Training Manual for Central level Health Professional
On
Climate Change and Health
June 2022

World Health Organization

IEDCR

Preface

Bangladesh is among the most vulnerable countries in the world facing the effects of climate change. Moreover, climate change is and will continue to affect Bangladesh's public health. A tangible resilience plan for the health sector is necessary to improve the understanding of the health impacts of and adaptation to climate change among relevant stakeholders. The Institute of Epidemiology Diseases Control and Research (IEDCR) under the Ministry of Health and Family Welfare (MoHFW) is carrying out a project named "Building resilience on health system from the impact of climate change" to set up a competent health sector to adapt with climate change through conducting training need assessment (TNA) on CC&H, developing training manuals and conducting training courses for health sector stakeholders with support from the World Health Organizations (WHO).

Due to the impact of climate change the health sector is facing numerous challenges. The recent COVID-19 situation has made the overall condition more distressing. Recent scientific studies show increased mortality from respiratory infections due to air pollution, soar in vector-borne diseases (Dengue, Chikungunya, Kala-azar) and water-borne diseases due to climate change in Bangladesh. Furthermore, the psychological and social effects of climate change on individuals and communities are immense. In the coming years, the climate condition will worsen and thus the pressure will increase on the public health system. To reduce the threat increased knowledge on Climate Sensitive Diseases (CSDs) is needed along with improved management capacity. For that reason, the understanding, knowledge and competency on CC&H, of Bangladeshi health professionals of the specific sector along with other contributors need to be increased.

Taking into consideration Bangladesh Center for Communication Programs (BCCP) has been awarded a project by the World Health Organization (WHO) for conducting "Training Need Assessment, Manual Development and Conduction of TOT for Health Sector Personnel on Climate Change and Health". Under this project BCCP entrusted to do TNA with central and field level health professional following Key Informants Interview (KII) at central level, Focus Group Discussion (FGD) at field level health professional and literature review.

Accordingly training manuals has been developed in consultation with WHO, IEDCR and concern professional of DGHS and others stakeholder. Objective of the manual is to build the capacity of senior health professional at central level and health care professionals at field level of DGHS on climate change and health.

This is a four-day long training manual. The manual has been developed using various participatory training methodology including Review Discussion and Sharing (RDS). In this training manual emphases also given to reduce the barriers caused due to discrimination and gender bias. Throughout the manual gender-neutral terminology has been used to make the manual gender sensitive.

We hope that this training manual will help to enhance the capacity of senior health professional at central level of DGHS in order to address the impact of climate change on health.

Sessions and Topics of Training Manual for Central level Health Professional

- **Session: 01 Introduction to climate change**

  Topic 01: Introduction to climate change

  Topic 02: Greenhouse effect (GHGs)

- **Session: 02 Climate change and Bangladesh perspective**

  Topic 01: Changes in Temperature, Rainfall & Humidity

  Topic 02: cyclone, water surge, flood

  Topic 03: Sea level rise, salinity intrusion

  Topic 04: river erosion and draught

- **Session: 03 Climate change and health burden**

  Topic 01: Consequence of Climate Change

  Topic 02: Health impact of climate change

  Topic 03: Direct Impact

  Topic 04: Indirect Impact

- **Session: 04 Adaptation and Mitigation to climate change**

  Topic 01: What is adaptation?

  Topic 02: Adaptation strategies

  Topic 04: What is Mitigation?

  Topic 05: Mitigation techniques

- **Session: 05 Vector-borne diseases and climate change**

  Topic 01: Introduction to Vector-borne diseases (VBD)

  Topic 02: Effect of climate on Vector-borne diseases

  Topic 03: Case -studies on VBD diseases

  Topic 04: Adaptation: Minimizing risks

  Topic 05: Surveillance and Outbreak activities

- **Session: 06 Water-borne diseases and climate change**

  Topic 01: Water Quality and Quantity

  Topic 02: Addressing water and foodborne diseases

  Topic 03: Effect of climate and weather on diarrheal and water-borne diseases

  Topic 04: Burden of diarrheal diseases **(TBD)**

  Topic 05: Health risk assessment for climate change

- **Session: 07 Food security and malnutrition**

  Topic 01: Food security what it is and cause

  Topic 02: Malnutrition/undernutrition

  Topic 03: Clemet change and food security: Present & Feature

  Topic 04: Improving food security

- **Session: 08 Assessing health vulnerability**

  Topic 01: Introduction of Health Vulnerability

  Topic 02: Approaches and methodology to assessing health vulnerability

- **Session: 09 Multi sectoral coordination and cooperation to reduce health outcome**

  Topic 01: Importance of multi sectoral coordination and cooperation

  Topic 02: Multi sectorial involvement of several Organization with utilization

  Topic 03: Well-functioning multisectoral collaboration mechanisms, with routine involvement of senior officials

  Topic 04: Forums for coordinated work with policy and stakeholder engagement

- **Session: 10 Financing to Climate Change and Health**

  Topic 01: Climate Sensitive Budgeting importance

  Topic 02: Ways to bring up climate sensitive budgeting in Health Sector Program

  Topic 03: Mechanism to access to National and global fund

Module: 01 Introduction to Climate Change

Time: 60m

Objectives:

After completion of the Module participants will be able -

- to explain what is weather and climate;
- to understand difference between climate and weather;
- to understand what is climate change ;
- to explain what are greenhouse gases;
- to understand what is greenhouse effect;
- How is the global climate changing and
- Consequences of climate change.

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	weather and climate	2 m	Brain storming, discussion and Visualized presentation	Flip chart , marker, VIPP board, multimedia
2.	difference between climate and weather	3 m	Brain storming, discussion and Visualized presentation	Flip chart , marker, VIPP board, multimedia
3.	climate change	10 m	Brain storming, discussion and Visualized presentation	Flip chart , marker, VIPP board, multimedia
4.	greenhouse gases and it's effect	10 m	Brain storming, discussion and visualized presentation	Flip chart , marker, VIPP board, multimedia

5.	Changing of global climate	15 m	Brain storming, discussion and visualized presentation	Flip chart , marker, VIPP board, multimedia
6.	Consequences of climate change	15 m	Brain storming, discussion and visualized presentation	Flip chart , marker, VIPP board, multimedia
3.	Sum up	5m	Q & A and discussion	Interaction with the participants

Process:

Welcome

- Greet the participants and invite them to the session to participate.
- Ask the participants to know their ideas about weather and climate
- Share the visual presentation deference between weather and climate
- Ask the participants what climate change is and share the visual presentation with them
- Ask the participants what greenhouse gases and its effect are and share the visual presentation with them
- Ask the participants how global climate is changing and it's consequence? share the visual presentation with them regarding changing of global climate and it's consequences.
- Ask if any question and give answer.
- Summarize and conclude the session.

Note for Facilitator

Weather

Weather consists of those meteorological events, such as rain, wind, and sunshine that can change week to week, day by day even hour by hour.

Weather

Step outside and you experience many facets of weather. Humidity, air temperature and pressure, wind speed and direction, cloud cover and type, and the amount and form of precipitation are all atmospheric characteristics of the momentary conditions we call weather.

Climate

Climate is weather averaged over an extended period (30-year intervals are typically used in establishing baseline climatology)

The climate of an area or country is known through the average weather over a long period of time. If an area has more dry days throughout the year than wet days, it would be described as a dry climate; a place which has more cold days than hot days would make it known to have a cold climate.

Differences:

	Weather	**Climate**
Definition	day-to-day information of the changes of particular area	Average changes for a long period of time of a vast area
Condition	Weather condition can be observed very frequently	changes in climate take a longer time to change.
Components	sunshine, rain, cloud cover, winds, hail, snow, sleet, freezing rain, flooding, blizzards, ice storms, thunderstorms, steady rains from a cold front or warm front, excessive heat, heat waves and more	Components: precipitation, temperature, humidity, sunshine, wind velocity, phenomena such as fog, frost, and hailstorms over a long period of time.
Time period	Measured for short term	Measured over a long period

Forecast	Day to day state thus forecast given daily and hourly	By aggregates of weather statistics over periods of 30 years

Climate change

Our planet's climate is always changing. In the past it has been altered following natural causes but at present the changes have been accelerated as a result of human behaviour. Nowadays the term "climate change" is generally used when referring to changes in our climate, which have been identified as occurring since the beginning of the mid-19th century. During the Earth's history, the climate has changed many times and has included ice ages and periods of warmth.

Effect of Climate change

Climate change causes a temperature rise, greenhouse and carbon dioxide gas emissions, erratic rainfall, salinity intrusion, the rise of floods, cyclones, drought, ice sheets melting which will seriously affect agriculture and livelihood, especially at the poor. Bangladesh is likely to be the most affected because of its geographical location. One-third of the total land of Bangladesh will go underwater if the sea level rises one meter.

Effect of Climate change

One of the most intense impacts will be the forced movement of people throughout Bangladesh as a result of losing their homes, lands, property and livelihoods to the effects of climate change. It is estimated that rising sea levels alone will displace 18 million Bangladeshis within the next 40 years. The vast majority of these people will be displaced domestically- not across international borders presenting the government with enormous challenges, particularly when it comes to finding places to live and work for those who have been displaced.

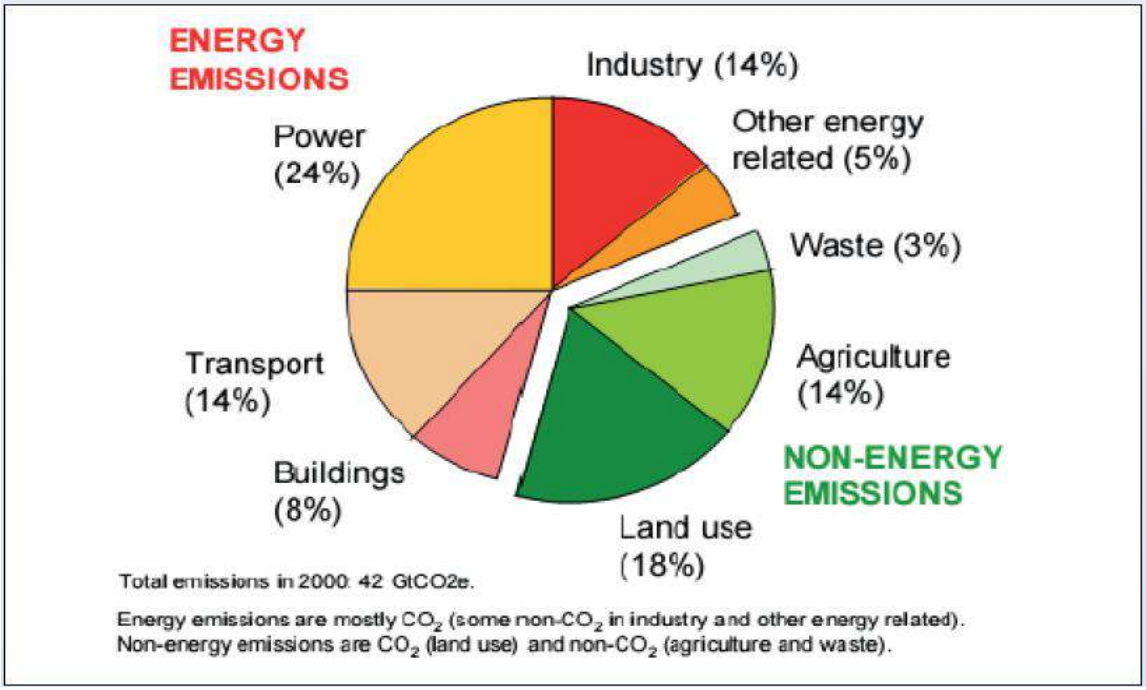
Greenhouse effect:

The greenhouse effect is the process by which the air surrounding the earth is becoming warmer day by day. In other words, it is the gradual warming of the air which ultimately results in the gradual increase in the world temperature. In short, we know the rise in atmospheric temperature as the greenhouse effect. The carbon dioxide is primarily responsible for temperature rise in the atmosphere. Burning coal and oil increases carbon dioxide. As a result, the ice covering the north and south poles is melting and may eventually lead to a rise in sea levels which can flood many areas of the world.

