HEAT WAVES, FLOODS AND THE HEALTH IMPACTS OF CLIMATE CHANGE

A Prototype Training Workshop for City Health Officials

World Health Organization

Centre for Health Development

www.who.or.jp

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This training manual is designed to accompany a workshop for city health officials on the health impacts of climate change. It is based on the book: Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP, 2003).

After going through this manual, you should be able to:

- Define key terms and concepts of climate change and human health
- Describe the effects of climate change on human health
- Describe the effects of climate change on your city
- Plan public health interventions to address climate change and its health impacts

This manual is divided into eleven sessions.

- Session 1: An overview of climate change and human health – risks and responses
- Session 2: Health situation in cities
- Session 3: Weather, climate, and climate change
- Session 4: Health impacts of climate extremes
- Session 5: Climate change and infectious diseases
- Session 6: How much disease could climate change cause?
- Session 7: Stratospheric ozone depletion
- Session 8: Monitoring health impacts of climate change
- Session 9: Public health research focus in studying climate change
- Session 10: Assessing community vulnerability and adaptive capacity
- Session 11: Planning public health interventions to address climate change and its health impacts
- Conclusions and recommendations

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CONTENTS

OVERVIEW

This training manual is designed to accompany a workshop for city health officials on the health impacts of climate change. It is based on the book: **Climate Change and Human Health: Risks and Responses** (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003).

As a city public health practitioner, you should already have background knowledge on topics such as infectious disease, cardiovascular disease, diarrhoea, malnutrition and the physiologic effects of temperature extremes. Prior knowledge on disaster management (e.g., caring for populations affected by floods), and public health program planning, is advantageous.

Because the goal of this training program is to help you develop action plans at the city level to address climate change, it is essential to have a good grasp of the procedures and mechanisms through which your action plans can be pursued and implemented.

In this training programme you will learn about many technical terms that are largely within the realm of ecology, the environmental sciences and in particular, meteorology and climatology. It is important that you apply this knowledge to a very practical concern: assessing the impact of climate change in our cities, and planning public health interventions to address this threat. The knowledge that you will gain here can be the starting point for change in your community.

Objectives

After going through this manual, you should be able to:

- Define key terms and concepts on climate change and human health
  - Describe the effects of climate change on human health
  - Identify the health impacts of climate extremes
  - Explain the link between climate change and infectious disease
  - Determine the approximate magnitude of the health impacts of climate change
  - Explain the interaction between ozone depletion and greenhouse gas-induced warming
- Describe the effects of climate change on your city
  - Analyze the current health situation in your city
  - Identify the main climate-related health threats
  - Identify vulnerable populations
- Plan public health interventions to address climate change and its health impacts
  - Discuss issues related to monitoring health impacts of climate change
  - Discuss key areas that can be addressed by public health research
  - Describe possible policies and measures to respond to climate change

How this Manual is Organized

This manual is divided into eleven Sessions.

- Session 1: An overview of climate change and human health: risks and responses
- Session 2: Health situation in cities
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- Session 4: Health impacts of climate extremes
- Session 5: Climate change and infectious diseases
- Session 6: How much disease could climate change cause?
- Session 7: Stratospheric ozone depletion
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- Session 10: Assessing community vulnerability and adaptive capacity
- Session 11: Planning public health interventions to address climate change and its health impacts
- Conclusions and Recommendations

Each Session has the following sections:

- **Objectives** – Learning objectives are stated for each session. Use these as guides for gauging your level of accomplishment of tasks to be done in this training programme.

- **Study Time and Workshop Time** – In this section, you are advised to allot time for self-study. Although a number of hours is recommended for each session, spend more self-study time on topics that are not very familiar to you. Self-study is important as not all topics will be "lectured" in a classroom setting. Advance preparation gives you more opportunities to reflect on issues, and you will be better prepared for group discussions. You will also be able to identify the areas where you need more guidance or information, and you can then pose your questions to resource persons. The Workshop Time will be determined by your facilitator/coordinator.

- **Readings** – This manual is based on the book: Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003). This book is available in print and online formats. Throughout this manual, you will be asked to read chapters from the book, so it is essential that you have a copy on hand. Note that the session titles do not exactly correspond to the chapters in the book. You will be guided on the readings required for each session. Some sessions list other sources for further reading.

- **Quick Quizzes** – In this manual, you will find tests on factual knowledge, with answers given at the end of the session. This is a form of self-assessment that you can use as a guide — if you have difficulty answering the questions, then it is best to go through the readings again, or ask a resource person to explain a topic to you. Remember, however, that memorization of facts and figures is not the end goal of this training. What is more important is how you analyze and apply what you learn.

- **Activities** – These give opportunities to apply knowledge and skills learned in solving problems in your context. Throughout the text, you will be asked to refer to a figure in the text **Climate Change and Human Health: Risks and Responses**, represented by this icon . Activities may be accomplished individually or in groups, depending on the design of the workshop. Not all activities need to be completed, and in some cases, options are provided. Instructions regarding activities will be discussed by your workshop coordinator/facilitator.

- **Worksheets** – These help you structure responses to questions in the Activities. The forms aid in preparing presentations and in compiling all workshop outputs into a personal or group portfolio.

SESSION 1:

An overview of climate change and human health: risks and responses

Objectives

After completing this session you should be able to:

- Define key terms and concepts on climate change and human health
- With other participants, establish a common framework on climate change and human health

Study Time

2 hours

Workshop Time

_____

Readings

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Preface
- Chapter 1 – Global climate change and health: an old story writ large

Quick Quiz

1. The primary challenge facing the world community is to achieve sufficient reduction in _____ _____ _____ so as to avoid dangerous interference in the climate system.

2. The answer to Question #1 is comprised principally of carbon _____, although other gases like methane, nitrous oxide and various human-made hydrocarbons are also involved.

3. During the 20th century, world average surface temperature increased by approximately _____ degrees C, which exceeds the upper limit of natural (historical) variability.

4. As a society becomes wealthier, more literate and better able to exert legislative control, the following community-wide environmental hazards increase or decrease?

   a. Heavy air pollution
   b. Household wastes
   c. Coliform bacteria in water
   d. Heavy metals
   e. Chlorofluorocarbon emissions
   f. Carbon dioxide emissions
   g. Biodiversity loss

5. _____ _____ refers to the supplies of food, water and raw materials, and the environmental "sinks" into which waste is emptied. It is large in modern industrialized societies.

6. _____ refers to actions taken to lessen the impact of climate change.

Activities

Activity 1-1

Study Figure 1-1 , which shows the global temperature record since instrumental recording began in 1860.

1. Why is there such a large variation in the high and low estimates for future decades?

2. What are the central estimates for 2050 and 2100? How much higher are these temperatures compared to the present time?

3. To what extent is the temperature increase attributable to human influence?

Activity 1-2

Study Figures 1-4 and 1-5  , which show the interrelationships between major types of global environmental change, including climate change, and their effects on health.

1. Trace the pathway from regional weather change to an increase in vector-borne diseases.

2. Describe the health effects of changes in temperature extremes (more heatwaves and less winter cold).

3. Describe the effects of increases in extreme weather events (floods, cyclones, storm-surges, droughts).

4. What disease conditions would increase if there are low supplies of freshwater?

5. What disease conditions would increase if there is loss of agricultural productivity?

6. How does conflict over decreasing resources affect human health?

Activity 1-3

There is a hierarchy of control strategies that can help to protect population health in the advent of climate change: administrative/legislative, engineering, and personal/behavioural.

Describe three specific personal/behavioural strategies that you can do (or are already doing) as an adaptation to climate change.

Date:

Name/s:

WORKSHEET 1-1

From Figure 1-1 , which shows the global temperature record since instrumental recording began in 1860:

1. Why is there such a large variation in the high and low estimates for future decades?

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Date:

Name/s:

WORKSHEET 1-2

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Date:

Name/s:

WORKSHEET 1-3

There is a hierarchy of control strategies that can help to protect population health in the advent of climate change: administrative/legislative, engineering, and personal/behavioural.

Describe three specific personal/behavioural strategies that you can do (or are already doing) as an adaptation to climate change.

1.

2

3.

