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CHAPTER 11: HUMAN HEALTH

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Southern Africa has multiple risks that contribute to the overall burden of disease (i.e. the quadruple burden of disease), which may make people more vulnerable to the health impacts from climate change. In addition, the sector is vulnerable as the links between climate and health are not well-quantified, and thus difficult to predict the impact. This chapter provides some examples of the breadth of issues concerned in climate change and human health.

11.1. Climate and health linkages

The links between climate and human health are complex and multi-faceted. Box 11.1 highlights a variety of climate-sensitive health impacts (Patz et al., 2005). These impacts of climate on health already exist in many areas in southern Africa. A changing climate has the potential to exacerbate these issues in areas where they already exist, as well as impact factors such as the frequency and spatial distribution of their occurrence. The largest human health risk from climate variability and climate change is expected in those populations that are currently impacted the most by climate-related diseases (Woodward et al., 2014). This chapter provides some examples of the breadth of issues concerned in climate change and human health.

Box 11.1: Key impacts of climate on health (modified from Patz et al., 2005)

Direct impacts	
Heat	Heat stress, cardiovascular disease
Extreme events/severe weather	Immediate impacts (injuries, fatalities) and indirect impacts (e.g. cholera)
Indirect impacts	
Air pollution	Asthma, cardiovascular disease
Water and food supply	Malnutrition, diarrhoea, harmful algal blooms
Mental health	Anxiety, despair, depression, post-traumatic stress
Water-borne diseases	Cholera, cryptosporidiosis, campylobacter, leptospirosis
Allergies	Respiratory allergies, poison ivy
Vector-borne diseases	Malaria, dengue, Zika virus, encephalitis, hantavirus, Rift Valley fever
Extreme events/severe weather	Immediate impacts (injuries, fatalities) and indirect impacts (e.g. cholera)

As highlighted in Box 11.1, climate can impact health directly (e.g. through increasing temperatures and immediate effects from severe weather) and indirectly (e.g. changes in agriculture and food supply due to climate change can impact malnutrition). Severe weather is listed twice as there can be immediate direct impacts as well as indirect impacts (e.g. increases in cholera from flooding).

Increases in temperature can have an impact on public health and workers' health (Garland et al., 2015; Andrade-Rivas & Rother, 2015), and is the basis of three case studies here to highlight the range of potential risks and considerations for an example of the direct impact of climate variables on human health.

Temperatures are already increasing in the region. By 2100, under a business-as-usual scenario, temperatures are projected to increase by 4-6 °C in the subtropics in Africa, and 3-5 °C over the tropics in Africa (refer to Chapter 2). These increases in temperature can have direct impacts on health (e.g. heat stress and heat stroke, and increases in mortality from exposure to high temperatures). Previous studies have found that urban areas may be more vulnerable to negative health impacts from exposure to high temperatures; the increased vulnerability can be due to many reasons including the urban heat island effect and the presence of air pollution (Kovats & Hajat, 2008). Case Study A below provides projections of high temperatures and potential risks to human health in SADC under a business-as-usual (BAU) scenario. Occupational health can also be impacted by increasing temperatures, and many outdoor workers can be exposed to multiple health risks. Case Studies B and C highlight the linkages between heat, sun and pesticide exposure, and the complexities in protecting worker health from these multiple risks.

The indirect impacts of climate on health are more varied and have complex interactions. For example, malaria is a well-studied climate-sensitive disease, though the impact that climate factors have on malaria are complex and non-linear. Temperature and rainfall are the most studied climate factors in relation to malaria. In general, there are optimal ranges of climate conditions where malaria risks are highest, and some studies have found that small changes in temperature can lead to non-linear and larger increases in malaria transmissions (Pascual et al., 2006, Alonso et al., 2011). In order to fully characterise the impact of climatic variables on malaria, multiple factors with high spatial and temporal resolution are needed (Parham and Michael, 2010). The spatial range for suitable climatic conditions in Africa for malaria are projected to increase as a result of climate change, especially in regions that are currently on edges of current malaria areas (e.g. Tanser et al., 2003). However, as discussed in section 11.2 below, for all health impacts, including malaria, the drivers are complex and not just climatic variables.