Green house gashes

Gases that trap heat in the atmosphere are called greenhouse gases. Five Major Greenhouse Gases that cause global warming via the greenhouse effect are the following:

- Carbon Dioxide
- Methane
- Nitrous Oxide
- Fluorinated Gases
- Ozone (O3) (Source: NRDC)


ENERGY EMISSIONS
Industry (14%)
Other energy related (5%)
Waste (3%)
Agriculture (14%)
NON-ENERGY EMISSIONS
Land use (18%)
Buildings (8%)
Transport (14%)
Power (24%)
Total emissions in 2000: 42 GtCO2e.
Energy emissions are mostly CO_2 (some non-CO_2 in industry and other energy related).
Non-energy emissions are CO_2 (land use) and non-CO_2 (agriculture and waste).

Greenhouse effect:

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Greenhouse effect:

- As temperatures change, many species are on the move. Some butterflies, foxes, and alpine plants have migrated farther north or to higher, cooler areas.
- Precipitation (rain and snowfall) has increased across the globe, on average. Yet some regions are experiencing more severe drought, increasing the risk of wildfires, lost crops, and drinking water shortages.
- Some species—including mosquitoes, ticks, jellyfish, and crop pests—are thriving. Booming populations of bark beetles that feed on spruce and pine trees, for example, have devastated millions of forested acres in the U.S. Rising temperatures are affecting wildlife and their habitats. (National Geography)

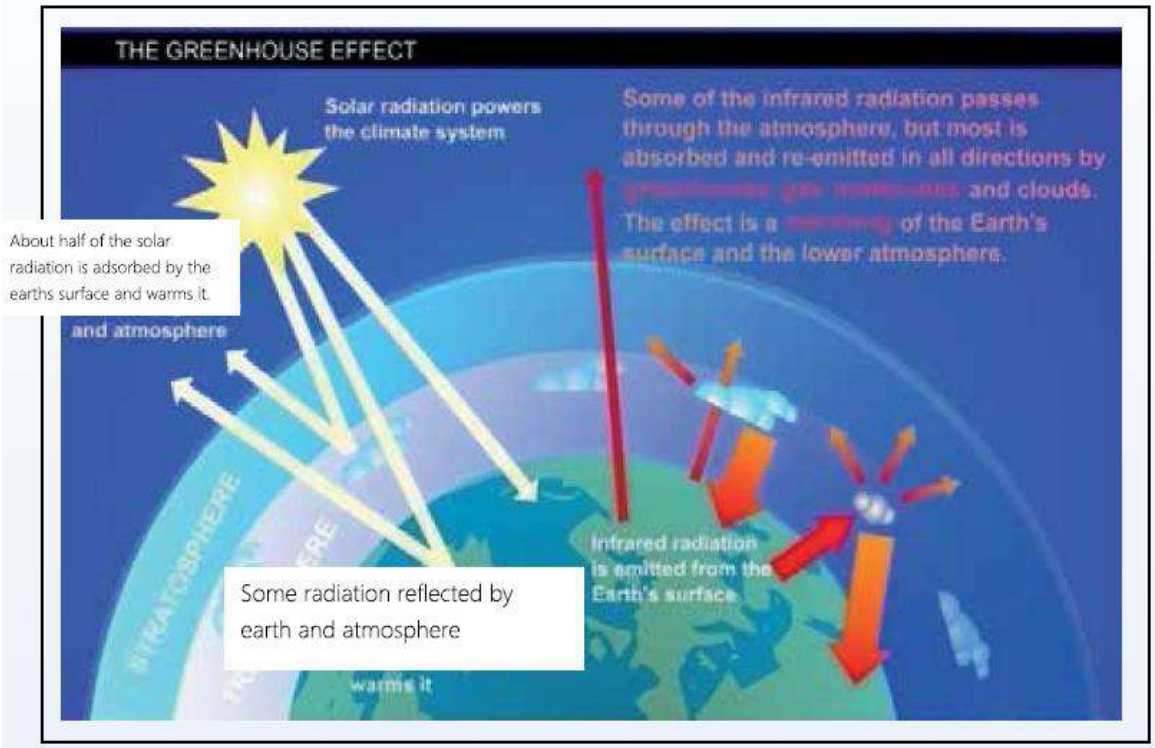
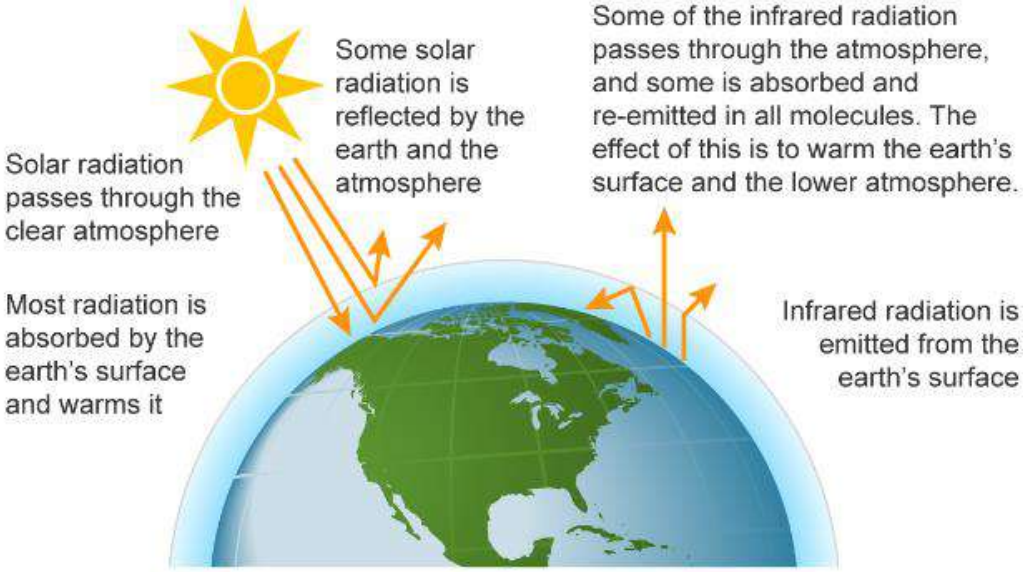


Figure (4): Green House Effect

Source: U.S. Environmental Protection Agency (public domain)



Source: Adapted from U.S. Environmental Protection Agency (public domain)

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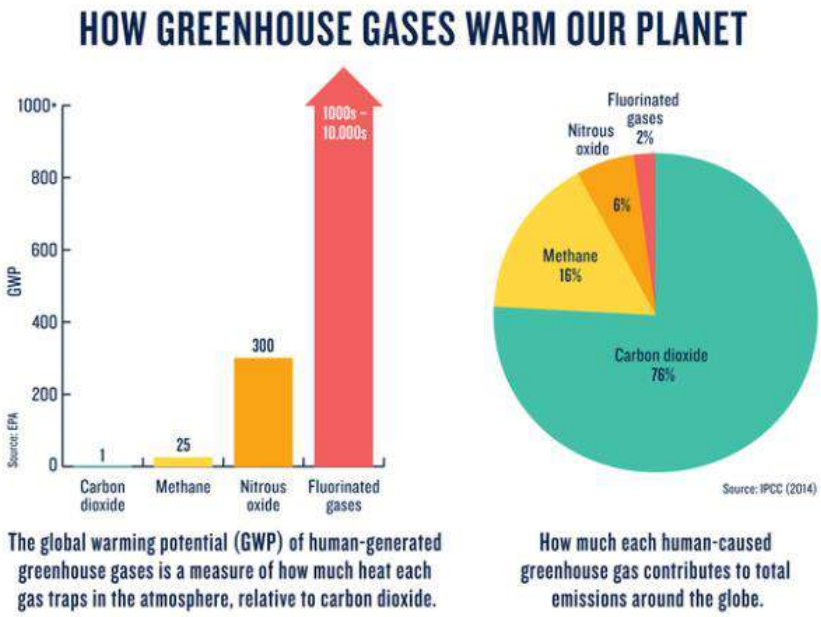
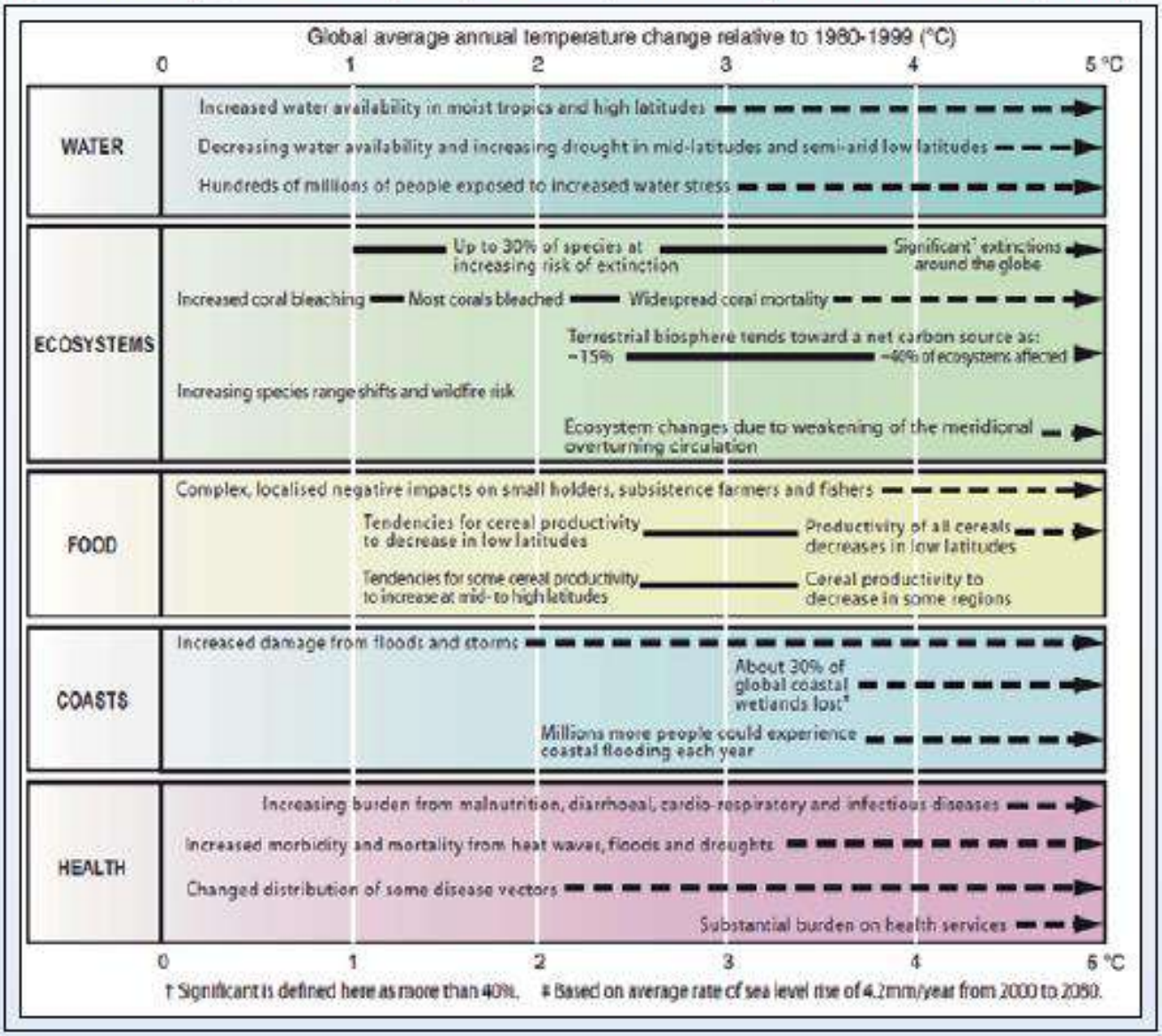
Vedio


