009

Geneva, Switzerland:
31-08-2009 to 04-09-2009
Working theme of the conference is "Climate prediction for decision making: focusing on seasonal to interannual time-scales, taking into account multi-decadal prediction".
Details: WMO, Conference Organizer, Case Postale 2300, CH-1211 Geneva, Switzerland.
Fax: +41-22-7308181
Email: info@wmo.ch
Web: www.wmo.ch|pages|world_climate_conference|index_en.html

Water Utilities & Law: Current Trends & Development

Dundee, UK:
03-09-2009 04-09-2009
Conference is organized by, and will be held at, the UNESCO Centre at the University of Dundee. Intends to provide a forum in which to address the role of law in promoting appropriate policies, structural design and regulatory solutions in order to meet the Millennium Development Goals target of reducing the proportion of people without access to sustainable, safe drinking water by half.
Details: Michael HantkeDomas, Centre for Water Law, Policy and Science, Peters Building, Unikversity of Dundee, DD1 4HN, Scotland, UK.
Fax: +44-1382-388671
Email: water@dundee.ac.uk
Web: www.dundee.ac.uk|water|news|waterutilities.php

11th Annual BIOECON Conference

Venice, Italy:
21-09-2009 to 22-09-2009
Working theme of this year's Biodiversity and Economics for Conservation (BIOECON) conference is "Economic instruments to enhance the conservation and sustainable use of biodiversity". Papers will cover such issues as assessment of the efficiency of biodiversity conservation instruments, the development of new, incentive-compatible instruments, applications of economic instruments and assessing socio-economic benefits.
Details: Conference Organizer, Fondazione Eni Enrico Mattei (FEEM), Palazzo Querini Stampalia, Castello 5252, I-30122, Italy.
Fax: 39-41-2711461
Email: infofeem@feem.it
Web: www.bioecon.ucl.ac.uk

8th International Workshop on Large-Scale Integration of Wind Power into Power Systems

Bremen, Germany:
14-10-2009-15-10-2009
Conference will include a workshop on Transmission Networks for Offshore Wind Farms. A field trip to be taken the day after the workshops is also planned. Intended to provide a platform for exchanging knowledge, ideas and experiences regarding wind energy and in-depth discussions and brainstorming. Representatives from companies and research institutes will give presentations.
Details: Workshop Organizer, Energynautics GmbH, Muhlstrasse 51, 632225 Langen, Germany.
Email: info@energynautics.com
Web: www.windintegrationworkshop.org

XIII World Forestry Congress 2009

Buenos Aires, Argentina:
18-10-2009 to 25-10-2009
Co-organized by the Food and Agriculture Organization and held every six years. Congress intent is to provide a forum whereby collective knowledge and experience can give guidance to the formulation and implementation of environmentally friendly forest policies.
Details: 2009 World Forestry Congress Organizer, Paseo Colon 982, Anexo Jardin, C1063ACV Buenos Aires, Argentina.
Email: info@cfm2009.org
Web: www.wfc2009.org

East Asian Seas Congress 2009

Manila, Philippines:
23-11-2009 to 27-11-2009
Working theme of the Congress is "Partnerships at Work: Local Implementation and Good Practices". Aims to provide a venue to debate issues and highlight good practices and lessons learned in coastal and ocean seas management which will include the impacts of climate change amongst other issues.
Details: EAS Congress 2009 Secretariat, PEMSEA Resource Facility, DENR Compound, Visayas Ave, Diliman, Quezon City, Philippines.
Fax: +63-2-9269712
Email: congress@pemsea.org
Web: www.pemsea.org|eascongress

15th Conference of the Parties to the UNFCCC & the 5th Meeting of the Parties to the Kyoto Protocol

Copenhagen, Denmark:
07-12-2009 to 18-12-2009
Overarching goal is to agree post-Kyoto climate treaty framework. Meetings will coincide with the 31st meetings of the treaty's subsidiary bodies - the Subsidiary Body for Implementation and the Subsidiary Body for Scientific and Technological Advice.
Details: UNFCCC Secretariat COP15|MOP5, PO Box 260124, D-53153 Bonn, Germany.
Fax: +49-228-8151999.
Email: secretariat@unfccc.int
Web: www.unfccc.int|meetings|unfccc_calendar|items|2655.php?year=2009

Climate and health in Bhutan

Dago Tschering and Gyambo Sithey identify the main areas in which Bhutan is at risk from adverse climate change effects on health

The Kingdom of Bhutan is sandwiched between the world's most populous countries, India and China. The terrain is among the most rugged and mountainous in the world. The Himalayas form a formidable natural boundary in the north and the plains of India border the southern part of the country.