SESSION 2:
Health situation in cities

Objectives

After completing this session you should be able to:

- Examine data on the health situation of your city
- Analyze how the health situation might be affected by climate change

Study Time

2 hours

Workshop Time

_____

Readings

Documents on National Health Statistics

Possible sources of information include:

- World Health Organization (http://www.who.int/countries/en)
- Nationmaster (http://www.nationmaster.com)
- Ministry of Health website
- Ministry of Tourism website
- Ministry of Environment website

Activity

Activity 2 -1

Find out about the following:

- Population
- Average height above sea level
- Temperature range
- Extreme weather events (floods, cyclones, storm-surges, droughts)
- 10 top causes of morbidity and mortality
- Under-5 mortality
- Childhood malnutrition statistics
- Immunization coverage
- Water and sanitation statistics
- Life expectancy
- Malaria/dengue/vector-borne disease prevalence
- Recent disease outbreaks
- Public / private spending for health

Discuss how the above statistics might change in the future because of climate change. You will find out more about the impacts of climate change in the succeeding sessions but at this point, record your thoughts (inferences) about how you think these statistics will be affected.

Date:

Name/s:

WORKSHEET 2-1

Country Statistics for _____

	Current Data (Year)	Possible Effect of Climate Change
Population		
Average height above sea level		
Temperature range		
Extreme weather events (floods, cyclones, storm-surges, droughts)		
10 top causes of morbidity and mortality		
Under-5 mortality		
Childhood malnutrition statistics		
Immunization coverage		
Water and sanitation statistics		
Life expectancy		
Malaria/dengue/vector-borne disease prevalence		
Recent disease outbreaks		
Public / private spending for health		

SESSION 3:
Weather, climate, and climate change

Objectives

After completing this session you should be able to:

- Differentiate between the terms "weather" and "climate"
- Describe the Greenhouse Effect
- Using graphs explain how climate has changed over the past thousands of years
- Compare recent climate changes (over the past 150 years) with those which have occurred over the past millennia
- Describe the projected climate changes in the 21st century, based on results of climate modelling

Study Time

3 hours

Workshop Time

_____

Readings

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Chapter 2 – Weather and climate as health exposures

Intergovernmental Panel on Climate Change Working Group I, Third Assessment Report

Quick Quiz

1. Put a check on the column that designates whether the definition refers to "weather" or "climate" or both.

	Weather	Climate
Always changing		
Considered in a time scale of minutes to weeks		
Day-to-day changing atmospheric conditions		
Considered over multiple years (e.g., a 30-year average)		
Characterized by temperature, precipitation, wind, cloudiness and humidity		
Characterized by soil moisture, sea surface temperature, and concentration and thickness of sea ice		
Average state of the atmosphere and underlying land or water in a region over a particular time scale		

2. Study Figure 2-2 on the Greenhouse Effect. State whether the following statements are True or False.

	True	False
Most of the radiation from the sun is absorbed, which warms the Earth.		
The Earth and atmosphere reflect some radiation back out to space but some of this radiation hits greenhouse gas molecules in the atmosphere.		
Greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, halocarbons, and ozone.		
Greenhouse gases serve to cool the temperature of the Earth and lower atmosphere.		
Without the greenhouse effect, the Earth would be 33 degrees colder than present.		
Without the greenhouse effect, diurnal temperature range would be more stable.		

Activities

Activity 3-1

Study Figure 2-4 , which shows three schematic diagrams of global temperature variations.

The **lower panel** shows global average surface temperatures from the present (the right edge of the panel) to 1000 years before present. The Medieval Warm Period and Little Ice Age, both of which had important impacts on human development, are small variations compared with earlier variability. The **middle panel** shows global average surface temperature from the present (the right edge of the panel) to 10 000 years before present. The warming at the end of the last ice age is shown at the left edge. The **top panel** shows global average surface temperature from the present (the right edge of the panel) to 1 000 000 years before present. The high degree of volatility in global temperature is clear. Historically, global temperature was rarely as warm as it was in the 1980s (and surface temperature has increased since then). Comparing the top and lower panels shows that the Earth's climate has been relatively warm and stable for the past 10 000 years compared with earlier periods.

Make sure you understand these concepts. If you have questions, discuss these with a resource person.

Try explaining the graphs to a colleague or to another participant.

Activity 3-2

Study Figures 2-4 and 2-5 . These show more recent temperatures, with those in the last 140 years with instrumental records. Global temperatures have been increasing since 1960, with a more rapid rate of increase in recent years. Temperature has been changing more rapidly over the past few decades than at any other time for at least the past 1000 years.

Make sure you understand these concepts. If you have questions, discuss these with a resource person.

Try explaining the graphs to a colleague or to another participant.

Activity 3-3

Figure 2-7 shows General Circulation Models (GCMs) used to examine climate going back to 1850. The model

estimates (in grey) were matched with actual observations (in red). In the left graph, the GCMs were run with only natural climate forcings (such as volcanoes, etc.). There is a poor fit between the model runs and the observations. In the middle graph, the GCMs were run with only anthropogenic forcings (primarily greenhouse gas emissions). There is a better fit between the model and the observations, although there is still a poor fit in the middle of the 20th century. The right graph shows that when the GCMs included both natural and anthropogenic forcings, there is a good fit between the models and observations.

Given these graphs, do you agree with this statement?

> Warming in the last 1,000 years "is unusual and is unlikely to be entirely natural in origin."
>
> *- Intergovernmental Panel on Climate Change Working Group I, Third Assessment Report*

What do the graphs tell you about the ability of models to provide useful projections about future climate? What are the limitations of modelling in predicting climate conditions?

Activity 3-4

Study Table 2-2 , which estimates confidence in observed and projected changes in extreme weather and climate events.

How likely would the following phenomena occur in your city? What would be the possible health effects?

- Higher maximum temperatures and more hot days
- Higher minimum temperatures and fewer cold days
- Reduced diurnal temperature range
- Increase of heat index (temperature and humidity)
- More intense precipitation events
- Increased summer continental drying
- Increase in tropical cyclone peak wind intensities
- Increase in tropical cyclone mean and peak precipitation intensities

Date:

Name/s:

WORKSHEET 3-3

1. Evidence to support the statement: Warming in the last 1 000 years "is unusual and is unlikely to be natural in origin"

2. Using models to predict climate change: capabilities and limitations

Date:

Name/s:

WORKSHEET 3-4

Effects of Climate Change on _____ (city)

	Likelihood of Event	Possible Health Effects
Higher maximum temperatures and more hot days		
Higher minimum temperatures and fewer cold days		
Reduced diurnal temperature range		
Increase of heat index (temperature and humidity)		
More intense precipitation events		
Increased summer continental drying		
Increase in tropical cyclone peak wind intensities		
Increase in tropical cyclone mean and peak precipitation intensities		

SESSION 4:
Health impacts of climate extremes

Objectives

After completing this session you should be able to:

- Identify potential health impacts of climate extremes
- Identify possible health impacts of climate extremes in your city

Study Time

3 hours

Workshop Time

_____

Readings

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Chapter 3 – International consensus on the science of climate and health: the IPCC Third Assessment Report
- Chapter 5 – Impacts on health of climate extremes

Activities

In Activities 2-1 and 3-4, you noted possible effects of climate change on health in your city. In Chapters 3 and 5 of the book, we will further discuss the relationship between climate and health.

Activity 4-1

Study Figure 5-1 . Find out about any unfamiliar terms. El Nino events cause events such as droughts in some regions, and floods in others. Where these overlap and interact with suitable ecological and socioeconomic conditions (within dotted lines), they may cause disease outbreaks (dark shaded area). For example, flooding in which a stream overflows its banks can result in changes in mosquito abundance and contamination of surface water, both of which could lead to disease outbreaks. Explain how ENSO affects your city. (Note that it is possible that your city is not directly affected by the Southern Oscillation, however, your city may still be affected because of trade ties with, migration to/from, disease spread from neighbouring areas which are directly affected.)

Activity 4-2

The risk of heat illness exists for the entire population. However, risk is increased at an individual level because of certain predisposing factors:

- Age and disease profile, including obesity
- Lack of acclimatization
- Low level of fitness
- Long-term high-level exercise or heavy physical work
- Dehydration due to reduced food and liquid intake
- Intestinal problems
- Use of drugs – diuretics, or drugs affecting the temperature regulation system such as stimulants, ß-blockers, anticholinergics, digitalis, barbiturates, and other medications
- Alcohol abuse
- Fatigue, sleep deprivation
- Low socioeconomic status
- Poor or substandard housing conditions
- Low prevalence of air conditioning
- Behaviour (such as use of protective clothing)

Discuss the presence of these risk factors in your community.