Case study A: High temperatures and risks to human health in SADC

By Rebecca Garland, CSIR

Temperatures in Africa have been increasing over the past 50 years. This increase is expected to continue into the future due to climate change, with increases as great as 3-6 °C by 2100 under a business-as-usual scenario. These increases in temperature can have large impacts on human health across the continent.

The health impacts from exposure to high temperatures can range from discomfort and fatigue to heat stress, and can also lead to death. During heat waves, increases in mortalities are often recorded.

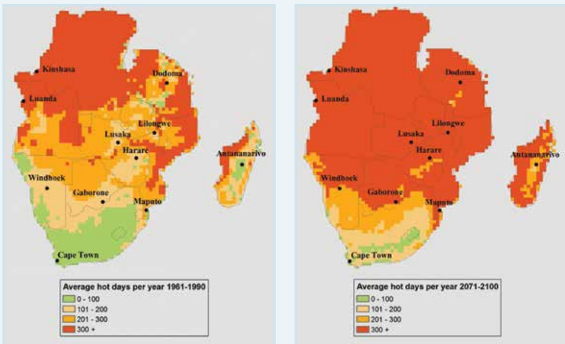
A recent study investigated the potential risk to human health from high apparent temperatures in Africa under a "business-as-usual" scenario. Apparent temperature is a temperature index that attempts to quantify "how hot it feels" by combining temperature, relative humidity and wind speed. The "business-as-usual" scenario (BAU) was the A2 scenario for the IPCC 4th Assessment, and depicts a scenario where there has been little mitigation of GHG emissions.

The study assessed the increase in "hot days", where a hot day was defined as a day where the maximum apparent temperature was above 27 °C. There were no areas in Africa that were projected to see decreases in hot days.

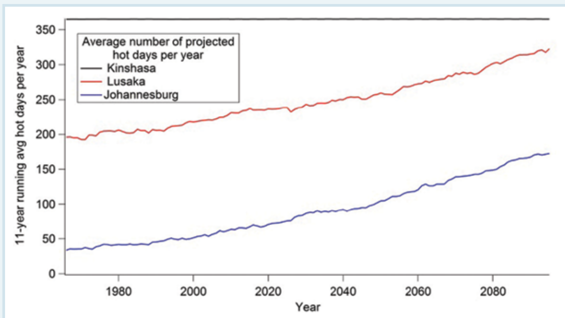
The maps highlight the modelled average number of "hot days" per year in the current climate (1961-1990) and in 2071-2100 assuming BAU. From this figure it can be seen that areas in tropical Africa already have almost every day above this threshold (in red in figure top panel). By the end of the century, under BAU, it is projected that a larger amount of the region would experience 300 plus days per year on average of "hot days".

The graph displays the 11-year running average of the number of hot days per year for Johannesburg, Lusaka and Kinshasa. Increases across the study period can be seen for Lusaka and Johannesburg, while there are no increases for Kinshasa as almost every day is already a "hot day"! However, when the temperature threshold for "extremely hot days" of maximum apparent temperatures above 39 °C was used, Kinshasa was projected to have an increase from ~10 days per year in 1970s and 1980s, to over 300 days per year by 2100.

These projections highlight the large risk to human health from high temperatures. Heat-health action plans are an effective public health measure, that when implemented can assist in decreasing the impact from high temperature events. These action plans consist of an early warning system for high temperatures together with actions and alerts that are activated when a high-temperature event is forecast by the country's meteorological agency.



Modelled average number of "hot days" per year in 1961-1990 (left) and 2071-2100 assuming BAU scenario (right).