HOW GREENHOUSE GASES WARM OUR PLANET
1000
800
600
400
200
0
GWP
Source: EPA
1
25
300
1000s – 10,000s
Carbon dioxide
Methane
Nitrous oxide
Fluorinated gases
The global warming potential (GWP) of human-generated greenhouse gases is a measure of how much heat each gas traps in the atmosphere, relative to carbon dioxide.
Fluorinated gases 2%
Nitrous oxide 6%
Methane 16%
Carbon dioxide 76%
Source: IPCC (2014)
How much each human-caused greenhouse gas contributes to total emissions around the globe.

Examples of impacts associated with global average temperature change

(Impacts will vary by extent of adaptation, rate of temperature change and socio-economic pathway)



Reading Materials:

Green house gashes:

Gases that trap heat in the atmosphere are called greenhouse gases. Five Major Greenhouse Gases that cause global warming via the greenhouse effect are the following: (Source: NRDC)

Carbon Dioxide

Accounting for about 76 percent of global human-caused emissions, carbon dioxide (CO2) sticks around for quite a while. Once it's emitted into the atmosphere, 40 percent remains after 100 years, 20 percent after 1,000 years, and 10 percent as long as 10,000 years later.

Methane

Although methane (CH4) persists in the atmosphere for far less time than carbon dioxide (about a decade), it is much more potent in terms of the greenhouse effect. In fact, pound for pound, its global warming impact is 25 times greater than that of carbon dioxide over a 100-year period. Globally it accounts for approximately 16 percent of human-generated greenhouse gas emissions.

Nitrous Oxide

Nitrous oxide (N2O) is a powerful greenhouse gas: It has a GWP 300 times that of carbon dioxide on a 100-year time scale, and it remains in the atmosphere, on average, a little more than a century. It accounts for about 6 percent of human-caused greenhouse gas emissions worldwide.

Fluorinated Gases

Emitted from a variety of manufacturing and industrial processes, fluorinated gases are man-made. There are four main categories: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), and nitrogen trifluoride (NF3).

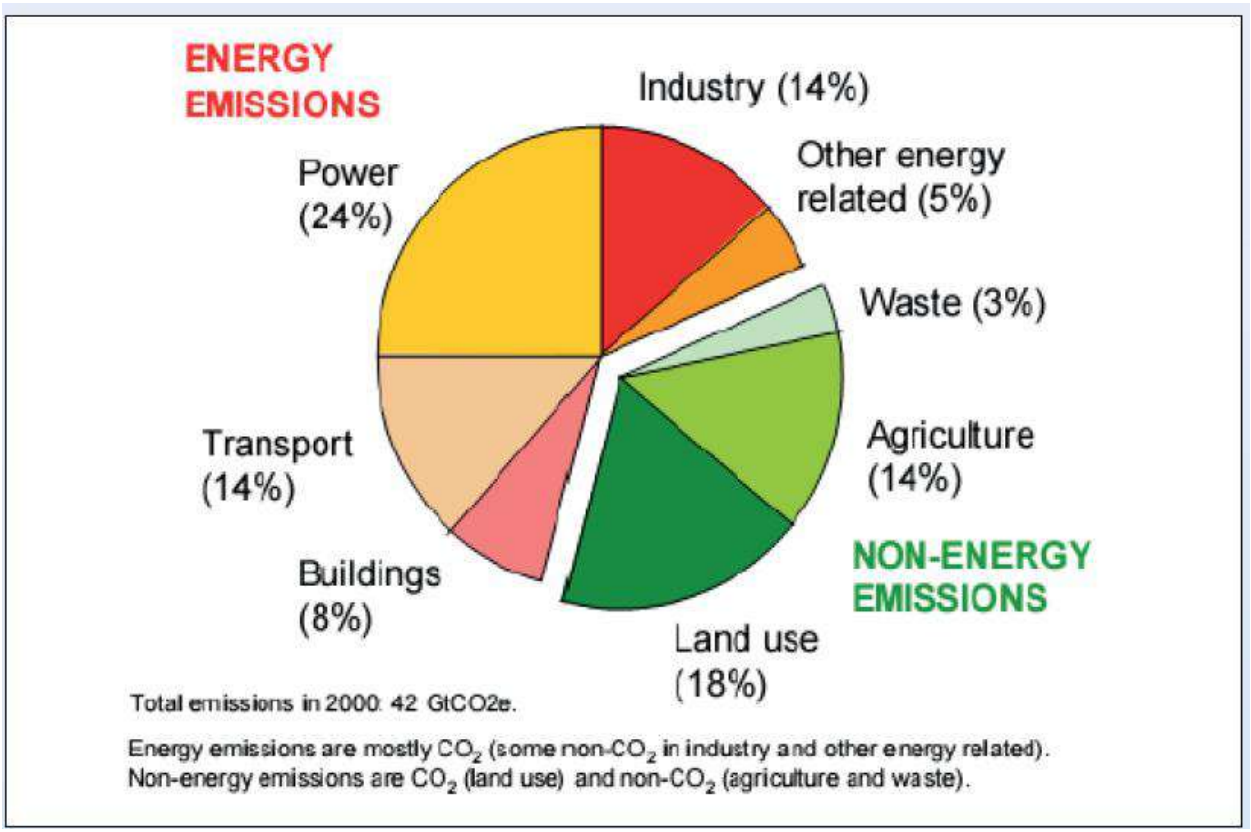
Although fluorinated gases are emitted in smaller quantities than other greenhouse gases (they account for just 2 percent of man-made global greenhouse gas emissions), they trap substantially more heat. Indeed, the GWP for these gases can be in the thousands to tens of thousands, and they have long atmospheric lifetimes, in some cases lasting tens of thousands of years.

HFCs are used as a replacement for ozone-depleting chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), usually in air conditioners and refrigerators, but some

are being phased out because of their high Global Warming Potential (GWP). Replacing these HFCs and properly disposing of them is considered to be one of the most important climate actions the world can take.

Ozone (O3)

Ozone is not put into the atmosphere directly by man but is generated there via a series of chemical reactions involving Nitrogen Oxides (NOX), Carbon Monoxide (CO) and Volatile Organic Compounds (VOC). In the stratosphere ozone layer absorbs ultraviolet rays and protect us from the effect of ultraviolet radiation of sun. While in the troposphere ozone traps heat and act as greenhouse gases.



Greenhouse effect:

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atmosphere. Burning coal and oil increases carbon dioxide. As a result, the ice covering the north and south poles is melting and may eventually lead to a rise in sea levels which can flood many areas of the world.

Scientists have already given warming that some parts of coastal countries including Bangladesh may go underwater due to the greenhouse effect. The total area of deserts is increasing day by day. Many animals and plants are endangered with the threat of extinction. In order to protect ourselves from its catastrophic impact and to prevent global warming, we should take some effective measures. Therefore, the deliberate cutting down of forests must be stopped. Govt. as well as NGOs should start more tree plantation programs. Govt should take steps to put an end to the causes and sources of emitting carbon dioxide in the atmosphere.

Sunlight passes through the atmosphere and warms the Earth's surface. Some of this solar radiation is reflected by the Earth and the atmosphere. Greenhouse gases in the atmosphere, such as carbon dioxide (CO2), absorb the reflected radiation and further warm the surface of the Earth. This is called the greenhouse effect. As more greenhouse gases are emitted into the atmosphere, heat that would normally be radiated into space is trapped within the Earth's atmosphere, causing the Earth's temperature to increase. The rise in GHG concentrations in the atmosphere is a direct consequence of our productive, economic and social model, based since the 19th century on an unsustainable increase in the use of energy, 85% of which comes from fossil sources (coal, oil and gas). *Rise in Greenhouse Gas concentrations Rise in temperatures*.