Activity 4-3

Below is a list of some of the health impacts of floods. As has been demonstrated in recent world events, the morbidity

and mortality in unprepared regions can be large.

- Immediate deaths and injuries
- Non-specific increases in mortality
- Infectious diseases – leptospirosis, hepatitis, diarrhoeal, respiratory, & vector-borne diseases
- Exposure to toxic substances
- Mental health effects - There is growing interest in the mental health impacts of floods, which may be a larger health burden than immediate deaths and injuries.
- Increased demands on health systems

Discuss how your community deals with floods, cyclones and storm-surges. Discuss how climate change affects the frequency and severity of these extreme weather events.

For more information on communicable diseases following floods, see "Communicable diseases following natural disasters: risk assessment and priority interventions" available from: http://www.who.int/diseasecontrol_emergencies/guidelines/CD_Disasters_26_06.pdf

Date:

Name/s:

WORKSHEET 4-1

Effects of the El Nino / Southern Oscillation (ENSO) on _____ (city)

Date:

Name/s:

WORKSHEET 4-2

Risk factors for heat illness

Risk Factors	Demographics (who, where, how many)

Date:

Name/s:

WORKSHEET 4-3

Characteristics of current emergency response system for extreme weather events	Needed improvements/modifications in light of climate change

SESSION 5:
Climate change and infectious diseases

Objectives

After completing this session you should be able to:

- Explain the link between climate change and infectious diseases
- Discuss malaria as an example of an infectious disease whose prevalence is likely to increase with climate change

Study Time

3 hours

Workshop Time

_____

Reading

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Chapter 6 – Climate change and infectious diseases

Quick Quiz

For this session, you will need a good working knowledge of how infectious diseases are transmitted.

Study Figure 6-1  . This summarizes the four main types of transmission cycles for infectious diseases. Draw a line between the types of disease and their matching descriptions.

Directly transmitted anthroponoses	*These are a class of diseases defined by pathogen transmission between two human hosts by either a physical vehicle (soil) or a biological vector (tick). The complete transmission cycle includes the pathogen, the vehicle or vector, and the human host. Examples include malaria and dengue fever.*
Directly transmitted zoonoses	*These are diseases in which the pathogen is normally transmitted directly between two human hosts through physical contact or droplet exposure, such as measles, TB, and HIV.*
Indirectly transmitted anthroponoses	*The pathogen is transmitted through physical contact or droplet exposure. However, these agents are spread naturally among animal reservoirs and the infection of humans is accidental; examples include Hantavirus and rabies.*
Indirectly transmitted zoonoses	*The complete transmission cycle includes the pathogen, the vehicle or vector, the animal reservoir, and the human host; Rift Valley fever is an example.*

Activities

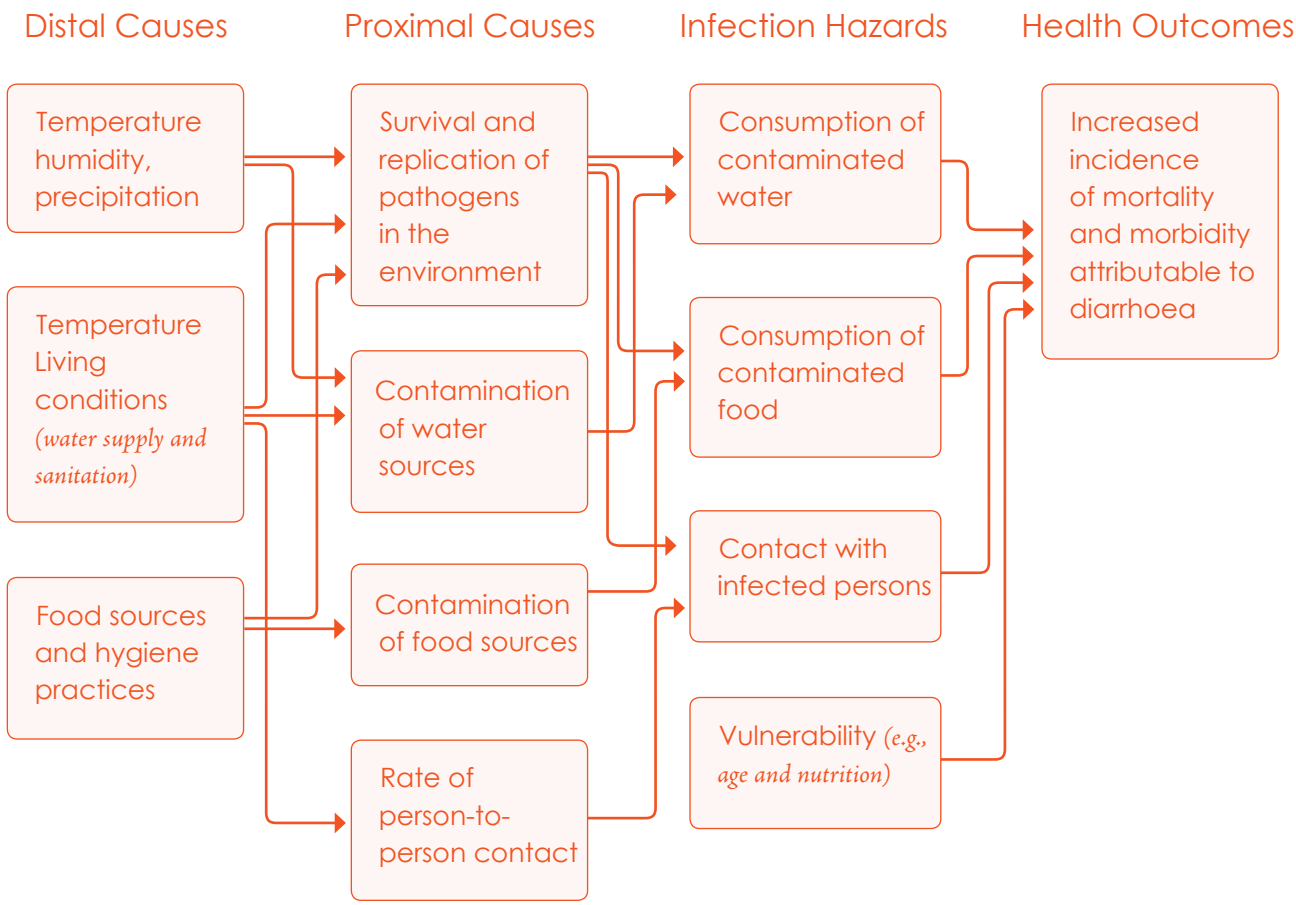
Activity 5-1

There are many drivers of health issues. Weather and climate are not the only determinants of climate-sensitive health outcomes. Other key factors influencing the state of health of a community include:

- Population growth
- Urbanization
- Public health funding
- Scientific developments
- Environmental conditions
- Number and distribution of populations at risk
  - Poor
  - Children
  - Elderly
  - Immunocompromised

For example, increasing urbanization in unplanned communities without access to safe water and sanitation will increase diarrhoeal disease independent of any effect of temperature. However, temperature, humidity, and precipitation can affect the proximal causes of diarrhoeal disease, particularly the survival and replication of pathogens in the environment, and the contamination of water sources. The proximal causes then determine infectious disease hazards. (See Figure below)

Discuss how increased incidence of mortality and morbidity attributable to diarrhoea might occur in your city. In your setting, what other factors (boxes) should be included in this model?



Activity 5-2

Temperature and precipitation affect vector- and rodent-borne diseases in various ways. For a comprehensive listing, refer to Table 6-1 .

What vector- and/or rodent-borne diseases might increase in your city because of climate change? Draw a model (similar to the one shown on Activity 5-1) that illustrates this.

Activity 5-3

Visit the website of MARA/ARMA (Mapping Malaria Risk in Africa/Atlas du Risque de la Malaria en Afrique): http://www.mara.org.za.

This project mapped and modeled the current distribution of malaria in sub-Saharan Africa. The website contains prevalence and population data, and regional and county-level maps. MARA/ARMA developed a biological model based on the minimum and mean temperature constraints on the development of the *Plasmodium falciparum* parasite and the *Anopheles* vector, and on the precipitation constraints on the survival and breeding capacity of the mosquito.