See more on Heat-health action plans at: World Health Organization Regional Office for Europe, "Heat-health action plans", 2008 (pdf available at: http://www.euro.who.int/en/publications/abstracts/heathealth-action-plans). For more information on this study see Garland et al., Regional projections of extreme apparent temperature days in Africa and the related potential risk to human health, Int. J. Environ. Res. Public Health, 2015. (pdf available at: http://www.mdpi.com/1660-4601/12/10/12577)

Case study B: Outdoor workers in the Western Cape, South Africa

By Manshil Misra, School of Public Health & Family Medicine, University of Cape Town, South Africa

A variety of sectors integral to the South African economy utilise outdoor workers. The Working for Water (WfW) programme was launched in 1995 by the South African Department of Environmental Affairs. The main goal of this state-funded initiative is to protect biodiversity in areas that contain important water sources by controlling invasive alien vegetation. WfW workers are sourced from local residents in removal areas, as an additional objective is to provide employment and skills development to needy communities.

WfW workers are typically exposed to several hazards (e.g. herbicides, sun, heat) while removing alien vegetation. A significant concern is the effect on the health of outdoor workers in light of climate change and its effect on severe variations in weather, including exposure to extreme heat.

A recent study involving WfW workers was conducted in Citrusdal (Western Cape), where temperatures are known to frequently exceed 40 ^{o}C during summer. The study sought to identify possible approaches to augment current exposure prevention strategies by exploring perceptions and practices of WfW employees toward their heat and sun exposure, as well as their understanding of climate change.

The results show that in this vulnerable population, there was varying knowledge and understanding of the health impacts of exposure to heat and sun, and ways to prevent harmful effects from them. Workers frequently experienced themselves, or observed in others, the immediate significant adverse effects (e.g. headache and loss of consciousness) from exposure to extreme heat and sun. This was often linked to the personal protective equipment (PPE) workers are provided with to protect them from exposure to toxic herbicide but which are unsuitable for working in extreme heat. Many workers indicated that the respirator could not be worn more than a matter of minutes when temperatures were 30 degrees or more. Other factors impacting on health and exacerbated by the heat were carrying heavy backpack sprayers in the direct sun and spraying in thick vegetation that retains the heat.

These results suggest that despite the recognised risks that are faced by outdoor workers who have some knowledge of how to mitigate these, and policy (within a national organisation) in place to address occupational health, further work must still be undertaken to bolster policy and enhance its practical application. Measures also need to be put in place to review how standard operating procedures (e.g. wearing PPE when applying hazardous pesticides) put workers at risk while working outdoors. This is especially imperative in light of the future threats related to climate change, such as increases in temperature.

Case study C: Climate change and pesticide health risks for Zimbabwean small-scale cotton farmers

By Cliff Zinyemba, School of Public Health and Family Medicine, University of Cape Town, South Africa

All pesticides are toxic and can cause a range of acute and chronic health effects from vomiting, rashes, allergies, asthma, cancer and interfering with the body's hormones. A study was conducted to assess whether climate change was a key factor impacting on small-scale Zimbabwean cotton farmers' exposure to pesticides.

Fifty farmers who had been consistently growing cotton over a period of 30 years were interviewed. They were asked a range of questions, including the types of pesticide used, changes in quantities of pesticides used on their farms, use of personal protective equipment (PPE) as well as the handling of pesticides, including spraying patterns.

The study found that many of the pesticides being used by the cotton farmers are hazardous. Several of these are endocrine-disrupting chemicals (EDCs) interfering with human hormones, impacting, for example, fertility and sexual development. Examples of pesticides used include some which are classified as slightly hazardous (Class III) by the World Health Organization, such as Lambda-cyhalothrin, carbaryl and atrazine; and others which are classified as moderately hazardous (Class II) such as dimethoate and fenvalerate. Farmers use these pesticides in large quantities, often handling them without any PPE. With increasing temperatures being experienced, farmers indicated that they are becoming less concerned why PPE such as rubber boots, gloves and long-sleeved clothing should be worn and highlighted the discomfort such clothing causes, which makes application with PPE virtually impossible. With more and more hazardous pesticides being used, the use of PPE becomes crucial to reduce health risks in the short and long term. However, PPE was not considered a priority as illustrated by the farmers, who preferred to spray while wearing sandals, short trousers and short-sleeved shirts in order to withstand the heat. Even if the correct PPE is available it is unlikely that they would be worn in extremely hot conditions.