The rapid rise of temperature in the atmosphere since the second part of the 20th century is only due to human activities. The linear warming trend over the last 50 years (0.13◦C per decade) is nearly twice that for the last 100 years. This means the average speed with which temperatures

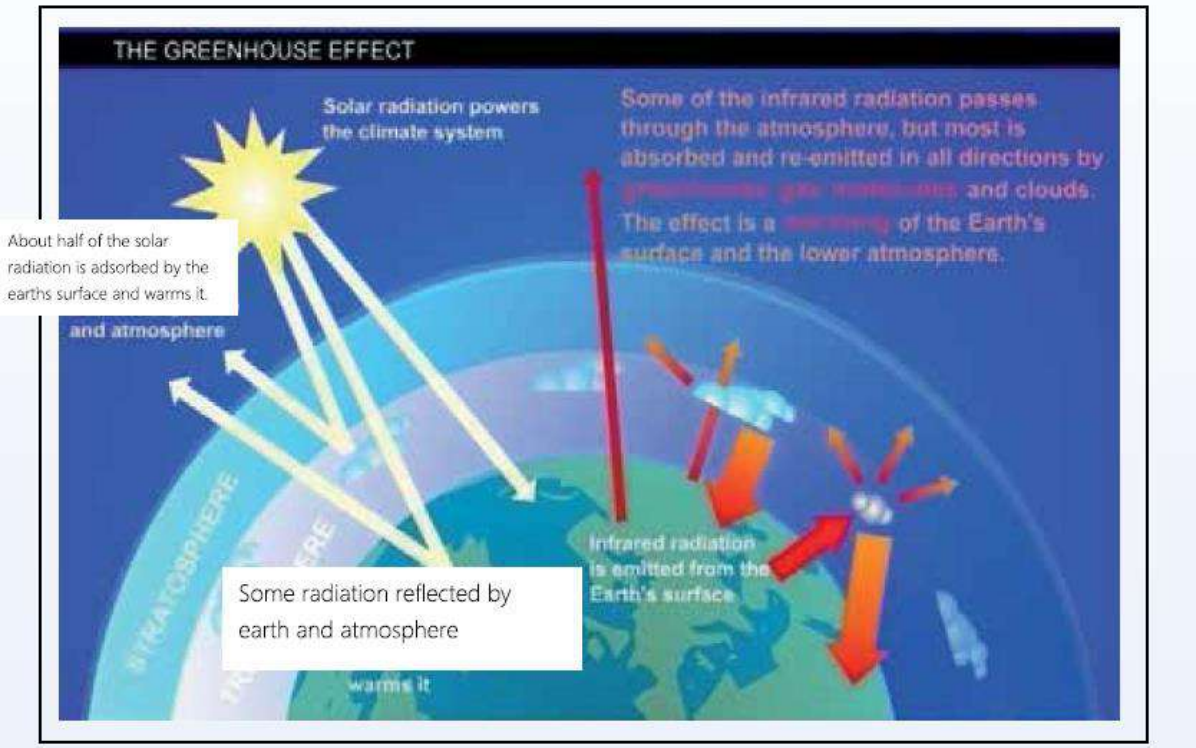


Figure (4): Green House Effect

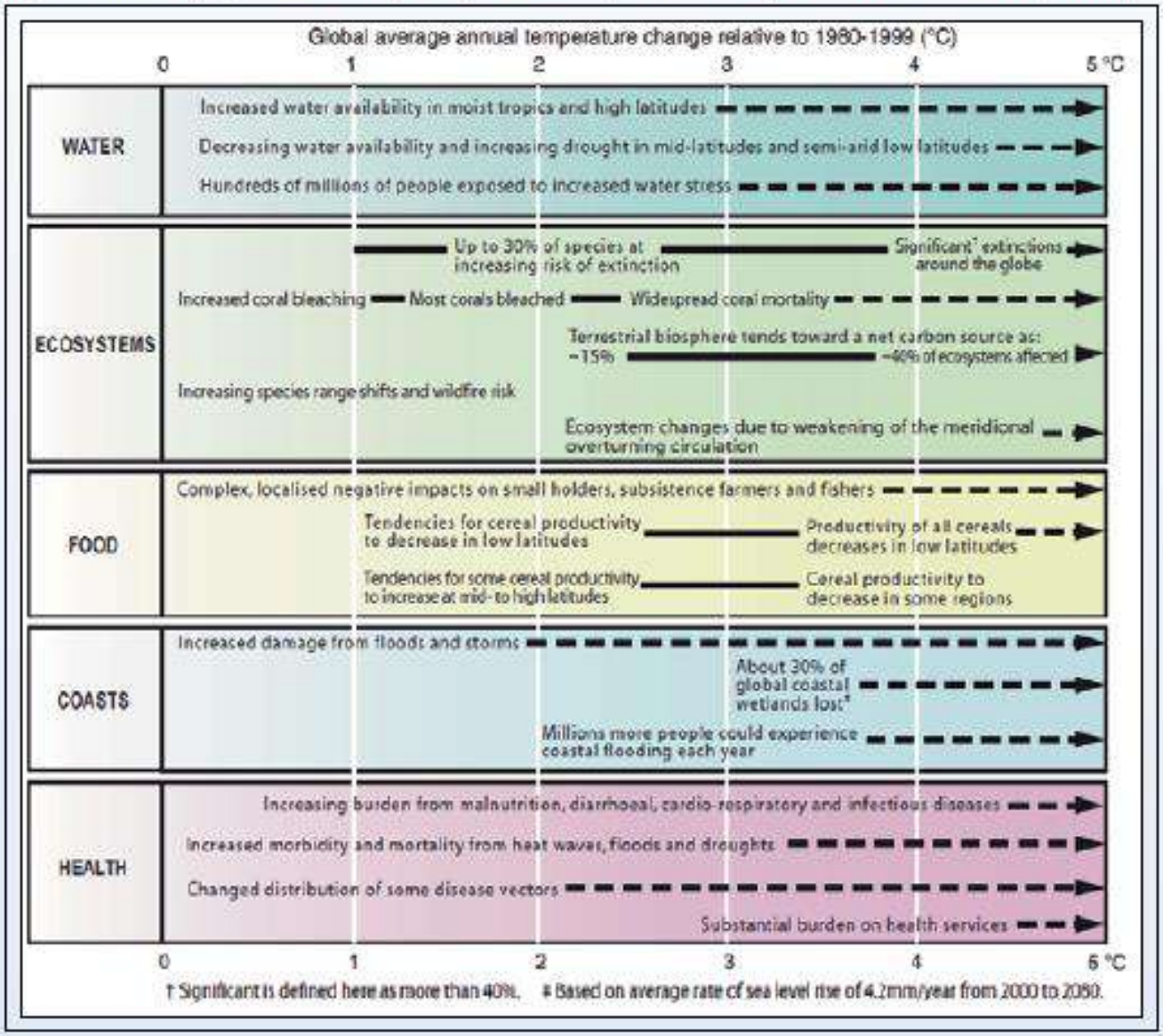
have increased in the last fifty years has doubled over the whole century.

video

video

Examples of impacts associated with global average temperature change

(Impacts will vary by extent of adaptation, rate of temperature change and socio-economic pathway)



Module: 02 Climate change and Bangladesh perspective



Time: 75 m

Objectives:

After completion of the Module participants will be able -

- To understand Changes in Temperature, Rainfall & Humidity due to climate change
- To understand Cyclone, Water surge, and Flood.
- To understand Sea level rise
- To understand Increase Salinity in land and water:
- To understand River Erosion
- To understand Drought due to climate change

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	Changes in temperature, Rainfall & Humidity	10 m	Brain storming, discussion and Visualized presentation	Flip chart , marker, VIPP board, multimedia
2.	Cyclone, Water surge, and Flood	10 m	Brain storming, discussion and Visualized presentation	Flip chart , marker, VIPP board, multimedia
3.	Sea level rise	10 m	Brain storming, discussion and Visualized presentation	Flip chart , marker, VIPP board, multimedia
4.	Salinity in land and water	10 m	Brain storming, discussion and visualized presentation	Flip chart , marker, VIPP board, multimedia
5.	River erosion	15 m	Brain storming, discussion and visualized presentation	Flip chart , marker, VIPP board, multimedia

6.	Drought	15 m	Brain storming, discussion and visualized presentation	Flip chart , marker, VIPP board, multimedia
3.	Sum up	5 m	Q & A and discussion	Interaction with the participants

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about changes in temperature, rainfall & humidity
- Ask the participants to know their ideas about cyclone, water surge, and flood
- Ask the participants to know their ideas about their sea level rise
- Ask the participants to know their ideas about salinity in land and water
- Ask the participants to know their ideas about river erosion
- Ask the participants to know their ideas about drought
- Ask if any question and give answer.
- Summarize and conclude the session.

Note for Facilitator

Changes in pattern of temperature, rainfall and & humidity effect:

The rainfall of Bangladesh varies from 1400 mm in the west to more than 4400 mm in the east. Average temperature of the country varies from 17°C to 21°C in winter and from 27°C to 30°C in summer. (Cited by MHR Khan 2019)· 31 In some places, in the western part of Bangladesh, the maximum temperature in summer rises up to 40°C or more. The climate models projected that temperature of Bangladesh would rise 1.0°C by 2030, 1.4°C by 2050, and 2.4°C by the end of this century. The models also predict 3.8% increase of rainfall by 2030, 5.6% by 2050, and 9.7% by the end of 21st century. Small changes in the mean and standard deviation values of rainfall and temperature can produce relatively large changes in the probability of extreme weather events. The impacts of more variable precipitation and extreme weather events are already felt in Bangladesh.

Cyclone, Water surge, and Flood

Bangladesh is one of the most disaster-prone countries in the world. Almost every year, the country experiences some sorts of disasters, such as tropical cyclones, storm surges, floods, and droughts, causing heavy losses of lives and properties. The projected high rainfall during monsoon would increase flow of rivers in Bangladesh.

Sea Level Rise

As warmer seas expand, the sea level will rise, threatening residents along the coastlines and on low lying islands in salinity. Relying on data from satellites and floats (mechanical devices drifting in the ocean), a group of oceanographers announced in June 2006 that sea level rose, on average, 3 millimeters (0.1inches) per year between 1993 and 2005.

Increase salinity in land and water

In a comparative study on soil salinity between 1993and 1997. It was Prevention of Climate Change Health Impact in Bangladesh found that in 1997 Magura, Narail, Faridpur,& Jhalokathi were not affected by salinity intrusion but 1997 these districts were found to be newly salinized in 24 hours of time . It has been predicted that 1 meter sea level rise will expand the soil and water salinity area at a faster rate. It has been predicted that 1 meter sea level rise will expand the soil and water salinity area at a faster rate.

Drought

In Bangladesh Drought is one of the main problems and the severity of such issue goes big when it comes as obstacle to ensure an optimum agricultural production for a country like Bangladesh. Drought is being considered as the main cause which hampers the estimated agricultural production, here in Bangladesh over the last few decades. Rising levels of CO2 and other GHGs have been recommended as causes of variations of rainfall that are characterized as climate change[1].

River Erosion

Bangladesh is a riverine country which is crisscrossed by more than 230 rivers, 57 of them are international, with a stretch of 2,400 kilometer of bank line. The country is a living delta formed of alluvial soil which is very prove to erosion with any degree of river activity or water movement. 283 locations as well as 85 towns and growth centers along the long bank line are seriously affected by river erosion almost every year. Besides, another 1200 kilometer of bank line is vulnerable to erosion[2]. Rangpur Dinajpur Rural Services (RDRS) staff report from Kurigam that since the 1998 flood about 795families were displaced due to river erosion in the char areas (small Sand Island) in the river Brahmaputra in Kurigram district.