Search for the following:

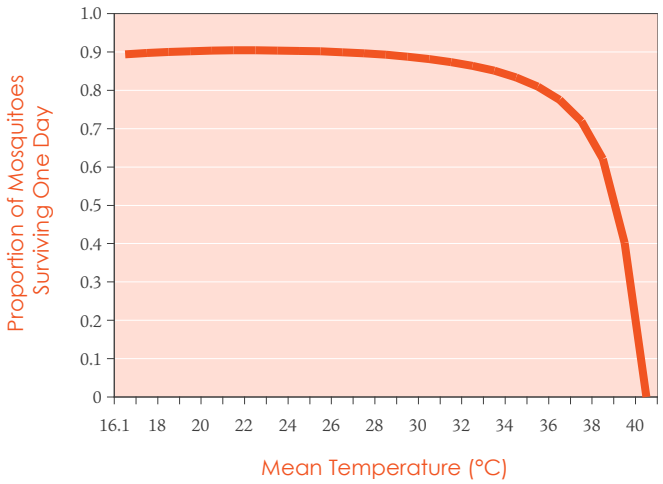
- Map showing the distribution of malaria in Africa
- Map showing the endemic/epidemic risk areas in Africa
- Map showing the duration of the malaria season in different parts of Africa
- Malaria prevalence model
- Population distribution

How will the distribution and prevalence of malaria be affected by climate change?

To help you in answering this question, consider the following graphs showing how the development of the parasite is affected by temperature.

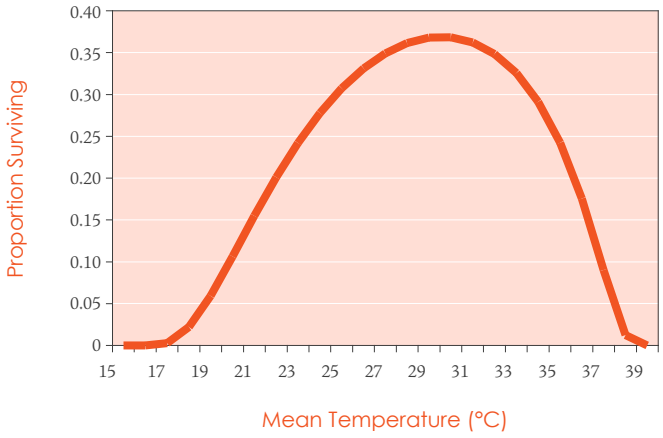
For a detailed discussion, refer to this reference: MARA/ARMA. 1998. Towards an Atlas of Malaria Risk in Africa: First Technical Report of the Mara/ARMA Collaboration. Chapter 3, Focus B-Modeling. Durban. Available online from: http://www.mara.org.za/

RELATIONSHIP BETWEEN TEMPERATURE AND DAILY SURVIVORSHIP OF *ANOPHELES*



Temperature is a major factor determining the distribution and incidence of malaria. Temperature affects both the *Plasmodium* parasite and the *Anopheles* mosquito, with thresholds at both temperature extremes limiting the survival or development of the two organisms. *Anopheles* must live long enough to bite an infected person, allow the parasite to develop and then bite a susceptible human. As shown, the proportion of mosquitoes surviving one day decreases when ambient temperature increases above 35°C.

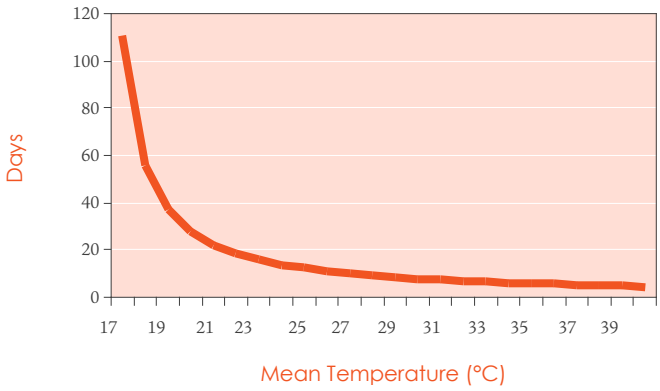
PROPORTION OF VECTORS SURVIVING TIME REQUIRED FOR PARASITE DEVELOPMENT



The lower temperature threshold of 18°C is based on the time required for parasite development and length of mosquito survivorship at that temperature; below 18°C few parasites can complete development within the lifetime of the mosquito (see next slide). The mosquito survivorship rate peaks at 31°C. At this point, less than 40% of the mosquitoes survive long enough for the parasite to complete its development cycle. As temperatures rise above 32°C, the mosquito's probability of survival decreases. However, higher temperatures enable the mosquitoes to digest blood meals more rapidly, which in turn increases the rate at which they bite. This increased biting rate coupled with faster development of the parasite leads to increased infective mosquito bites for those mosquitoes that do survive. The upper temperature threshold for both mosquitoes and larvae to survive is 40°C.

RELATIONSHIP BETWEEN TEMPERATURE AND TIME REQUIRED FOR PARASITE DEVELOPMENT

The number of days required for the parasite to develop increases significantly at temperatures higher than 21°C.



Activity 5-4

Many factors affect the range and incidence of infectious diseases. In addition to climate, a number of other factors influence the range and incidence of infectious diseases, particularly sociodemographic factors and environmental influences.

Sociodemographic influences

- Human travel, trade, and migration
- Disease control efforts
- Drug resistance
- Nutrition

Environmental influences

- Land-use, including deforestation, agricultural development, and urbanization
- Ecological influences

There is limited evidence that climate change is currently affecting the range of diseases such as malaria; drug resistance, disease control programs, and land use are more important factors. However, this does not mean that climate change might not play a larger role in the future.

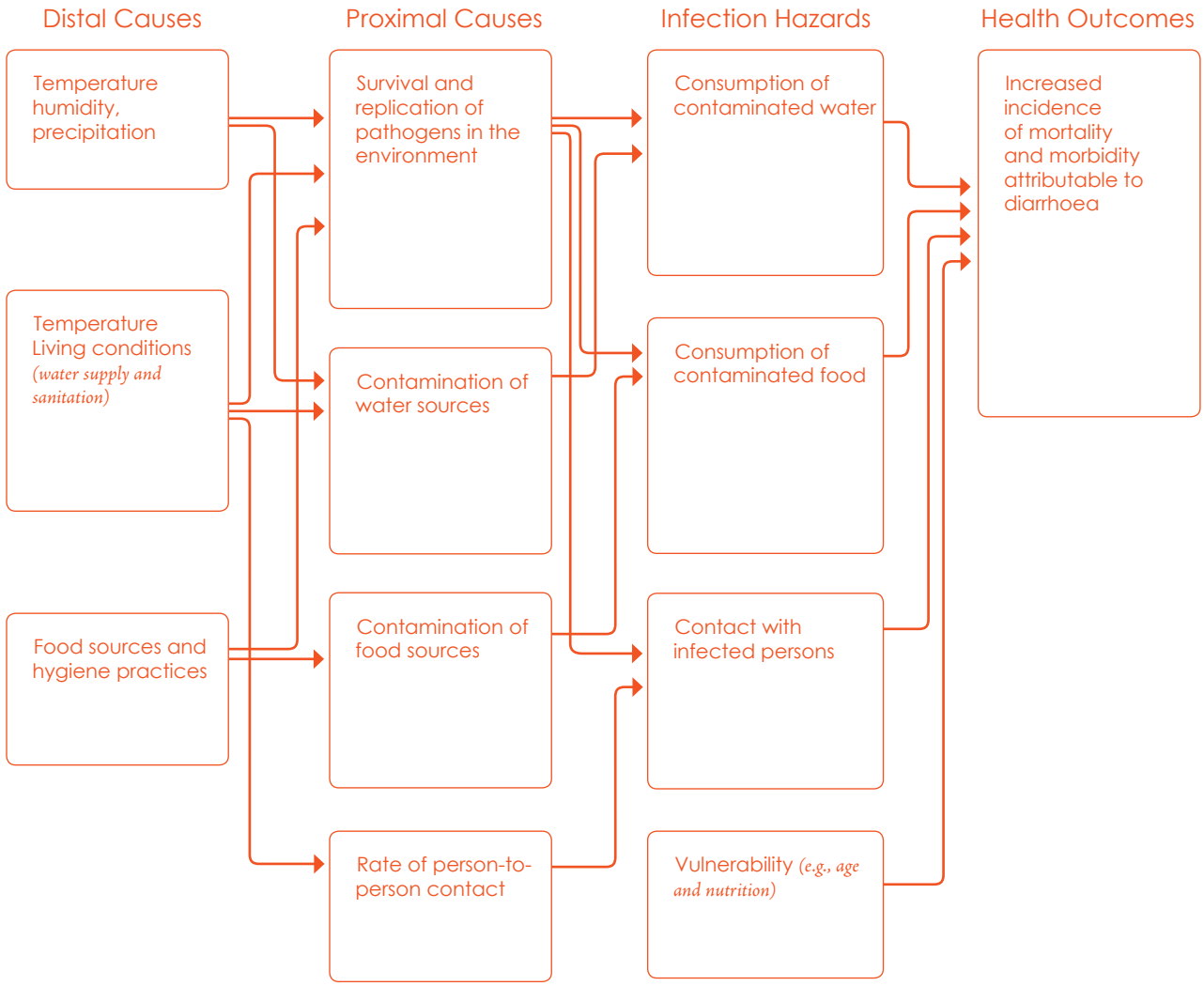
Discuss current efforts toward malaria prevention and control in your country. What factors support or hinder their success? How would your work be affected by the projected change in the distribution of malaria?