Climate change is likely to perpetuate the health risks associated with such pesticides as a result of increased exposure to pesticides, not only for farmers but also for their families and other residents. Increased exposure to hazardous and endocrine-disrupting pesticides is resulting from increased use, potential for increased vapourisation and limited use of PPE.

The use of pesticides has increased in Rushinga, with some farmers using up to four times the recommended dosage of pesticides per hectare than they did during the 1980s. The indication is that this increase is resulting from climate change and variability impacts on pest populations, cropping patterns and pest resistance. Farmers also spray more frequently, and as a result spend more time spraying than they did in the past, thus significantly increasing the risks associated with their direct exposure to pesticides, and that of their families and neighbours. This also leads to an increase in indirect exposure from contaminated air, drinking water and soil used for household crops, as well as an increase in pesticide residues in produce sold and consumed.

Climate change may, therefore, be a key factor – among others – impacting on Zimbabwean small-scale cotton farmers' exposure to pesticide. If adaption measures are not introduced in Rushinga, climate change may not only perpetuate the dependency of the farmers on pesticides, but increase pesticide usage and health risks associated with direct and indirect exposure. Adaptive strategies should focus on integrated and reduced toxicity pest management as a priority to enable farmers to adapt to climate change in a sustainable way, in which pesticide-related health risks are minimised. The health sector plays a key role in effective pesticide poisoning surveillance programmes to inform evidence-based policy-making.

11.2. Key drivers and processes of change within the sector

Figure 11.1 highlights the linkages between climate change and human health, as well as mitigation and adaptation potential. The impacts on human health from climate variability are similar, however the representation of the impact of mitigation measures is only applicable to climate change. This figure highlights both the direct and indirect impacts on health from Box 11.1.

For all health impacts listed in Box 11.1, there are non-climate factors that also influence and drive the risk to human health (highlighted as modifying factors in Figure 11.1). For example, cholera epidemics are caused by a lack of access to safe water and lack of proper sanitation. A study in Lusaka, Zambia found that cholera outbreaks occurred mostly during the rainy season, and that parts of the city with insufficient drainage had increased risk of cholera outbreaks (Sasaki et al., 2009). Thus, for water-borne diseases, service delivery can be modifying factors that can either exacerbate the health impact (i.e. from poor service delivery) or mitigate the health impact (i.e. effective service delivery even in severe weather). With respect to exposure to high temperatures and resultant impacts on public health, the built environment can play a role as the thermal comfort of buildings can impact heat stress. In addition, across all potential health impacts, the condition of the health system is a key modifying factor; an over-burdened health system may exacerbate the impact on health from a changing climate. These non-climate factors do need to be accounted for when trying to quantify the potential impacts on health from climate change. For example, it has been estimated that the projected future impacts on malaria are around two orders of magnitude smaller than the impacts possible from appropriate and effective malaria control measures (Gething et al., 2010). Identifying these factors will also play an important role in developing specific adaptation options for the sector; however targeted research is needed to identify the relevant local modifying factors that can be the basis for adaptation options.