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The following impact of climate changes have already been observed in Bangladesh:

- Summers are becoming hotter
- Irregular monsoon irregular
- Untimely rainfall
- Heavy rainfall over short period causing water logging and landslides
- Very little rainfall in dry period
- Increased river flow and inundation during monsoon
- Increased frequency, intensity and recurrence of floods
- Crop damage due to flash floods and monsoon floods
- Crop failure due to drought
- Prolonged cold spell
- Salinity intrusion along the coast leading to scarcity of potable water
- Coastal erosion
- Riverbank erosion
- Deaths due to extreme heat and extreme cold
- Increasing mortality, morbidity, prevalence and outbreak of cholera and diarrhea, etc.

Reading Materials

Changes in pattern of temperature, rainfall and & humidity

Bangladesh is one of the most disaster-prone countries in the world. Almost every year, the country experiences some sorts of disasters, such as tropical cyclones, storm surges, floods, and droughts, causing heavy losses of lives and properties. The projected high rainfall during monsoon would increase flow of rivers in Bangladesh.

Changes in pattern of temperature, rainfall and & humidity

Situated in the subtropical region, the climate of Bangladesh is characterized by wide seasonal variations in rainfall, moderately warm temperatures, and high humidity. The rainfall of Bangladesh varies from 1400 mm in the west to more than 4400 mm in the east. Average temperature of the country varies from 17°C to 21°C in winter and from 27°C to 30°C in summer. (Cited by MHR Khan 2019)· In some places, in the western part of Bangladesh, the maximum temperature in summer rises up to 40°C or more. The climate models projected that temperature of Bangladesh would rise 1.0°C by 2030, 1.4°C by 2050, and 2.4°C by the end of this century. The models also predict 3.8% increase of rainfall by 2030, 5.6% by 2050, and 9.7% by the end of 21st

century. Small changes in the mean and standard deviation values of rainfall and temperature can produce relatively large changes in the probability of extreme weather events. The impacts of more variable precipitation and extreme weather events are already felt in Bangladesh. Floods in 1988, 1998, 2004, and 2007; and cyclones and tidal surges in 1991, 1998, 2000, 2004, 2007 and 2009 record the increase of extreme events both in frequency and severity in Bangladesh.

Cyclone, Water surge, and Flood

Bangladesh is one of the most disaster-prone countries in the world. Almost every year, the country experiences some sorts of disasters, such as tropical cyclones, storm surges, floods, and droughts, causing heavy losses of lives and properties. The projected high rainfall during monsoon would increase flow of rivers in Bangladesh. The increased run-off would also aggravate the existing drainage problems and create new ones. Most of the rivers in Bangladesh already have lost gradient during the past several decades. An increase in monsoon rainfall, therefore, will complicate drainage problem further resulting in increasing duration of floods (Ahmed et al., 1998a). The ' best-estimate' scenario for the year 2030 is that monsoon rainfall could increase by 10 to 15 per cent. Due to its geological location Bangladesh is likely to remain vulnerable to cyclonic hazards with perhaps a higher possibility of formation of cyclones in a warmer world. Moreover, the fact that peak intensities may increase by 5-10% has serious implications for a country already very vulnerable to storm surges. Finally, an increase in 20-30% in the associated precipitation could only make the concerns even more serious, particularly in the coastal embanked areas where heavy rainfall can instantaneously inundate otherwise protected agricultural lands.

Sea Level Rise

As warmer seas expand, the sea level will rise, threatening residents along the coastlines and on low lying islands in salinity. Relying on data from satellites and floats (mechanical devices drifting in the ocean), a group of oceanographers announced in June 2006 that sea level rose, on average, 3 millimeters (0.1inches) per year between 1993 and 2005.

Increase Salinity in land and water

In a normal hydrological cycle, rivers suffer from low flow conditions when there is no appreciable rainfall runoff. During low flow surface salinity penetrates further inland due to lack of adequate flushing. Under climate change scenarios low flow conditions are likely to aggravate with the possibility of withdrawal of appreciable rainfall in winter (Ahmed et al., 1998a). The southwest part of the country will be particularly vulnerable. In a comparative study on soil salinity between 1993and 1997. It was Prevention of Climate Change Health Impact in Bangladesh found that in 1997 Magura, Narail, Faridpur,& Jhalokathi were not affected by salinity intrusion but 1997 these

districts were found to be newly salinized in 24 hours of time . It has been predicted that 1 meter sea level rise will expand the soil and water salinity area at a faster rate.

River Erosion

Bangladesh is a riverine country which is crisscrossed by more than 230 rivers, 57 of them are international, with a stretch of 2,400 kilometer of bank line. The country is a living delta formed of alluvial soil which is very prove to erosion with any degree of river activity or water movement. 283 locations as well as 85 towns and growth centers along the long bank line are seriously affected by river erosion almost every year. Besides, another 1200 kilometer of bank line is vulnerable to erosion. Across Bangladesh hundreds of families have been rendered homeless because of soil erosion and rising water levels in almost all major rivers coupled with incessant rains. They live a floating life: there are more or less 4.0 million such homeless people in the country lead floating life. In most cases such floating families live on public land such as char lands, embankments, abandoned railway trucks, slopes of highways. Strong currents in the rivers Padma, Jamuna and Brahmaputra have devoured vast low-lying and riverside areas as well as seriously damaged standing crops and properties. Rangpur Dinajpur Rural Services (RDRS) staff report from Kurigam that since the 1998 flood about 795families were displaced due to river erosion in the char areas (small Sand Island) in the river Brahmaputra in Kurigram district. Some 10 to 15% % of these families have been displaced again by the recent soil erosion. Displaced families are 350 from three Unions of Rajibpur, Thana, 200 from three Unions of Chilmari Thana,145 families from Ulipur Thana and 100 families from three Unions of Kurigram Sadar (centre) Thana.

Officials from the national Water Development Board (WDB) state that different flood protection embankments, roads and housing establishments in and around the rivers Padma and Jamuna are now under severe threat due to "massive" river erosion. The WDB has already sent messages to their local authorities to take adequate steps to cope with the devastation. It has also sent experts to different vulnerable areas to see the situation and take precautionary measures to save the embankments. In different areas they are dumping sandbags along with bricks and stones to restore the embankments from erosion

The rise of global sea level by the end of AD 2050 would mean that there is a high risk of coastal inundation by sea water. In the case of Bangladesh the projected 1.44m rise of sea level would inundate 16% of the populated land, displace 13% of the population and lose 10% of the GDP. The effect of sea level rise is more critical, since the Bengal delta is subsiding. River currents strengthened by rising sea levels have devoured half of Bangladesh's biggest island in 40years, leaving half a million people homeless, researchers said. From a size of 6,400 square kilometers(3,968 square miles) in 1965, Bhola Island near the mouth of the Bay of Bengal is now only half its original size. If the erosion continues at the same rate, it will completely disappear over the next four decades. Rising sea levels were responsible for the erosion of coastal islands such as Bhola that were not previously vulnerable to the problem. The erosion of Bhola Island

only started in the 1960s. Before that the size was stable and only a small amount of erosion took place on one side, but from the mid-1960s the erosion began, and the rate has accelerated over the years. Recently, in some parts of Chittagong coastal belt, erosion has increased at an alarming rate. A vast area including the export processing zone, the naval establishment, and a large industrial estate could be in danger if the present rate of erosion continues. Port facilities will have to be adjusted to a higher sea level. However, in a country like Bangladesh, where inland areas are occupied by agriculture or settlements and protected by dikes, the mangrove zone would become narrower by erosion and might even disappear.

Draught

In Bangladesh Drought is one of the main problems and the severity of such issue goes big when it comes as obstacle to ensure an optimum agricultural production for a country like Bangladesh. Drought is being considered as the main cause which hampers the estimated agricultural production, here in Bangladesh over the last few decades. Rising levels of CO2 and other GHGs have been recommended as causes of variations of rainfall that are characterized as climate change[1]. There are strong evidence that climate change will change the rainfall pattern and consequently more frequent droughts are happened. Among the local-level reasons are human-induced alterations resulting from vegetation loss because of deforestation and over exploitation of resources.

Drought is primarily an agricultural phenomenon that affects both the vegetative growth and yield of crops. It occurs when supply of moisture stored in the soil is insufficient to meet the optimum need of a particular type of crop. As a consequence of usual hydro-meteorological variability, drought occurs in pre-monsoon season when the potential evapo-transpiration (PET) is higher than the available moisture due to uncertainty in rainfall while in post-monsoon season it is due to prolonged dry periods without appreciable rainfall (Karim et al, 1990a). In both the seasons, due to sudden increases in temperature. temperature coupled with nonavailability of rainfall causes a sharp rise in PET.

In both the seasons, due to sudden increases in temperature coupled with nonavailability of rainfall causes a sharp rise in PET.

Consequences of Climate Change

One of the most intense impacts will be the forced movement of people throughout Bangladesh as a result of losing their homes, lands, property and livelihoods to the effects of climate change. It is estimated that rising sea levels alone will displace 18 million Bangladeshis within the next 40 years. The vast majority of these people will be displaced domestically- not across international borders presenting the government with enormous challenges, particularly when it comes to finding places to live and work for those who have been displaced. The number of “climate change refugees” in Bangladesh is expected to rise dramatically in the coming decades. If sea levels rise by just 3.2 feet, one-fifth of the country located on the delta formed by some of Asia’s biggest

rivers, is expected to be covered in water. Poor populations are the most vulnerable to the changing conditions.

Bangladeshis have already started to move away from the lowest-lying villages in the river deltas of the Bay of Bengal; 1.5 million of the five million slum inhabitants in Dhaka, moved from villages near the Bay of Bengal.

In Bangladesh, climate change will affect many sectors, including water resources, agriculture and food security, ecosystems and biodiversity, human health and coastal zones. Many environmental and developmental problems will be worsened by climate change. Predicted rainfall increases, particularly during the summer monsoon, could increase flood prone areas in Bangladesh.

It is predicted that climate change could have devastating impact on agriculture which is a key economic driver in Bangladesh, accounting for nearly 20 percent of the GDP and 65 percent of the labor force. Crop yields are predicted to fall by up to 30 per cent, creating a very high risk of hunger. The global warming increases risk of flooding, erosion and mudslides during the wet season and it could lead to disappearance of many glaciers that feed many rivers in South Asia. The achievement towards the MDGs, such as eradicating poverty, combating communicable diseases and ensuring environmental sustainability could be in jeopardy.

The following impacts of climate changes have already been observed in Bangladesh: Summers are becoming hotter, monsoon irregular, untimely rainfall, heavy rainfall over short period causing water logging and landslides, very little rainfall in dry period, increased river flow and inundation during monsoon, increased frequency, intensity and recurrence of floods, crop damage due to flash floods and monsoon floods, crop failure due to drought, prolonged cold spell, salinity intrusion along the coast leading to scarcity of potable water and redundancy of prevailing crop practices, coastal erosion, riverbank erosion, deaths due to extreme heat and extreme cold, increasing mortality, morbidity, prevalence and outbreak of cholera and diarrhea, etc.