Date:

Name/s:

WORKSHEET 5-1

Factors influencing incidence of diarrhoea in _____ (city)



General comments

Date:

Name/s:

WORKSHEET 5-2

Factors influencing incidence of vector- or rodent-borne diseases in _____ (city)

Distal Causes	Proximal Causes	Infection Hazards	Health Outcomes

Date:

Name/s:

WORKSHEET 5-3

Effect of climate change on the distribution and prevalence of malaria

Date:

Name/s:

WORKSHEET 5-4

Characteristics of current system for malaria prevention and control	Needed improvements/modifications in light of climate change

SESSION 6:
How much disease could climate change cause?

Objectives

After completing this session you should be able to:

- Determine the approximate magnitude of the health impacts of climate change

Study Time

2 hours

Workshop Time

_____

Readings

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Chapter 7 – How much disease could climate change cause?

World Health Report 2002 (WHO)

- Chapter 4 – Environmental Health Risks http://www.who.int/whr/2002/chapter4/en/index7.html

Global Burden of Disease Project (WHO) http://www.who.int/topics/global_burden_of_disease/en/

Activities

Activity 6-1

Visit this website:

Global Burden of Disease Project (WHO) http://www.who.int/topics/global_burden_of_disease/en/

Familiarize yourself with the Global Burden of Disease Study, which began in 1990 with the objective of quantifying the burden of disease and injury in human populations. The burden of disease refers to the total amount of premature death and morbidity within a population. The goals of the study were to produce the best possible evidence-based description of population health, the causes of lost health, and likely future trends in health in order to inform policy-making. The WHO Global Burden of Disease 2000 project (GBD) updated the 1990 study. It drew on a wide variety of data sources to develop internally consistent estimates of incidence, health state prevalence, severity and duration, and mortality for over 130 major health outcomes, for the years 2000 and beyond. To the extent possible, the GBD synthesized all relevant epidemiologic evidence on population health within a consistent and comprehensive framework, the comparative risk assessment.

Twenty-six risk factors were assessed, including major environmental, occupational, behavioral, and lifestyle risk factors. Climate change was one of the environmental risk factors assessed. The goal was to answer these two questions:

- What will be the **total** potential health impact caused by climate change (2000 to 2030)?
- How much of this could be avoided by reducing the risk factor (i.e. stabilizing greenhouse gas (GHG) emissions)?

The study began with greenhouse gas emission scenarios, which were used as input into a global climate model that generated maps of projected future temperature and precipitation patterns. These were used as input into models of the relationship between weather/climatic factors and disease burdens; these models projected the increased (or decreased) relative risk of disease under different scenarios. Finally, the projected relative risks were applied to demographic patterns to calculate a summary measure of population health, the Disability Adjusted Life

Years lost (DALYs). The attributable burden of DALYs for a specific risk factor was determined by estimation of the burden of specific diseases related to the risk factor; estimation of the increase in risk for each disease per unit increase in exposure to the risk factor; and estimation of the current population distribution of exposure, or future distribution as estimated by modeling exposure scenarios. Alternative exposure scenarios to the current distribution of risk factors were created to explore disease burdens with a theoretical minimum level of exposure (e.g. for exposure to carcinogens, the alternative exposure scenario would be no exposure).

Health outcomes were selected according to the following criteria:

- Sensitivity to climate variation
- Importance as global health burden
- Availability of quantitative model at the global scale

The health outcomes selected were:

- Heat and cold related cardiovascular disease mortality
- Diarrhoeal disease (incidence)
- Vector-borne diseases – dengue and *Falciparum* malaria
- Inland and coastal floods (mortality)
- Malnutrition (prevalence)

The health outcomes included in the analysis were chosen based on sensitivity to climate variation, predicted future importance, and availability of quantitative global models (or feasibility of constructing them). The health outcomes selected were the direct impacts of heat and cold, episodes of diarrhoeal disease, cases of dengue and *Falciparum* malaria, fatal unintentional injuries in coastal floods and inland floods/landslides, and non-availability of recommended daily calorie intake (as an indicator for the prevalence of malnutrition). Global and regional estimates for WHO regions were generated.

Climate change was estimated to be responsible in the year 2000 for approximately 2.4% of worldwide diarrhea, 6% of malaria in some middle-income countries, and 7% of dengue fever in some industrialized countries. Note that these estimates are for a year when the amount of climate change since baseline (1990) was near zero; therefore, future disease burdens would be expected to increase with increasing climate change, unless effective adaptation measures are implemented. In the year 2000, the attributable mortality was 154 000 (0.3%) deaths, and the attributable burden was 5.5 million (0.4%) DALYs, with approximately 50% of the burden due to malnutrition. About 46% of the DALYs were estimated to have occurred in the WHO South-East Asia Region, 23% in countries in the Africa region with high child mortality and very high adult male mortality, and 14% in countries in the Eastern Mediterranean region with high child and adult male mortality.

For each health outcome, ranges of estimates were projected for relative risks attributable to climate change in 2020 under the alternative exposure scenarios. The burden of floods, malaria, diarrhea, and malnutrition is projected to increase by 2020.

In Africa, Southeast Asia, and the Eastern Mediterranean region, the health impacts of climate change are at least as large as those of urban air pollution.

The study makes the following conclusions:

- Climate change may already be causing a significant burden in developing countries.
- Unmitigated climate change is likely to cause significant public health impacts out to 2030, with the largest impacts attributable to diarrhea, malnutrition, and vector-borne diseases.
- Uncertainties include:
  - Uncertainties in projections
  - Effectiveness of interventions
  - How changes in non-climatic factors will affect future disease burdens

Activity 6-2

Chapter 7 of the book showed you how to estimate burden of disease attributable to a risk factor. For each such factor, we need to know:

- Burden of the disease
- Estimated increase in risk of each disease per unit

increase in exposure ("relative risk")
- Current population distribution of exposure, or future distribution as estimated by modelling exposure scenarios

On the global scale, much work has already been done on selected health outcomes as seen in Activity 6-1: direct impacts of heat and cold, episodes of diarrhoeal disease, cases of dengue and *Falciparum* malaria, fatal unintentional injuries in coastal floods and inland floods/landslides, and non-availability of recommended daily calorie intake.

What country/city data do you currently have in order to estimate burden of disease due to climate change? What data need to be generated? Which agencies in government or the private sector might be of help?

Activity 6-3

What are the main climate-related health threats your city?

Use the Ishikawa fishbone diagram to identify the actionable root causes of a problem (within a given time frame and limited resources).

Read more about Ishikawa diagrams at: http://en.wikipedia.org/wiki/Ishikawa_diagram

Date:

Name/s:

WORKSHEET 6-3

Main climate-related health threats in _____(city)

SESSION 7:
Stratospheric ozone depletion

Objectives

After completing this session you should be able to:

- Explain interactions between ozone depletion and greenhouse gas-induced warming
- Describe the effects of ozone depletion and increased exposure to ultraviolet radiation on health

Study Time

2 hours

Workshop Time

_____

Reading

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Chapter 8 – Stratospheric ozone depletion, ultraviolet radiation and health

Quick Quiz

True or false?

1. Stratospheric ozone destruction is a separate process from greenhouse gas accumulation in the lower atmosphere.

2. CFCs and NO2 are examples of anthropogenic greenhouse gases that are also ozone-depleting gases.

3. Warming in the troposphere induces cooling of the stratosphere, which exacerbates ozone destruction.

4. Loss of ozone leads to warming of the stratosphere.

5. Global climate change may delay recovery of the ozone layer.

6. Global climate change is likely to alter patterns of personal exposure to solar radiation, leading to a rise in skin cancers.