Bhutan's climate is influenced mainly by the monsoon, which blows in from the Bay of Bengal, local topography and the variation in elevation as one moves from south to the north. In general, Bhutan has three distinct climatic zones: the southern foothills, the inner Himalayas, and higher Himalayas. While southern Bhutan is generally hot and humid, the central inner Himalayas have a cool climate. The inner Himalayan Mountains in the northern borders of the country experience severe alpine climate conditions and are under perpetual snow.

Modern medical care in Bhutan began in the early 1960s. Since then the Royal Government has been providing free healthcare services and it has been the national health policy to provide an integrated, equitable, cost-effective and well-balanced health services to all Bhutanese. Following the World Health Organization's Alma-Ata Declaration on primary healthcare, the Royal Government chose to use primary healthcare as its core thrust to reach the rural population scattered over the rugged mountainous terrain of Bhutan. Bhutan has, therefore, committed itself to the ideals of 'Health For All'. Currently, there are 1.8 doctors per 10,000 people and 14 hospital beds per 10,000 people.

Bhutan's resident population is 634,982 with 69.1 per cent of the population still residing in rural areas. The Total Fertility Rate has reduced from 5.6 in 1994 to 2.6 in 2005. The rate of growth (the difference between the number of births and deaths in a population) is 1.3 per 1000 population, compared to 3.1 in 1994. The infant mortality rate has been reduced to 40 per 1000 live birth from 70.7 per 1000 live births in 1994.

Access to safe drinking water in the community is an important parameter as there is a high association between safe drinking water, hygiene, sanitation and morbidity. Currently,

MAIN POINTS

- **The authors identify** the main impacts of climate change on the health of the population of Bhutan.
- **Higher morbidity and mortality** from extreme weather and climate events and an expansion of vector-borne and water-related diseases are expected.
- **They consider that** the health sector's primary role lies in emergency preparedness for damage control and that the health sector's participation in all areas identified as vulnerable to the adverse effects of climate change must be recognized.

A mountainous region in Bhutan

Photo: © Kevin Hicks

84 per cent of households drink from piped water either within the house (22.7 per cent) or from outside the house (61.5 per cent). In terms of sanitation, only 10 per cent of the houses do not have toilet facilities; 90 per cent have either an independent flush toilet or pit.

Acute respiratory infection and diarrhoeal diseases lead in the ten most common diseases in the country. Following these, skin infection, viral and/or bacterial intestinal infections, gastritis and peptic ulcer, conjunctivitis, malaria and other infectious diseases are most prevalent. Acute respiratory infection alone contributes to an average 20-25 per cent of the morbidity cases, followed by diarrhoeal diseases contributing to another 10-15 per cent of the morbidity cases. The top three diseases alone contribute to 40-50 per cent of the overall morbidity cases in Bhutan.

Mortality data for Bhutan are still very limited. Although routine collection of annual vital statistics has been a regular activity of health centres, data quality and coverage remains highly questionable due to various reasons like under-reporting. The accuracy of the diagnosis of a disease for the underlying cause of deaths is another weak area in the mortality data. Cardiovascular disease, cirrhosis of liver and accidental injuries are the most common causes of mortality. Malignancy is another emerging cause of death, though the incidence of communicable diseases like acute respiratory infection, diarrhoeal/dysentery and tuberculosis remains high.

Climate change health impacts

Changes in world climate would impact human health. While some health impacts would be beneficial, most of the impacts will probably be adverse. In Bhutan, there are three major areas of concern.

First, there would be higher morbidity and mortality from extreme weather and climate events. Four types of floods are common in tropical Asia: riverine floods, flash floods, glacial lake outburst floods and breached landslide-dam floods. Flash floods are common in the foothills, mountain borderlands and steep coastal catchments.