The climate change in Bangladesh creates insecurities for food, water, life, property, settlement, livelihoods, and others. Environmental degradation, degradation of land resources ultimately reduces food and health securities etc. Increased cyclone, storm surges, floods, river 3 bank erosion destroys and damage peoples properties including land, house, cattle, and other livelihood assets and living essentials. Frequent disasters increase damage and loss by many folds. Following the climate change, the riverbank and costal erosion are increasing at alarming rate.

The rough sea limits fishing opportunities. Health hazards, malnutrition, access to services prior, during and after disasters reduce working days and opportunities. Women and disadvantaged groups are suffering more during disasters as they don’t receive warning in time and women has to take care of their children, elderly and disabled. Most migrants end up in urban slums, particularly in Dhaka and this constant influx of people is contributing to rising crime and insecurity in these areas. About 20 million people in the coastal areas of Bangladesh are already affected by salinity in drinking water and Salinity intrusion into the countryside reached 100km and degrades land resources.

The fisheries sector has also experienced an adverse effect because of the impacts of Climate Change. The fisheries sector contributes about 3.5% of the GDP in Bangladesh and people depend on fish products in order to meet up majority of their daily protein requirements. There are around 260 species of fish in the country and almost all the varieties are sensitive to specific salt and freshwater conditions.

In a high-density country like Bangladesh, the effects of Climate Change on the Surface and Ground water resources will be very severe and alarming. Changes hydrology will have a significant impact on the country's economy, where people mostly depend on the surface water for irrigation, fishery, industrial production, navigation, and similar other activities. Bangladesh relies almost entirely on groundwater for drinking supplies because the rivers are so polluted. The resultant pumping causes the land to settle. So as sea levels are rising, Bangladesh's cities are sinking, increasing the risks of flooding.

Majority of the population living in coastal area are somehow affected by coastal floods, tidal surges, river-bank erosion, salinity, tropical cyclones etc. Agriculture, industry, infrastructure (school, hospitals, roads, bridges and culverts etc.), marine resources, forestry, biodiversity, human health and other utility services are the major affected areas of livelihoods. Since most of the country is less than 10 meters above Sea level and almost 10% of the population of the country is living below 1 meter elevation the whole coastal area is highly vulnerable to high tides and storm surges.

Biodiversity would be reduced in some of the most fragile environments, such as Sundarbans and tropical forests. Bangladesh has got a wide diversity of ecosystems including mangrove forests at the extreme south of the country. The "Sundarbans" a World Heritage, is the largest Mangrove Forest in the world, comprising 10,000 sq km (mostly in Bangladesh) of land area along the Bay of Bengal. Around 425 species are living there including the most significant famous Royal Bengal Tiger. Climate Change impacts will have negative effects on the Ecosystem of the Forest recourses in Bangladesh while the Sundarbans is likely to suffer the most.

The urban poor are directly at the risk of natural disasters being enhanced by the impacts of Climate Change- especially in the shortage of the necessary infrastructure as well as employment opportunity for them in the major cities of the country. Women are especially vulnerable because of the gender inequalities in the socio- economic situation.

Module: 03 Climate Change and Health Burden

Time: 75 m

Objectives:

After completion of the Module participants will be able -

- To understand the global health impact of climate change
- To understand health Impact of climate change in Bangladesh
- To understand direct and indirect health effect of climate change
- To understand impact on infectious diseases and mental health
- To understand Bangladesh, need to do tackle these Challenges?

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	Health Impact of Climate Change	10 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia , video
2.	Direct and indirect health effect of climate change	30 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia

3.	River erosion	10 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia
4.	Drought	10 m	Brain storming, discussion and visualized presentation	Flip sheets , marker, VIPP board, multimedia
5.	Impact on infectious diseases and mental health	15 m	Brain storming, discussion and visualized presentation	Flip sheets , marker, VIPP board, multimedia
6.	Bangladesh need to do tackle these Challenges?	15 m	Brain storming, discussion and visualized presentation	Flip sheets , marker, VIPP board, multimedia
7.	Sum up	5 m	Q & A and discussion	Interaction with the participants

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about changes in temperature, rainfall & humidity
- Ask the participants to know their ideas about cyclone, water surge, and flood
- Ask the participants to know their ideas about their sea level rise
- Ask the participants to know their ideas about salinity in land and water
- Ask the participants to know their ideas about river erosion
- Ask the participants to know their ideas about drought
- Ask if any question and give answer.
- Summarize and conclude the session.

Note for Facilitator

Global health impact of climate change

- Climate change affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter.
- Between 2030 and 2050, climate change is expected to cause approximately 250 000 additional deaths per year, from malnutrition, malaria, diarrhoea and heat stress.
- The direct damage costs to health (i.e. excluding costs in health-determining sectors such as agriculture and water and sanitation), is estimated to be between USD 2-4 billion/year by 2030.
- Areas with weak health infrastructure – mostly in developing countries – will be the least able to cope without assistance to prepare and respond.
- Reducing emissions of greenhouse gases through better transport, food and energy-use choices can result in improved health, particularly through reduced air pollution[3].

Climate change - Globally biggest health threat facing humanity

- Climate change is the single biggest health threat facing humanity, and health professionals worldwide are already responding to the health harms caused by this unfolding crisis.
- The Intergovernmental Panel on Climate Change (IPCC) has concluded that to avert catastrophic health impacts and prevent millions of climate change-related deaths, the world must limit temperature rise to 1.5°C.
- Past emissions have already made a certain level of global temperature rise and other changes to the climate inevitable.
- Global heating of even 1.5°C is not considered safe, however; every additional tenth of a degree of warming will take a serious toll on people's lives and health[3].

Climate change - Globally biggest health threat facing humanity

Over 930 million people - around 12% of the world's population - spend at least 10% of their household budget to pay for health care. With the poorest people largely uninsured, health shocks and stresses already currently push around 100 million people into poverty every year, with the impacts of climate change worsening this trend[3].

Fact Sheet on climate change[3]

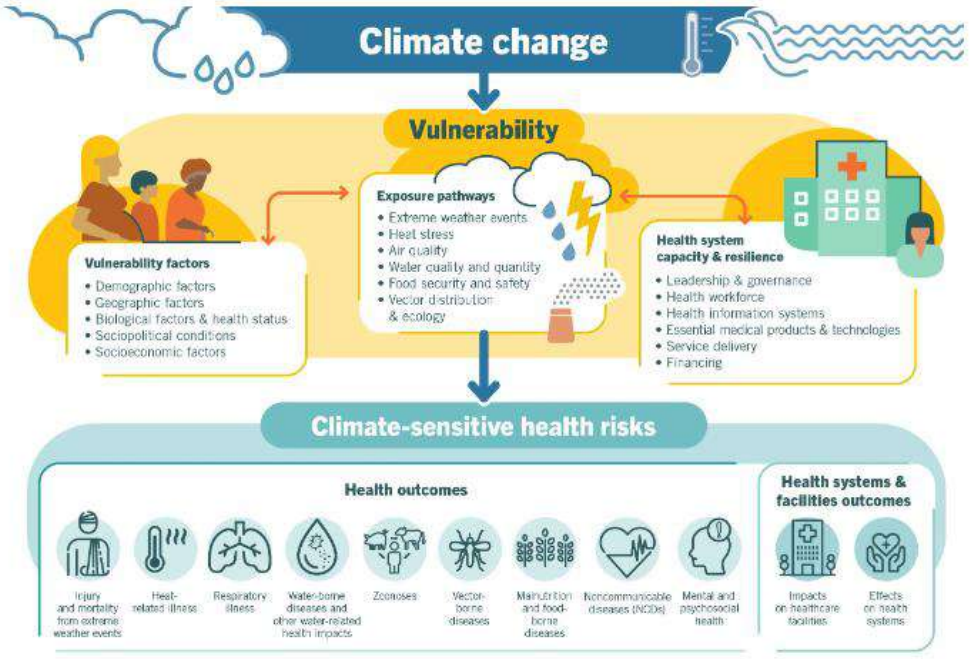


Figure: An overview of climate-sensitive health risks, their exposure pathways and vulnerability factors. Climate change impacts health both directly and indirectly, and is strongly mediated by environmental, social and public health determinants.

Health Impact of Climate Change in Bangladesh:

A change in climatic conditions can have direct and indirect kinds of health impacts in Bangladesh. Direct impacts are caused by weather extremes e.g., impacts of thermal stress, death/injury in cyclones and storms, etc. Indirect impacts can be in two forms: (a) health consequences due to environmental change and ecological disruption that occur in response to climate change; and (b) the diverse health consequences e.g, traumatic, infectious, nutritional, psychological, etc.

Direct Impacts

Climate change can affect human health in numerous ways. Some of the possible direct impacts of climate change on human health in Bangladesh are as below:

The impact of temperature rises and heat waves:

- Heat stress or hypothermia
- Diarrheal diseases
- Cardiovascular and respiratory diseases
- Seasonal peak of "Escherichia coli" diarrhea
- Heat stroke among the rickshaw pullers and the people working in industries has increased in the recent years.
- Rise of temperature can also increase the renal disease and mental disorders especially among the elderly people.
- Organic illnesses, including symptomatic mental disorders; dementia; mood (affective) disorders; neurotic, stress related, and somatoform disorders; disorders of psychological development; and senility.

The impact of frequent natural disasters

Bangladesh is one of the most vulnerable countries of the world to floods and cyclones. Tropical cyclones Storms batter Bangladesh almost every year. It has been projected that climate change will cause more frequent and severe floods, cyclones and droughts in Bangladesh. Increase of extreme weather events will cause more losses of lives. Threatened or actual loss of valued resources due to natural disaster might lead to psychological distress i.e., negative mood, stress-related physical symptoms, and psychological symptoms.

The impact of stagnant weather conditions and air pollution

Stagnant weather conditions can trap both warm air and air pollutants leading to smoke episodes with significant health impacts i.e., cardiovascular, respiratory and allergy diseases including lung infections, asthma, chronic obstructive pulmonary disease, lung cancer, coronary artery disease, heart-rhythm problems.

Indirect Impacts

Indirect impacts of climate change on public health of Bangladesh will be much more severe and diverse compared to direct impacts. Some of the possible indirect impacts are discussed below.

The impact of frequent floods and water-logging

- In Bangladesh enteric infections and infectious diseases are common due to the tropical climate, combined with the existence of large open waterbodies and dense population.
- Directly transmitted infectious diseases are least likely to be influenced by climate change since the agent spends little to no time outside the human host.
- Waterlogging, destruction of freshwater resources and contamination of drinking water wells caused by frequent floods and cyclones may increase the health-related problems such as cholera, diarrhea, malnutrition and skin diseases in Bangladesh.
- According to a government report, flood related diarrheal decease cases and number of death due to diarrhea in Bangladesh have increased in the recent years.
- Cholera outbreaks occur in Bangladesh during the monsoon season. Recent research predicted that the regions of Bangladesh where cholera is merely a seasonal disease can become regular phenomena in future due to the climate change.