Activities

Activity 7-1

Study Table 8-1 , which summarizes possible effects of solar ultraviolet radiation on the health of human beings. Some of the certain or possible health impacts of stratospheric ozone depletion are listed. Many epidemiologic studies have reported an association between UVR exposure and skin cancer in fair-skinned people. High intensity UVR also damages the outer tissues of the eye, leading to a number of health impacts. UVR exposures cause both local and whole body immunosuppression in humans and experimental animals; however, little direct evidence exists for UVR exposure influencing the patterns of infectious diseases. A variety of other effects have been reported.

Discuss how increased incidence of these disease conditions will affect your city.

Activity 7-2

Study Figure 8-2 which estimates ozone depletion and skin cancer incidence in the US fair-skinned population under a scenario of no restrictions on emissions of CFC, a scenario reflecting the original Montreal Protocol of a 50% reduction in the production of the five most important ozone-depleting chemicals by the end of 1999, and a scenario reflecting achievement of the Copenhagen Amendment to the Montreal Protocol (production of 21 ozone-depleting chemicals reduced to zero by the end of 1995).

The graph does not take into consideration that climate change is projected to delay the healing of the ozone hole by at least several decades. How will the graph change if climate change is considered?

Date:

Name/s:

WORKSHEET 7-1

Projected impact of increased incidence of diseases caused by exposure to ultraviolet radiation in _____ (city)

Disease	Impact

SESSION 8:
Monitoring health impacts of climate change

Objectives

After this session, you will be able to:

- Discuss issues related to monitoring the health impacts of climate change
- Explain criteria for selecting diseases for monitoring to measure the impact of climate change
- Select diseases for monitoring in your own setting
- List data needs for monitoring the health impact of climate change
- Plan your own monitoring system for given specific categories of health impacts

Study Time

3 hours

Workshop Time

_____

Readings

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Chapter 4 – Looking to the future challenges for scientists studying climate change and health
- Chapter 10 – Monitoring the health effects of climate change

Activities

Activity 8-1

Detection and measurement of the health impacts of climate change are needed to provide evidence on which to base national and international policies related to adaptation and mitigation measures. Three issues related to monitoring are: (1) documenting evidence of climate change, which requires collecting data to demonstrate that the climate has changed in the area being monitored; (2) attributing changes in health outcomes to climatic change, which requires separating its influence from other factors; and (3) appropriately collecting and analyzing health and climate data, as well as data on potential modifiers of the relationship between climate and health, so that there is sufficient confidence that any observed change in health is the result of a climatic effect rather than an alteration in population susceptibility.

Read the following scenarios and find out whether they are real or "reel" (manufactured as in a movie) cases of impact of climate change. Justify by discussing the three main issues for monitoring. Use the worksheet for your answers.

ISSUES RELATED TO MONITORING HEALTH IMPACTS OF CLIMATE CHANGE

- Evidence
  - Not just seasonal and inter-annual variation
- Attribution
  - Influence of climate has to be separated from the other influences on health outcomes
- Effect modification
  - Climate and non-climate factors change over the time scale at which climate change is evident
  - Extent of adaptation is one determinant of vulnerability

Activity 8-2

Given that limited resources will be available to implement new (or revise existing) monitoring systems, priorities must be identified. Criteria for selecting diseases for monitoring include evidence of *climate sensitivity* (demonstrated through either observed health effects of temporal or geographical climate variation, or evidence of climatic effects on components of the disease transmission process); *potential to significantly threaten public health* (diseases with a high current prevalence and/or severity) and considered likely to become more prevalent under climate change; and *practical issues* such as choosing monitoring sites where change is most likely to occur. Priorities will vary between regions with differences in current climate, level of socioeconomic development, and spectrum of disease. Monitoring systems should take account of local needs and be alert to the appearance of potential new health concerns.

CRITERIA FOR SELECTING DISEASES FOR MONITORING HEALTH IMPACTS OF CLIMATE CHANGE

- Evidence of climate sensitivity
  - Demonstrated through either observed health effects of temporal or geographical climate variation, or evidence of climate effects on components of disease transmission process
- Significant public health burden
  - Monitoring should focus on diseases that are significant threats to public health
- Practicality
  - Dependable, consistent, long-term data records needed for both health outcome and environmental factors

List potential diseases for monitoring in your own setting using the above criteria. Select which number (rating) corresponds to your perceived evidence of climate sensitivity, magnitude of public health burden and practicality. Use the following rating scale 1=very low, 2=low, 3=fair, 4=high, 5=very high. Add all the numbers to get a total score. The disease which gets the highest score should be top priority for monitoring.

Activity 8-3

A broad range of data is needed to monitor the impacts of climate on health. The specific meteorological variables required will depend on the health outcome of concern. Climate measurements at the local scale, and in important microclimates, should be recorded in study sites where health outcome data are being collected. Monitoring should be sensitive and specific enough to quantify changes in the intensity and temporal and geographic distribution of the health outcome. Data also need to be collected on other explanatory factors, such as the age structure of the population at risk, the underlying rates of disease, the level of socioeconomic development, environmental conditions (for example, land use), the quality of health care, and the effectiveness of control measures. All data need to be collected on the same temporal and spatial scale (see Figure 10-1).

Plan for your own monitoring of the health impacts of climate change. Use the worksheet overleaf.

Date:

Name/s:

WORKSHEET 8-1

Real or reel impacts of climate change?

Scenario	Evidence	Attribution	Effect Modification	Verdict: Real or Reel
1. Increased deaths among the very young and very old during heat wave				
2. Chest pains, nausea, and pulmonary congestion in areas that are warmer by four degrees Fahrenheit				
3. Deaths due to extreme weather events (typhoons, floods, drought)				
4. Increased incidence of skin cancer				
5. Outbreaks of new infectious diseases like SARS, Avian flu				
6. Re-emergence of malaria				
7. Increased cases of cholera				

Date:

Name/s:

WORKSHEET 8-2

Prioritizing diseases to be monitored

Disease to be monitored	Evidence of climate sensitivity					Magnitude of public health burden					Practicality					Total score
1.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
2.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
3.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
4.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
5.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
6.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
7.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
8.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
9.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
10.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	

Date:

Name/s:

WORKSHEET 8-3

Monitoring system for _____ (city/country)

	Principal health outcomes	Target population	Sources/methods for data collection		Other variables
			HEALTH DATA	METEOROLOGICAL DATA	
Thermal extremes					
Extreme weather events					
Food- and water-borne diseases					
Vector-borne diseases					

SESSION 9:
Public health research focus in studying climate change

Objectives

After this session, you will be able to:

- Explain the focus of public health research in studying climate change and its impact on health
- Discuss key areas that can be addressed by public health research
- List possible topics for public health research

Study Time

3 hours

Workshop Time

_____

Readings

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Chapter 4 – Looking to the future challenges for scientists studying climate change and health
- Chapter 13 – Conclusions and recommendations for action

Activities

Activity 9-1

Public health research focus in assessing the potential health effects of climate variability and change include:

- Establishing baseline relationships between weather and health
- Seeking evidence for early effects of climate change
- Developing scenario-based models
- Evaluating adaptation options
- Estimating the coincidental benefits and costs of mitigation and adaptation.

Study Figure 4-1 . Consideration of the links between science and policy development must be incorporated in each of these steps.

Key areas to address in current and future research include:

- Identifying areas where the first effects of climate change on human health will be apparent,
- Improving estimates of climate change impacts by a combination of anticipated trends in adaptive capacity and climate scenarios, and
- Identifying the most helpful ways of expressing uncertainties associated with studies of climate change and health.

Study table 13-1 which lists examples of priority health research areas for different risk factors resulting from climate change.

For your own city, list some priority topics for possible public health research. Use the worksheet overleaf.

Date:

Name/s:

WORKSHEET 9-1

Type of public health research	Risk factors	Health effects	Possible research area	Topic sentence
Relationship between climate and health				
Evidence for early effects of climate change				
Scenario-based models				
Adaptation options				
Benefits and costs				

SESSION 10:

Assessing community vulnerability and adaptive capacity

Objectives

After this session, you will be able to:

- Define the vulnerability and adaptive capacity of individuals and communities
- Identify vulnerable populations
- Discuss determinants of adaptive capacity
- Explain steps in assessing vulnerability and adaptive capacity

Study Time

3 hours

Workshop Time

_____

Reading

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Chapter 9 – National assessments of health impacts of climate change: a review
- Chapter 11 – Adaptation and adaptive capacity in the public health context

Quick Quiz

Fill in the blanks.