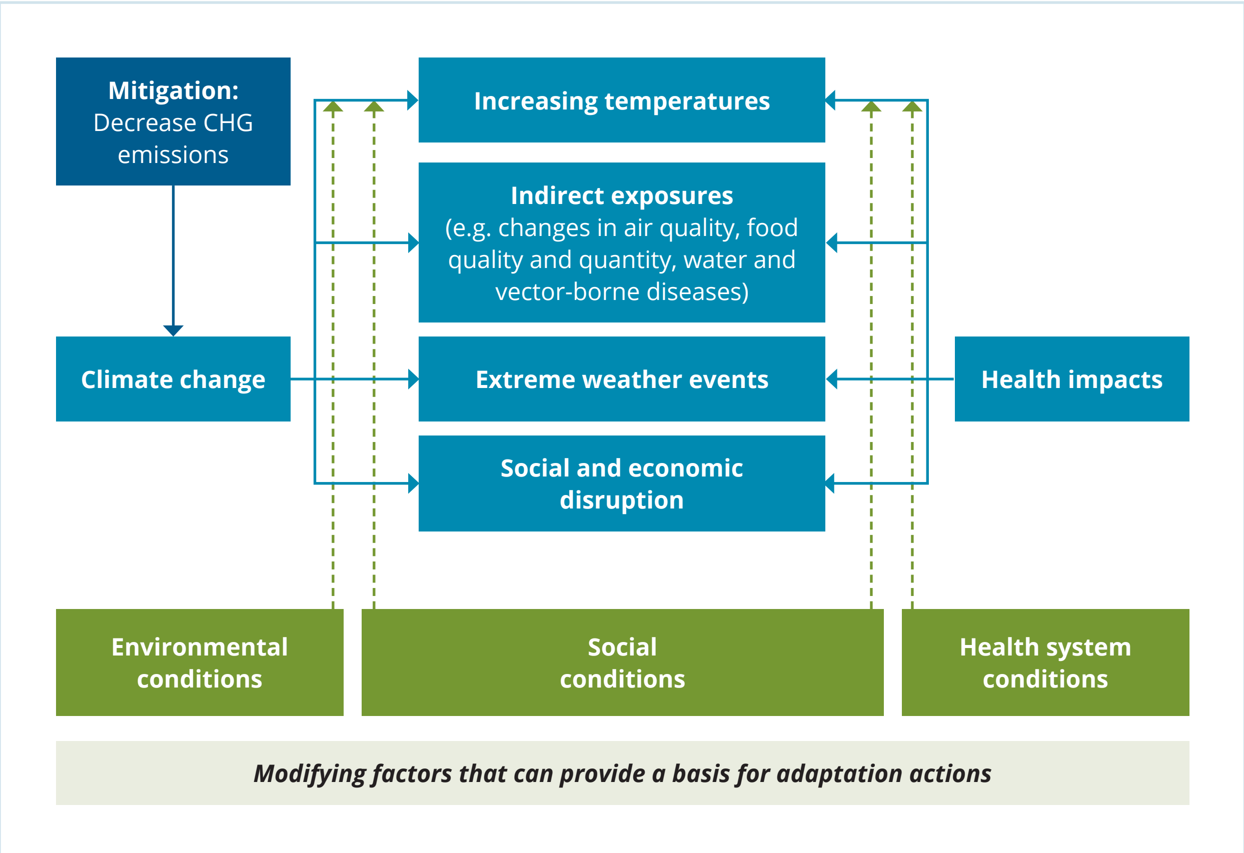


Figure 11.1: Linkages between climate change and health (adapted from Confalonieri et al., 2007; Ahdoot & Pacheco, 2015).

11.3. Health sector role in mitigation

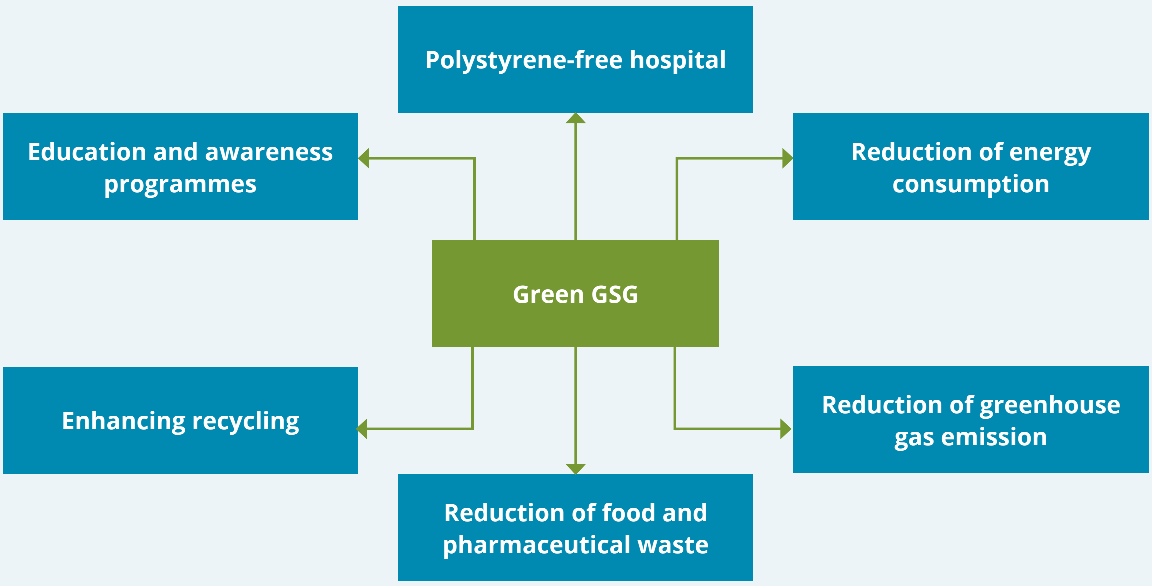
In order to mitigate climate change, decreases in greenhouse gas (GHG) emissions are necessary. The health sector can play a role in mitigating climate change; an example of such an initiative in Cape Town, South Africa is highlighted in Case Study D. Government support would be needed to implement this type of initiative in all hospitals in southern Africa.