Second, there could be an expansion of vector-borne diseases. Many vector-borne diseases are sensitive to ambient temperature and precipitation. Even small changes in temperature and precipitation, or in vegetation, host populations or water availability, may increase or decrease the distribution and abundance of vectors, especially at the margins of their distribution, thus potentially changing their range.

Finally, there would be an increase in water-related diseases. As noted earlier, diarrhoeal diseases are one of the major causes of morbidity and mortality in a developing country such as Bhutan.

Current public health concerns

Dengue, encephalitis, airborne environmental pollutants/asthma, diarrhoeal diseases (cholera) and malaria are all sensitive

to climate change and are of particular public health concern in Bhutan today.

In Bhutan, dengue fever was first diagnosed and reported in July 2004 when an alarming number of people reported to Phuntsholing hospital with fever and rashes. Although the mosquito vectors *Aedes aegypti* and *Aedes albopictus* were known to exist in the southern regions, this was the first time that the disease was suspected and investigated.

A significant number of encephalitis cases have been reported from various hospitals around the country. The majority of them are caused by viruses and it is suspected that Japanese Encephalitis might be one of significant ones. Frequent outbreaks occur in neighbouring states of India.

Anecdotal data from medical doctors' indicate an increased number of asthmatic cases every year. It is suspected that changes in the environment due to rapid urbanization and climatic changes could be relevant factors.

Diarrhoeal disease continues to be a major problem affecting the survival of the children in this country and remains one of the top causes of morbidity. Finally, malaria is the second most fatal communicable disease in Bhutan and has been claiming about 18 lives (average) annually since 1995. Although there has been a significant reduction in the malaria case load, the case fatality ratio is still high.

Priorities for action

We consider that, as far as adverse climate change is concerned, the health sector's primary role lies in emergency preparedness for damage control. In this respect, it is imperative to recognize the health sector's participation in all areas identified as vulnerable to the adverse effects of climate change. In this regard, we recommend revisiting the Bhutan National Adaptation Programme of Action in the context of health. Currently, the health area is confined to emergency medicine and this needs to be extended to cover health information and management for climate-sensitive infectious diseases.

There is a need to sensitize and become aware of the effects of climate change on human health among stakeholders. It would be beneficial to integrate meteorological data into the Health Information Management System for statistical analysis in respect to climate/seasonal diseases and gear towards developing an early warning system for probable outbreaks. Installation of weather stations in all of Bhutan's malaria-endemic districts would ensure accurate meteorological data.

It is also necessary to develop guidelines and indicators for assessing morbidity, mortality and other health information (hygiene, sanitation, mental state and so on) of the population suffering from natural calamities. These key health statistics are required for immediate intervention as well as for surveillance and evaluation of affected communities. ■