1. _____ is the degree to which individuals and systems are susceptible to or unable to cope with the adverse effects of climate change, including climate variability and extremes.

2. The answer to #1 is a function of:

   - _____, which includes the extent to which health, or the natural or social systems on which health outcomes depend, are affected by changes in weather and climate (the exposure–response relationship) and the characteristics of the population, such as the level of development and its demographic structure;
   - _____ to the weather or climate-related hazard, including the character, magnitude and rate of climate variation; and
   - _____ and actions in place to reduce the burden of a specific adverse health outcome, the effectiveness of which determines in part the exposure–response relationship.

3. Adaptation includes the strategies, policies and measures undertaken now and in the future to reduce potential adverse health effects. _____ _____ describes the general ability of institutions, systems and individuals to adjust to potential damages, to take advantage of opportunities and to cope with the consequences. The primary is to reduce future vulnerability to climate variability and change.

4. _____ describes what could be implemented now to minimize the negative effects of climate variability and change. In other words, it encompasses the interventions that are feasible to implement today (in a specific population).

Activities

Activity 10-1

Who are the most vulnerable in your city? Where are they? How many are they?

In general, the vulnerability of a population to a health risk depends on the local environment, the level of

material resources, the effectiveness of governance and civil institutions, the quality of the public health infrastructure and the access to relevant local information on extreme weather threats. These factors are not uniform across a region or country or across time and differ based on geography, demography and socioeconomic factors. In a city, the urban poor cannot choose where to live and as a result end up in the worst part of the city environment, prone to floods, landslides, fire or extremes of temperature. Effectively targeting prevention or adaptation strategies requires understanding which demographic or geographical subpopulations may be most at risk and when that risk is likely to increase. Thus, individual, community and geographical factors determine vulnerability.

Populations, subgroups and systems that cannot or will not adapt are more susceptible to weather and climate (for example, the urban poor who live in low-lying areas, slums and informal settlements, children, elderly adults, etc.).

Activity 10-2

In this activity, you will study the determinants of adaptive capacity.

To explain the observed diversity in the ability of systems to adapt (primarily to natural hazards), the IPCC offered the hypothesis that adaptive capacity is a function of a series of determinants:

- the range of available technological options for adaptation;
- the availability of resources and their distribution across the population;
- the structure of critical institutions, the derivative allocation of decision-making authority and the decision criteria that would be employed;
- the stock of human capital, including education and personal security;
- the stock of social capital, including the definition of property rights;
- the system's access to risk-spreading processes;
- the ability of decision-makers to manage information, the processes by which these decision-makers determine which information is credible, and the credibility of the decision-makers themselves; and
- the public's perceived attribution of the source of stress and the significance of exposure.

Use the worksheet overleaf to identify the indicators of adaptive capacity in your country/city.

Activity 10-3

Systematic assessments of the potential human health impacts of climate variability and change are needed to inform the development of adaptation strategies, policies, and measures to lessen projected adverse impacts. Guidelines have been developed for country-level assessments to help policy-makers make evidence-based decisions on risk management programs to increase resilience to current and future climates. The steps in an assessment typically include:

1. determining the scope of the assessment;
2. describing the current distribution and burden of climate-sensitive diseases;
3. identifying and describing current strategies, policies, and measures designed to reduce the burden of climate-sensitive diseases;
4. reviewing the health implications of the potential impacts of climate variability and change in other sectors;
5. estimating the future potential health impacts using scenarios of future changes in climate, socioeconomic, and other factors;
6. synthesizing the results and drafting a report; and
7. identifying additional adaptation policies and measures to reduce potential negative health impacts.

Key issues for ensuring that an assessment is informative, timely, and useful include stakeholder involvement, an adequate management structure, and a communication strategy.

Conduct an assessment of the vulnerability and adaptive capacity of your country/community. Follow the steps provided in the worksheet and write a narrative report.

Date:

Name/s:

WORKSHEET 10-1

Vulnerable groups in _____ (city)

Who	Where	Estimated Number

Date:

Name/s:

WORKSHEET 10-2

Identify indicators of adaptive capacity of your country/city. Then rate using the following scale: 1=very low, 2=low, 3=fair, 4=high, 5=very high. Analyse where you need to suggest interventions to improve your country's/community's adaptive capacity. Explain your rating in the space below.

Adaptive Capacity	Indicators	Rating Scale				
1. Economic resources		1	2	3	4	5
2. Technology		1	2	3	4	5
3. Information and skills		1	2	3	4	5
4. Infrastructure		1	2	3	4	5
5. Institutions		1	2	3	4	5
6. Equity		1	2	3	4	5
7. Health status and pre-existing disease burdens		1	2	3	4	5

Date:

Name/s:

WORKSHEET 10-3

Assessment of vulnerability and adaptive capacity

1. The current distribution and burden of climate-sensitive diseases

2. The association between climate and disease outcomes

Continued on next page

Assessment of vulnerability...continued

3. Current strategies, policies, and measures to reduce that burden (adaptation baseline)

4. Health implications of the potential impact of climate variability and change on other sectors

Continued on next page

Assessment of vulnerability...continued

5. Estimate of future potential health impacts using scenarios of climate change
6. Synthesis of results
7. Additional adaptation measures to reduce potential negative health effects

SESSION 11:

Planning public health interventions to address climate change and its health impacts

Objectives

After completing this session you should be able to:

- Plan specific public health interventions to address the health impacts of climate change
- Highlight which aspects of the plan can be implemented in one year

Study Time

2 hours

Workshop Time

_____

Readings

Climate Change and Human Health: Risks and Responses (Editors: McMichael, Campbell-Lendrum, Corvalan, Ebi, Githeko, Scheraga, Woodward WHO/WMO/UNEP. 2003)

- Chapter 12 – From science to policy: developing responses to climate change
- Chapter 13 – Conclusions and recommendations for action

Activities

Activity 11-1

Adaptation to climate change is needed because, as discussed previously, the Earth is committed to decades of climate change even after stabilization of greenhouse gas emissions is achieved. Further, climate change may occur more rapidly and with greater intensity than currently projected. The extent to which impacts are experienced will depend on the effectiveness of adaptation. Current societies are only partially adapted to weather and climate, so improving adaptation will provide benefits now and in the future.

Adaptation is needed because:

- Climate change cannot be totally avoided
- Climate change may be more rapid and more pronounced than current estimates
- The severity of impacts will depend on the capacity to adapt and its effective deployment
- Immediate benefits can be gained from better adaptation to climate variability and extreme events
- Climate change brings opportunities as well as threats

Explain these five points in the context of your city.

Activity 11-2

Adaptations can be viewed in terms of existing or new risks. For existing risks, current programs should be modified to take climate variability and change into account. For example, low-lying and flood-prone areas in slums and informal settlements can be prioritized for slum-upgrading and city health officials can point out the critical importance of relocation of high risk homes and households. Current food safety programs may need to be enhanced to encourage proper food handling in a warmer world. Effective prevention programs, such as vector-control programs, that have been neglected over the past few decades may need to be re-instituted to address concerns about the spread of vector-borne diseases in a warmer climate. For example, although climate change likely played a small role in past reductions in malaria incidence in temperate developed countries, this does not provide reassurance that climate will not play a larger role in determining the future range and intensity of malaria transmission. Because of the uncertainty about projected changes in climate and population health, it will be prudent to implement adaptation measures that will reduce disease burdens or increase population resilience no matter what the future climate would be.

Climate also will bring new risks, such as when thresholds are crossed either because a disease was close to its boundary conditions or because there was a sudden and/or large change in prevailing weather conditions. The best way to address these potential risks is to be prepared.

The following questions need to be addressed when designing adaptation policies and measures.

- Adaptation to what?
- Is additional intervention needed?
- What are the future projections for the outcome? Who is vulnerable?
- Who adapts? How does adaptation occur?
- When should interventions be implemented?
- How good or likely is the adaptation?

Adaptation to what – is adaptation required to flooding, the spread of vector-borne disease, etc.? The policies and measures implemented must be specific to both the weather/climate hazard and the health outcome of concern.