Case study D: Green hospitals as role models to mitigate climate change

By Edda Weimann & Bhavna Patel, Groote Schuur Hospital, Cape Town

The South African health system is characterised by a stark inequality between public and private health care providers, with life expectancy significantly differing between socio-economic groups. Public healthcare facilities are under severe austerity measures, are experiencing shortages of hospital beds, have limited transport services and a lack of skills. Hence, every effort should be undertaken to minimise the impact of climate change and alleviate the burden of an already overloaded health system. In addition to the need for adaptation measures in the sector, GHG mitigation measures are needed, too. The health sector itself contributes to climate change as a major energy consumer, polluter and creator of hazardous waste. Consequently, health care providers can take action to reduce their own climate impact and perform as leaders inspiring others in reducing GHG emissions.

Groote Schuur Hospital (GSH) in Cape Town, South Africa has developed and practices the GSH Green hospital leadership framework (figure below). It comprises awareness campaigns, continuous education of staff and students, improvement of energy efficiencies, reduction of water consumption, waste and hazardous waste such as mercury and polystyrene, recycling throughout the hospital, reduction and recycling of food waste and the decrease of pharmaceutical waste. The framework can be applied to any other health care provider.



Groote Schuur Green Hospital Framework (adapted from Weimann and Patel, 2017).

11.4. Response measures

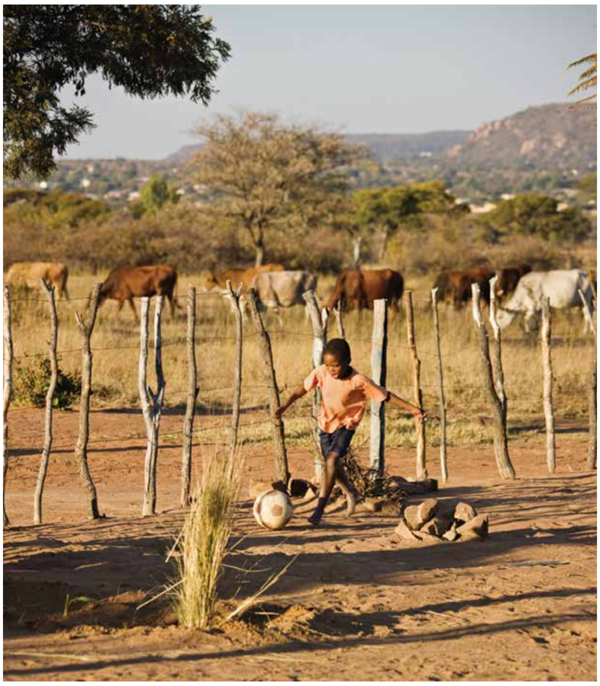
Currently, there is limited information on climate-health linkages, specifically in southern Africa. This makes it difficult to quantify the current impact of climate variables on health and estimate the potential risk from a changing climate. What is of particular concern are the uncertain risks to children – future generations – resulting in negative health outcomes from years of exposure to climate-induced health impacts (Box 11.2).