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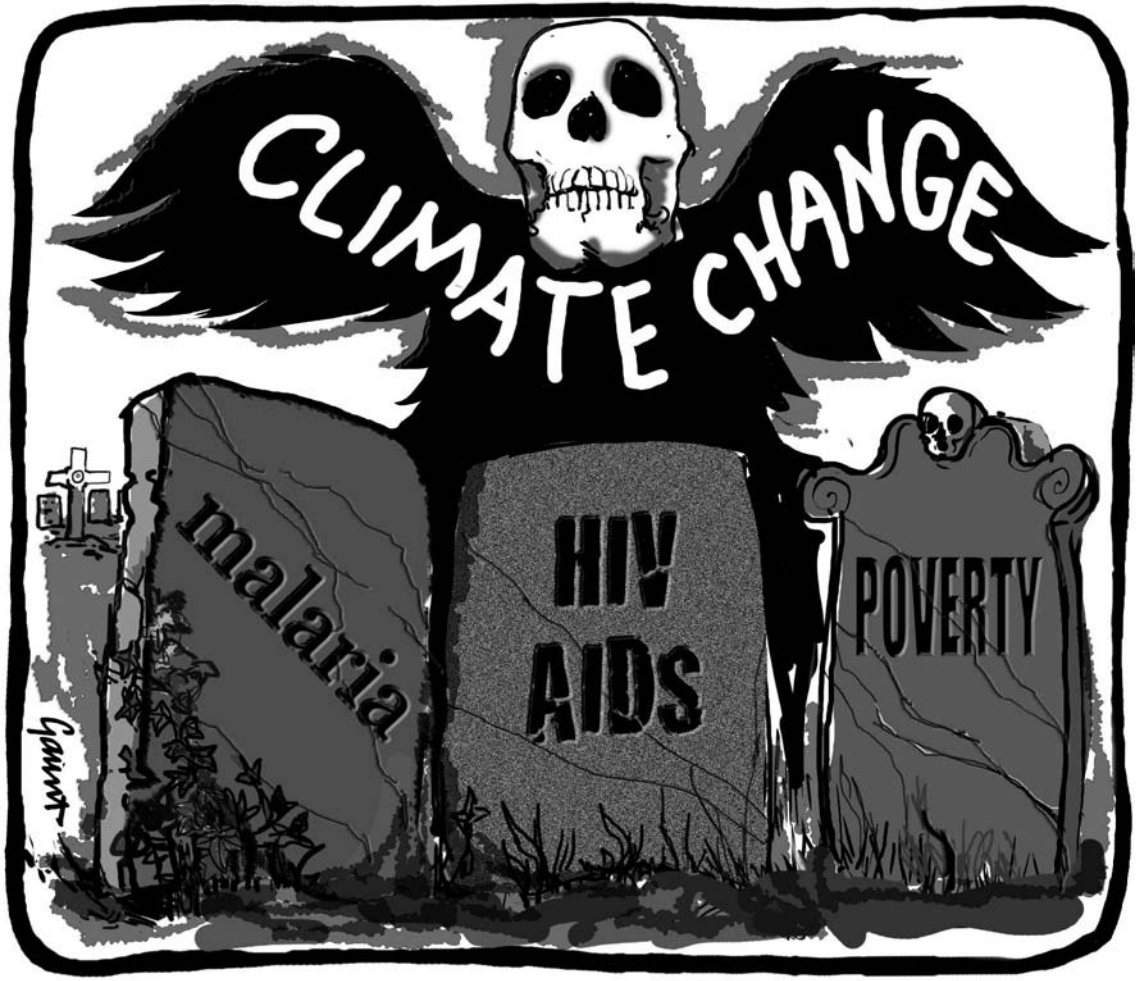
FURTHER INFORMATION

● **On the Web:** The report on which this article is based is available at www.clacc.net/HumanHealth/index.html, along with other national studies on climate change and human health.

A GAUNT VIEW



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Foundations of sand

THE FINAL WORD

Mick Kelly considers the challenge of reconciling current health priorities with the demands of meeting the long-term threat of climate change

Malaria is responsible for over one million deaths a year worldwide, according to the World Health Organization (WHO). Sub-Saharan Africa is worst-affected. The Joint UN Programme on HIV/AIDS and the WHO estimate that 33 million people were living with HIV at the end of 2007. During that year, around two million people died of AIDS. Two thirds of HIV infections are in sub-Saharan Africa.

The Intergovernmental Panel on Climate Change (IPCC) has concluded that anthropogenic climate change is currently contributing to the global burden of disease and premature deaths. At this early stage, the IPCC considers that "the effects are small but are projected to progressively increase in all countries and regions."

The challenge for politicians and planners is to identify measures that can ease the climate threat to future health without diverting resources away from what are, in the here and now, more pressing concerns for much of the world's population, such as malaria and HIV/AIDS.

Two suggestions emerge from the discussion in this special issue of *Tiempo*.

First, as the IPCC has also pointed out, there is a lack - a lamentable lack - of basic data regarding human health in the developing world. In a desert of hard information, efforts to improve the present-day situation rest on foundations of sand and there can be little hope of developing an effective long-term response to global warming.

Second, there is a need for greater integration and coordination. Examples abound at all levels. Climate data should be held alongside health statistics in medical databanks. Health concerns have to be an integral part of all climate impact studies, not treated as a separate issue. The climate treaty secretariat must intensify its efforts in reaching out to other parts of the UN system, those responsible for health issues in this instance.

Our success or failure in improving human health over coming years will determine the outcome of our efforts to adapt to the changing environment. A weakened population will be less able to adapt to climate stress.

Yet it's sad but true - malaria and HIV/AIDS don't capture the media headlines, nor the attention of politicians and even the scientific community, as does the latest apocalyptic tale of climate woe. Perhaps if they did, we'd be a good step further in responding effectively to both of these critical issues.

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