The effectiveness of interventions needs to be determined before improving current programs or implementing new ones. Are there additional interventions that could reduce the current burdens of climate-sensitive health outcomes? Would a heat event early warning system be useful? Additional surveillance?

Using projections of changes in climate and socioeconomic conditions, what are the likely impacts? Which population groups are likely to be at the highest risk? For example, ageing of populations in developed countries is likely to increase population vulnerability to heat events.

Who will undertake the adaptations – individuals, communities, nations? Will the adaptation be reactive to climate change or proactive? How can the process be facilitated? It is important to bear in mind that adaptation to climate change will work best when the affected groups are actively engaged in the process. Using participatory processes that enable people to express their doubts, fears and concerns is critical to achieving sustained adaptation.

When should the interventions be implemented? For example, there is concern about malaria spreading to highland areas of Africa. Surveillance systems should be established at the edges of the current distribution where changes in temperature and/or precipitation could provide a suitable climate for malaria vectors. Once surveillance has identified the presence of the vectors, then programs to distribute treated bednets could be implemented.

Finally, the effectiveness of all interventions should be monitored and evaluated to ensure that public health funds are being used effectively and efficiently.

Action planning: What specific adaptation interventions in cities can be established, supported and disseminated to protect public health within a one-year time frame?

Date:

Name/s:

WORKSHEET 11-1

Climate change in _____ (city)

Climate change cannot be totally avoided
Climate change may be more rapid and more pronounced than current estimates
The severity of impacts will depend on the capacity to adapt and its effective deployment
Immediate benefits can be gained from better adaptation to climate variability and extreme events
Climate change brings opportunities as well as threats

Date:

Name/s:

WORKSHEET 11-2

Climate change action plan for _____ (city)

Focus area for adaptation
Justification for adaptation strategy/measure/policy

Continued on next page

Climate change action plan...continued

Persons, groups, agencies involved
Description of specific adaptation strategy/measure/policy to be created or implemented

Continued on next page

Climate change action plan...continued

Possible barriers or difficulties and how to overcome them
Monitoring and evaluation plan

Continued on next page

Climate change action plan...continued

Timetable (one-year time frame)
Estimated cost

CONCLUSIONS AND RECOMMENDATIONS

Key Principles in Agenda 21 and UNFCCC

- Precautionary approach
- Costs and responsibilities
- Equity

Precautionary Approach: Agenda 21

In order to protect the environment, the precautionary approach shall be widely applied to States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

The precautionary principle is one approach used by policy-makers to decide when to institute policies and measures to protect a population from potential hazards with serious or irreversible threats to health or the environment before there is strong proof of harm. Invocation of the precautionary principle is a recommendation to implement policies and measures in the face of scientific uncertainty that harm will occur. It is essentially a "better safe than sorry" approach.

The precautionary principle posits that significant actions may be justified when the degree of possible harm is large and irreversible, such as sea level rise and the other possible consequence of anthropogenic climate change. The choices of possible actions range from doing nothing to banning a potentially harmful substance or activity. Many factors influence the choice of specific actions, including an assessment of the possible severity of the potential harm and the degree of scientific uncertainty associated with that assessment.

Precautionary Approach: UNFCCC

The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing such measures.

Costs and responsibilities

- Mitigation of and adaptation to climate change will come at a cost
- Decisions on the policies and measures to be implemented need to be taken in light of other pressing public health issues
- It is important to seek opportunities for win-win solutions that make sense no matter what happens with the weather

Adaptation to and mitigation of climate change will come at a cost, and the human and financial resources required will likely be diverted from other public health issues. Therefore, decisions on the policies and measures to be implemented need to be taken in light of other pressing public health issues. Once individuals, communities, and nations have identified what they want to adapt to (e.g. increased frequency of heat events, or the possible spread of tick-borne encephalitis), then they need to decide what, when, where, and how measures will be implemented. The decision of whether to adapt now or later should be based on a comparison of the present value of expected net benefits associated with acting sooner or later. Addressing these questions has become more urgent with the realization that health-related climate change impacts are already occurring.

Adding adaptation measures into existing programs may not be costly. For example, integrated vector management programs could adjust some monitoring sites to determine if a vector or the disease it carries is expanding or contracting its range. The focus should be on win-win strategies that are designed to improve public health no matter what changes in weather and climate actually occur. In addition, there are opportunities to adapt to multiple factors. For example, the existence of federal flood insurance in the United

States provides an incentive for development in high-risk coastal areas (as strongly evidenced in the 2005 hurricane season), which increases the risk of injury and death to coastal populations (Scheraga et al. 2003). Elimination of federal flood insurance today would reduce the size of the coastal communities currently at risk (at a financial cost to individuals living in coastal communities), and at future risk due to rising sea levels.

Equity

- Agenda 21: The right to development must be fulfilled so as to equitably meet the developmental and environmental needs of present and future generations.
- UNFCCC: The Parties should protect the climate system for the benefit of present and future generations of humankind on the basis of equity.

The Knowledge Network on Urban Settings, WHO Commission on Social Determinants of Health, notes how health inequity is created by both social and environmental determinants of health and that equity needs to be achieved within social groups of the city. It is recommended that local governments undertake municipal adaptation strategies to ensure that vulnerable groups and the urban poor in particular are given priority attention in planning, implementing and monitoring actions on climate change and health.

Answers to Quick Quizzes

Answers to Quick Quiz: Session 1

1. Greenhouse gas emissions
2. Carbon dioxide
3. 0.6
4. Increase or decrease?
   a. Heavy air pollution - decrease
   b. Household wastes – decrease
   c. Coliform bacteria in water - decrease
   d. Heavy metals – initially increase then decrease
   e. Chlorofluorocarbon emissions – initially increase then decrease
   f. Carbon dioxide emissions - increase
   g. Biodiversity loss - increase
5. Ecological footprint
6. Adaptation

Answers to Quick Quiz : Session 3

1. Put a check on the column that designates whether the definition refers to "weather" or "climate" or both.

	Weather	Climate
Always changing *While weather changes over a short period (hours, days), climate changes over longer time spans (decades, centuries, millennia). What is alarming is that the pace of climate change has been significantly accelerating because of anthropogenic factors.*	✓	✓
Considered in a time scale of minutes to weeks	✓	
Day-to-day changing atmospheric conditions	✓	
Considered over multiple years (e.g., a 30-year average)		✓
Characterized by temperature, precipitation, wind, cloudiness and humidity	✓	✓
Characterized by soil moisture, sea surface temperature, and concentration and thickness of sea ice		✓
Average state of the atmosphere and underlying land or water in a region over a particular time scale		✓

1. Study Figure 2-2 on the Greenhouse Effect. State whether the following statements are True or False.

	True	False
Most of the radiation from the sun is absorbed, which warms the Earth.	✓	
The Earth and atmosphere reflect some radiation back out to space but some of this radiation hits greenhouse gas molecules in the atmosphere.	✓	
Greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, halocarbons, and ozone.	✓	
Greenhouse gases serve to cool the temperature of the Earth and lower atmosphere.		✓
Without the greenhouse effect, the Earth would be 33 degrees colder than present.	✓	
Without the greenhouse effect, diurnal temperature range would be more stable.		✓

Answers to Quick Quiz : Session 5

- **Directly transmitted anthroponoses** include diseases in which the pathogen is normally transmitted directly between two human hosts through physical contact or droplet exposure, such as measles, TB, and HIV.
- **Directly transmitted zoonoses** are similar to directly transmitted anthroponoses in that the pathogen is transmitted through physical contact or droplet exposure. However, these agents are spread naturally among animal reservoirs and the infection of humans is accidental; examples include Hantavirus and rabies.
- **Indirectly transmitted anthroponoses** are a class of diseases defined by pathogen transmission between two human hosts by either a physical vehicle (soil) or a biological vector (tick). The complete transmission cycle includes the pathogen, the vehicle or vector, and the human host. Examples include malaria and dengue fever.
- For **indirectly transmitted zoonoses**, the complete transmission cycle includes the pathogen, the vehicle or vector, the animal reservoir, and the human host; Rift Valley fever is an example.

Answers to Quick Quiz : Session 7

1. True
2. True
3. True
4. False. Loss of ozone further cools the stratosphere, hastening the process of ozone destruction.
5. True
6. True

Answers to Quick Quiz : Session 10

1. Vulnerability
2. Sensitivity, exposure, adaptation measures
3. Adaptive capacity
4. Coping capacity