Urgent response measures are needed in the southern Africa region to reduce the impacts on the health of populations, especially children, workers and the elderly. Adaptive capacity varies, particularly at the individual level. In addition, the risk of climate variables to health will be different across regions, and a spatial assessment to identify hotspots can assist in understanding the key climate-health risks by area (such as in Case Study A).

Climate-related impacts can be modified through the listed modifying factors (purple boxes) in Figure 11.1. These modifying factors highlight areas where adaptation efforts can be placed in order to decrease the impact on human health from a changing climate. For example, for decreasing occupational health risk to high temperatures, actions such as effective early warning systems and flexible work hours can assist in decreasing the impact to human health from high temperatures.

Once health risks are identified, potential adaption options can be screened following frameworks such as that of Ebi and Burton (2008). This framework screens options using factors such as their technical feasibility, degree of effectiveness, environmental acceptability, economic efficiency, social and legal acceptability and compatibility, and the available human and financial capacity of the area. Examples of potential adapation options that can help to decrease vulnerability and mitigate negative health impacts are illustrated in Box 11.3.

A challenge for the health sector in southern Africa is to prioritise climate change in relation to other pressing health burdens, as well as secure ample funding for adaptation measures and to support research in a vulnerability context of weak health systems, fragile health care facilities in terms of service provision and infrastructure, and limited adaptation capacity within the sector.



Box 11.2: Are children the canary in the "mineshaft" of climate-linked disease outcomes?

By Hanna-Andrea Rother, Division of Environmental Health, University of Cape Town, South Africa

For children, the risk of climate-related health burdens is much higher than for adults. Children are not little adults. Their physiology (including still developing systems) and their behaviours (hand-to-mouth, spending large amounts of time outdoors, and playing close to the ground) increase their exposure risks; along with that they breathe, eat and drink more for their size compared with adults. In 2007, Zang and Hiller projected that children under the age of five from high-income and low-income countries would bear 88% of the global burden of disease resulting from climate-linked factors. Children in the poorest countries of southern Africa where the disease burden is high will be most impacted by climate variability and climate change effects. The table below illustrates the primary (i.e. direct) and secondary (i.e. coping and adaption strategies) impacts that need to be taken into account when assessing children's health risks, as well as developing appropriate risk-reduction strategies.

As research on climate-health links in southern Africa is limited and the long-term impacts on health are still widely unknown, one has to ask if African children are the "canary" to assess what the hazards really are. In order for children not to become an experimental indicator, policy-makers urgently need to devise policies based on the precautionary principle as well as ensure that climate issues are entrenched in all policies. Furthermore, health uncertainties need to be stated when managing for and communicating risks to vulnerable populations and decision-makers so as to ensure focus on impact suppression.

Primary and secondary impacts of climate on southern African children

Time frame*	Primary impacts	Secondary impacts
Short-term and immediate impacts	• Drowning and injury risks from damaged infrastructure • Vulnerability to disease (e.g. cholera & diarrhoea)	*Household level* (e.g. adapting livelihood practices such as children involved in income-generating activities; lifestyle changes)
Medium-term	• Risk of food shortages leading to child hunger and malnutrition	*Community level* (e.g. increased impacts on poverty, basic services, food provision, housing)
Long-term	• Increased incidence of malaria • Increased incidence of respiratory diseases and heat stroke	*Local/national/regional government level* (e.g. limited climate response strategies; sound planning tools and by-laws; dedicated budgets for climate and health)

* Time frame relates to the response time between a given climate event and health impact. For example, an extreme weather event can have short-term and immediate health impacts; (a) season(s) of drought can have longer impacts on child hunger that are more persistent in the medium term. Source: Adapted from UNICEF, 2011

Box 11.3: Examples of health sector policy options for adaptation to climate change [Source: Kula et al., 2013]

- Improving, modifying, or expanding health protection systems including surveillance systems for vector- and water-borne diseases, and seasonal forecasting and early warning systems for infectious diseases (e.g. epidemic malaria).
- Developing and implementing health forecasting and early warning systems (including emergency incident response plans) for extreme events such as heat- and flood-health warning measures.
- Maintaining and improving current environmental health regulatory standards (e.g. water and air quality standards).
- Improving or modifying health systems infrastructure by adapting hospitals and clinics to increased frequency of extreme weather events such as heat waves and floods.
- Increasing the capacity of health care services and human resources to cope with additional disease burden associated with extreme weather events.
- Preventing or treating the additional cases of disease due to failure in adaptation upstream.
- Improving the provision of medication to reduce the impact of potential increases in the transmission of infectious diseases.