The impact of increased breeding of vectors

- Climate change is likely to have important effects on the prevalence of vector borne diseases in Bangladesh.
- Breeding period of mosquitoes may be shifted and prolonged, leading to a possible change in malaria pattern in Bangladesh.
- Global warming would produce more rapid replication of the dengue virus which is a major infectious disease of Bangladesh.
- Japanese encephalitis virus is an emerging cause of encephalitis in Bangladesh. Higher breading of mosquitoes can accelerate the transmission of Japanese encephalitis in Bangladesh.
- Visceral Leishmaniasis (also known as kala azar) cases seem to cluster near flood control embankments. Building more embankments, a likely response to sea-level rise, may favor Visceral Leishmaniasis vectors and result in increasing cases of Visceral Leishmaniasis in Bangladesh.

The impact of sea-level rise

- Sea-level rise due to global warming may cause an increase of salinity in river water as well as in groundwater of Bangladesh.
- Increase salinity in drinking water will increase the risk of diarrhea and skin diseases. Prolonged exposure to water containing salts (TDS > 500 ppm) can cause kidney stone.
- Increased cases of diarrhea and gynecological diseases have been observed in the coastal areas of Bangladesh in a recent study.

- Inland intrusion of salt water may turn former freshwater habitats into salt-marsh areas which could act as a breeding ground of salt-marsh mosquitoes and may in turn increase the vector-borne diseases in the coastal areas of Bangladesh.

The impact of increased recharge in monsoon and groundwater pollution

As more than 95% of drinking water in Bangladesh comes from groundwater, presence of toxic pesticides in groundwater may increase the cases of nervous, reproductive and endocrine systems damages. Specially, children are more susceptible to pesticides as they are still developing and have faster metabolisms.

The impact of increased recharge in monsoon and groundwater pollution

As more than 95% of drinking water in Bangladesh comes from groundwater, presence of toxic pesticides in groundwater may increase the cases of nervous, reproductive and endocrine systems damages. Specially, children are more susceptible to pesticides as they are still developing and have faster metabolisms.

The impact of droughts and lack of water

Lack of clean water due to droughts for drinking, public sanitation and personal hygiene can lead to a wide range of life-threatening diseases

The impact of increased recharge in monsoon and groundwater pollution

As more than 95% of drinking water in Bangladesh comes from groundwater, presence of toxic pesticides in groundwater may increase the cases of nervous, reproductive and endocrine systems damages. Specially, children are more susceptible to pesticides as they are still developing and have faster metabolisms.

The impact of decreased food production and malnutrition

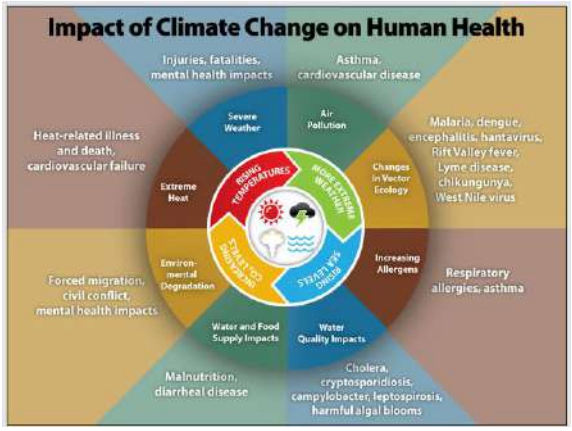
Food production will be reduced due to the elevated temperature. Chronic malnutrition may be caused by shrinking food-grain absorption. Protein-energy deficiency may increase the child death. Deficiencies in micro-nutrients (vitamins and minerals) can also affect mental and physical health.

The impact of hostile conditions

Land inundation due to sea level rise, prolonged water logging in the coast region due to frequent flooding and severe droughts in southwestern Bangladesh can create hostile conditions that may cause extensive damage to already be shrinking food supplies and force many people to become so called 'refugees of climate change' and create diverse health consequences e.g., trauma and psychological stress. Anxiety, depression, suicidal thinking and other psychiatric symptoms are common among the refugees.

VEDIO

Impact



Climate Change in Bangladesh: Impact on Infectious Diseases and Mental Health

Climate change in Bangladesh is not just about cyclones and floods. Changing and erratic weather pattern have also affected our physical and mental health. The climate change in Bangladesh have started to impact health with an increase in respiratory diseases, mosquito-borne diseases like dengue, along with deteriorating mental health conditions[4].

Impact on Physical Health

- **Respiratory illnesses are likely to increase with rising temperature and humidity.**

✓ A 1°C increase in temperature rises the likelihood of contracting a respiratory infection by 5.7 percentage points

- **Waterborne diseases like cholera are likely to decrease with rising humidity and temperature**

✓ 1°C increase in mean temperature reduces the likelihood of respiratory infections by 4.2 percentage points.

- **Dengue is likely to increase for Dhaka as the climatic conditions become more suitable.**

✓ Weather data between 1976 and 2019 indicate Dhaka is experiencing falling humidity levels, rising temperatures, and heavier summer rainfall. These together with factors like urbanization are increasing the risk of the spread of dengue in Dhaka city.

Vedio

Impact on Mental Health

- Changes in weather can cause mood swings. But seasonality have a slightly different impact on anxiety than depression.
- The level of anxiety disorders increases with temperature and humidity. Increase in mean humidity and mean temperature increases the probability of having anxiety by 0.3 percent and 0.8 percent, respectively.
- More people suffer from depression during winter. Increase in temperature lowers the probability of depression by 1.6 percent.
- Further, women are at higher risk than men for depression, while men are more susceptible to anxiety[4].

VEDIO

Bangladesh needs to do tackle these Challenges?

By 2050, Bangladesh is expected to experience an increase in temperature of about 1.5°C. And between 2040 and 2059, annual rainfall is also expected to increase by 74 millimeters. These projected changes will escalate spread of infectious diseases and mental health issues. By taking urgent actions, Bangladesh can remain better prepared to mitigate the impacts of climate change on health.

The world bank report suggests three ways for better adaptation:

- Improved data collection systems will help the country better track the evolution of climate-sensitive diseases and predict potential disease outbreaks.
- Strengthen health systems to preempt and mitigate outbreaks of infectious and other emerging or reemerging climate-sensitive diseases
- Strengthen response to mental health issues through awareness building, improving assessment mechanisms and facilitating means to address shortcomings such as self-help groups[4].

Reading Materials

Health Impact of Climate Change in Bangladesh:

A change in climatic conditions can have direct and indirect kinds of health impacts in Bangladesh. Direct impacts are caused by weather extremes e.g., impacts of thermal stress, death/injury in cyclones and storms, etc. Indirect impacts can be in two forms: (a) health consequences due to environmental change and ecological disruption that occur in response to climate change; and (b) the diverse health consequences e.g, traumatic, infectious, nutritional, psychological, etc., that occur in demoralized and displaced populations in the wake of climate-induced economic dislocation, environmental decline, and conflict situations. Identification of probable impacts of climate change on public health is essential to adopt necessary adaptation strategies in advance. Possible direct and indirect impacts of climate change on public health in Bangladesh are discussed below.

Direct Impacts

Climate change can affect human health in numerous ways. Some of the possible direct impacts of climate change on human health in Bangladesh are described below:

The impact of temperature rises and heat waves:

It can be anticipated that increased temperature will increase heat waves in Bangladesh. It has been observed that prevalence of heat stress or hypothermia, diarrheal diseases, dehydration and aggravation of cardiovascular and respiratory diseases increased during extreme temperatures and heat waves in Bangladesh. The seasonal peak of "Escherichia coli" diarrhea in Bangladesh coincides with the time when food is most contaminated due to higher bacterial growth caused by high temperatures.

The number of non-cholera diarrhea cases in Dhaka increases with higher temperature, particularly in those individuals at a lower socio-economic and sanitation status. Cholera in Bangladesh increases with the increase in sea surface temperature. Therefore, it is very clear that rise of temperature due to global warming is increasing diarrheal diseases in Bangladesh. Another significant impact of rising temperature will be on heat stress or hypothermia specially those living in urban areas. It has been mentioned in a government report that incidence of heat stroke among the Rickshaw pullers and the people working in industries has increased in the recent years.

Rise of temperature can also increase the renal disease and mental disorders especially among the elderly people. Admissions for renal disease and acute renal failure increases during heat waves. As heat waves become more frequent, the burden of renal morbidity may increase in susceptible individuals as an indirect consequence of global warming. Specific illnesses for which admissions increased included organic illnesses, including symptomatic mental disorders; dementia; mood (affective) disorders; neurotic, stress related, and somatoform disorders; disorders of psychological development; and senility.

Rickshaw pullers, the people working in industries and the farmers working in open field are most vulnerable to **heat stroke** due to the rise of temperature. Children and elderly people are at particular risk to the diseases caused by elevated temperatures especially those living in cities because of the effect known as the “urban heat island”.

The impact of frequent natural disasters

Bangladesh is one of the most vulnerable countries of the world to floods and cyclones. Tropical cyclones Storms batter Bangladesh almost every year. It has been projected that climate change will cause more frequent and severe floods, cyclones and droughts in Bangladesh. Increase of extreme weather events will cause more losses of lives. Threatened or actual loss of valued resources due to natural disaster might lead to psychological distress i.e., negative mood, stress-related physical symptoms, and psychological symptoms.

The impact of stagnant weather conditions and air pollution

Air pollution is a major problem in densely populated cities of Bangladesh. Stagnant weather conditions can trap both warm air and air pollutants, leading to smoke episodes with significant health impacts i.e., cardiovascular, respiratory and allergy diseases including lung infections, asthma, chronic obstructive pulmonary disease, lung cancer, coronary artery disease, heart-rhythm problems.

Indirect Impacts

Indirect impacts of climate change on public health of Bangladesh will be much more severe and diverse compared to direct impacts. Some of the possible indirect impacts are discussed below.

The impact of frequent floods and water-logging

In Bangladesh enteric infections and infectious diseases are common due to the tropical climate, combined with the existence of large open water-bodies and dense population. Directly transmitted infectious diseases are least likely to be influenced by climate change since the agent spends little to no time outside the human host. Water-logging, destruction of freshwater resources and contamination of drinking water wells caused by frequent floods and cyclones may increase the health-related problems such as cholera, diarrhea, malnutrition and skin diseases in Bangladesh. River level, above a threshold (4.8 m), is associated with an increase of rotavirus diarrhea in Bangladesh by 5.5% per 10cm river-level rise. According to a government report, flood related diarrheal decease cases and number of death due to diarrhea in Bangladesh have increased in the recent years.

Cholera outbreaks occur in Bangladesh during the monsoon season. Recent research predicted that the regions of Bangladesh where cholera is merely a seasonal disease can become regular phenomena in future due to the climate change.