The World Health Organization (WHO) has rightly indicated that reducing climate change impacts is a risk management issue. As highlighted by the 2015 Lancet Health and Climate Change Commision, not only do mitigation measures and relevant health policies reduce climate change impacts or assist in managing them, these can also have health benefits (Watts et al., 2015), as is the case with cycling (Case Study E). This is an apt example of the need for the health sector to work with other sectors, for instance in the planning of cycle routes and by using health benefits such as reducing obesity and heart conditions to promote cycling rather than just climate change alone.

As the WHO (2015c) has emphasised, it is critical that climate change adaptation measures are mainstreamed into existing and future health interventions to increase success and reduce the silo approach to climate management. Creating and implementing separate climate and health adaptation policies not integrated into other initiatives and policies will have limited success. Perhaps a "Climate in All Policies" approach similar to the "Health in All Policies" approach should be taken.

Case study E: Barriers to cycling mobility in Masiphumelele, Cape Town

By James Irlam, Primary Health Care Directorate, University of Cape Town, South Africa

Non-motorised transport (NMT) such as cycling and walking has multiple social, economic, environmental, climate and public health benefits and is integral to the agenda of sustainable development. There is considerable potential for more cycling mobility in South Africa, especially in low-income communities. Barriers to cycling mobility were investigated using a mixed methods study design in Masiphumelele, a low-income community in Cape Town, in October 2015.

A focus group discussion with local bicycle shop customers informed the design of a questionnaire and a Best-Worst Scaling (BWS) stated choice survey of 100 household residents. The BWS survey used 10 choice sets of four statements each to rank the relative importance to study participants of 20 potential barriers to cycling mobility on their average Best-Worse (B-W) scores.

Key findings

Taxis were the most frequently used mode of household transport (93%), followed by walking (44%), train (23%), bicycle (16%) and bus (11%). A third of households (32%) owned at least one bicycle that is used for transport. Twenty-two participants (22%) reported that they cycle fairly often (n=15 respondents) or regularly (n=7 respondents), primarily to save money (44%), keep fit and healthy (32%), and to save time (15%). The main reasons against cycling were unsafe roads (23%), unaffordable bicycles (15%), inability to cycle (15%), inadequate health and fitness (12%), long distances (10%) and no bicycle (7%).

The BWS survey identified and ranked significant perceived barriers to cycling as poor road safety (B-W score = 0.16); inability to transport loads on a bicycle (0.15); not being permitted to transport a bicycle on the train during peak commuting hours (0.13); and the risk of being late for work (0.12). Unaffordability and lack of safe storage of bicycles were significantly more important barriers for men than for women, whereas poor health was more important for women than for men.

Two-thirds (68%) of respondents supported the promotion of cycling mobility in Masiphumelele, mostly for reasons of financial savings (43%) and health benefits (28%). The main suggestions for promoting cycling were to teach cycling skills (30%), sponsor bicycles (21%), actively promote the benefits of cycling (20%), and create a safe environment for cyclists (12%).

Conclusion

There is a relatively high prevalence of bicycle ownership and use, as well as good support for promoting cycling mobility in Masiphumelele, mostly due to the perceived benefits of financial savings and health.

The health sector's role in actively promoting the benefits of cycling, educating about road safety, teaching cycling skills, making bicycles and spares more affordable, enhancing the safety of the cycling environment, and building local capacity is a key intervention for increasing cycling mobility in low-income communities like Masiphumelele, mitigating climate change while increasing health benefits.