The impact of increased breeding of vectors

Climate change is likely to have important effects on the prevalence of vector borne diseases in Bangladesh. The Anopheles mosquitoes tend to prefer a temperature range from 24 to 27 degrees Celsius. If the overall temperature rises, their habitat may be reduced. However, at the same time breeding period of mosquitoes may be shifted and prolonged, leading to a possible change in malaria pattern in Bangladesh. Global warming would produce more rapid replication of the dengue virus which is a major infectious disease of Bangladesh. Japanese encephalitis virus is an emerging cause of encephalitis in Bangladesh. Higher breading of mosquitoes can accelerate the transmission of Japanese encephalitis in Bangladesh. Visceral Leishmaniasis (also known as kala azar) cases seem to cluster near flood control embankments. Building more embankments, a likely response to sea-level rise, may favor Visceral Leishmaniasis vectors and result in increasing cases of Visceral Leishmaniasis in Bangladesh.

The impact of sea-level rise

Sea-level rise due to global warming may cause an increase of salinity in river water as well as in groundwater of Bangladesh. Increase salinity in drinking water will increase the risk of diarrhea and skin diseases. Prolonged exposure to water containing salts (TDS > 500 ppm) can cause kidney stone. Increased cases of diarrhea and gynecological diseases have been observed in the coastal areas of Bangladesh in a recent study. Inland intrusion of salt water may turn former freshwater habitats into salt-marsh areas which could act as a breeding ground of salt-marsh mosquitoes and may in turn increase the vector-borne diseases in the coastal areas of Bangladesh.

The impact of increased recharge in monsoon and groundwater pollution

Higher groundwater recharge due to the increased precipitation in monsoon, river flow at higher level and flood may bring the groundwater level near to the surface during monsoon in some parts of Bangladesh. This will make the groundwater more vulnerable to pesticide and fertilizer pollution. Pesticide in groundwater above the prescribed level has already been reported in many parts of Bangladesh. As more than 95% of drinking water in Bangladesh comes from groundwater, presence of toxic pesticides in groundwater may increase the cases of nervous, reproductive and endocrine systems damages. Specially, children are more susceptible to pesticides as they are still developing and have faster metabolisms.

The impact of droughts and lack of water

Lack of clean water due to droughts for drinking, public sanitation and personal hygiene can lead to a wide range of life-threatening diseases.

The impact of decreased food production and malnutrition

Food production will be reduced due to the elevated temperature. Chronic malnutrition may be caused by shrinking food-grain absorption. Protein-energy deficiency may increase the child death. Deficiencies in micro-nutrients (vitamins and minerals) can also affect mental and physical health.

The impact of hostile conditions

Land inundation due to sea level rise, prolonged water logging in the coast region due to frequent flooding and severe droughts in southwestern Bangladesh can create hostile conditions that may cause extensive damage to already be shrinking food supplies and force many people to become so called ‘refugees of climate change’ and create diverse health consequences e.g., trauma and psychological stress. Anxiety, depression, suicidal thinking and other psychiatric symptoms are common among the refugees.

Health impact of climate change

The health impacts of climate change are diverse and exerted through multiple pathways. Examples of the **direct** impacts include extreme ***weather events***, while **indirect** effects involve ***quality of water and air***. Population density and gender roles act as mediators of these effects on local population.

Direct Impacts

People are exposed directly to changing weather patterns (temperature, precipitation, sea-level rise and more frequent extreme events)

Indirect Impacts

People are exposed indirectly through changes in the quality of water, air and food, and changes in ecosystems, agriculture, industry, human settlements and the economy.

These direct and indirect exposures can cause death, disability and suffering. Health problems increase vulnerability and reduce the capacity of individuals and groups to adapt to climate change.

Climate change and human health exposure

Human health is exposed to below conditions –

- Regional weather change
- Heat waves
- Extreme weather
- Temperature
- Precipitation
- Sea-level rise
- Salinity intrusion

Being exposed caused health effects are –

- Temperature-related illness and death
- Extreme weather-related health effects
- Air pollution-related health effects
- Water/foodborne diseases
- Vector-borne and rodent borne diseases
- Effects on food and water shortage
- Mental, nutritional, infectious and other health effects

Health problem interlinked with water supply, sanitation and food production:

This has been seen that diarrhoea and dysentery is on the rise especially during the summer months. It has been predicted that the combination of higher temperatures and potential increase in summer precipitation may cause the spread of many infectious diseases [Ministry of Environment and Forests (MoEF), Bangladesh].

Climate change also brings about additional stresses like dehydration, malnutrition and heat-related morbidity especially among children and the elderly.

Module: 04 Extreme weather

Time: 45 m

Objectives:

After completion of the Module participants will be able -

- To understand the extreme weather in South- Asia
- To understand the health risks from extreme weather in Bangladesh
- To understand health risk from extreme weather in Bangladesh

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	Extreme weather in South- Asia	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, video
2.	Health risks from extreme weather in Bangladesh	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia
3.	Sum up	5 m	Q & A and discussion	Interaction with the trainee

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about Extreme weather in South- Asia
- Ask the participants to know their ideas about health risks from extreme weather in Bangladesh

- Ask if any question and give answer.
- Summarize and conclude the session.

Note for Facilitator

Extreme weather in South Asia

South Asia is home to over 600 million children and has the highest number of young people globally. South Asian countries are among the most vulnerable globally to the impacts of climate change. Extreme climate-related events - heatwaves, storms, floods, fires and droughts - affect more than half of the region's population every year and continue to burden South Asian countries' economies. Rising global temperatures and changing weather patterns have put the futures of particularly millions of children living in climate-vulnerable areas in South Asia at constant risk[5].

- ***Temperatures****:* Asia had its warmest year on record in 2020, with the mean temperature 1.39 °C above the 1981–2010 average.
- ***Precipitation:*** The East Asian and South Asian summer monsoons were both unusually active, This, combined with frequent tropical cyclones, caused floods and landslides, leading to loss of life and displacement in many countries.
- ***Ocean warmth:*** Sea-surface temperature changes and ocean heat directly affect the ocean-atmosphere coupling and thus regional and global circulation, as well as marine life.
- ***Sea level:*** Global average sea level has risen at a rate of 3.3 mm per year since the early 1990s[5].

Agriculture and food security:

Progress on food security and nutrition has slowed down. In 2020, 48.8 million people in South-East Asia and 305.7 million in South Asia are estimated to have been undernourished. Asia accounts for more than half of the global total. The number of undernourished people in 2020 increased by 6% in South-East Asia and West Asia, and by 20% in South Asia. Climate-related disasters compounded the problem.

Impact on children health:

Pakistan, Bangladesh, Afghanistan and India are among four South Asian countries where children are at extremely high risk of the impacts of the climate crisis. Together, climate change and the COVID-19 pandemic have created an alarming crisis for South Asian children. South Asian children are in constant danger from riverine floods and air pollution, but also that investments in child health, nutrition, and education can make a significant difference to protect children from climate change.

Extreme Weather in Bangladesh

These extreme weather events are expected to be exacerbated by the effects of climate change in Bangladesh (Rahman et al. 2019). These are as follows.

- Including increasing temperature and heat stress
- More frequent and longer droughts
- Increasing rainfall intensity
- Higher river flows and flood risks
- Greater riverbank erosion
- Sea level rises and salinity intrusion
- landslides
- Increasing intensity of cyclones
- Storm surges and
- Coastal flooding (Government of Bangladesh 2018).

Extreme Weather in Bangladesh

Hazards are exacerbated by high population density, poverty, rural–urban migration, illiteracy, and a lack of public utilities and services (Rabbani et al. 2011). Rapid urbanization and a growing urban slum population are quickly changing the population dynamics in

Bangladesh, and this has implications for climate-induced health risks (Mani and Wang 2014).

Extreme Weather in Bangladesh

The country has the world's highest rate of mortalities that are caused by natural disasters, with more than half a million people lost to disaster events since 1970. Most of these deaths have occurred during floods or cyclones (Nahar 2014). Not long ago, Bangladesh was hit by two major cyclones: Sidr in 2007 and Aila in 2009. Cyclone Sidr killed 3,406 people while more than 55,000 sustained physical injuries.

Extreme Weather in Bangladesh

Heavy rain and tidal waves caused by wind effects led to extensive physical destruction and damage to crops and livestock. After Cyclone Sidr, an assessment by the Government of Bangladesh found widespread outbreaks of diarrhea, dysentery, acute respiratory infection, and pneumonia. Children ages five or younger were the most vulnerable (Kabir et al. 2016b).

Reading Materials

Health risks from extreme weather

Extreme weather events are occurrences of unusually severe weather or climate conditions that can cause devastating impacts on communities and agricultural and natural ecosystems. For Bangladesh the extreme weather events are usually cyclone, heavy rainfall, flooding and heat waves, cold waves are also an alarming catastrophe. Furthermore, according to global climate report 2021, Bangladesh is seventh among the 10 countries worst hit by extreme weather events.

Loss of internal temperature control can result in various illnesses, including **heat cramps, heat exhaustion, heatstroke** and **hyperthermia** from extreme heat events. Some existing health threats will intensify, and new health threats will emerge. Not everyone is equally at risk. Important considerations include **age, economic resources** and **location**.

Above all due to extreme weather most affected resource is water. Salinity intrusion is affecting people largely and consuming this salty, contaminated water can expose populations to health problems like **cardiovascular diseases**. But health risks due to climate change is actually dynamic and interlinked. For example:

- Cyclone and coastal storms generate projectiles and debris that can cause injury during the event. They can also increase the potential for hazardous chemicals and waterborne and vector-borne pathogens to spread through communities and the environment.
- Flood and sea level rise can contaminate water with harmful bacteria and viruses that cause foodborne and waterborne illnesses.
- When floodwaters recede from indoor spaces, there is increased risk of mold growth and impacted or poor indoor air quality. Exposure to mold spores can cause headaches and eye, nose, and throat irritation. Mold exposure can worsen lung diseases, such as asthma, and increase the risk for lung infection in immunocompromised individuals.
- Extreme heat can lead to exhaustion, heat cramps, heat stroke, and heat-related death. People with chronic lung or heart illnesses or other conditions are at greater risk of heat-related complications or death.
- Gastrointestinal illness like diarrhea, effects on the body's nervous and respiratory systems, or liver and kidney damage

Extreme weather in South Asia

South Asia is home to over 600 million children and has the highest number of young people globally. South Asian countries are among the most vulnerable globally to the impacts of climate change. Extreme climate-related events - heatwaves, storms, floods, fires and droughts - affect more than half of the region's population every year and continue to burden South Asian countries' economies. Rising global temperatures and changing weather patterns have put the futures of particularly millions of children living in climate-vulnerable areas in South Asia at constant risk[5]. Worse, before they can recover from one disaster, another one strikes, reversing any progress made[5].

***Temperatures**:* Asia had its warmest year on record in 2020, with the mean temperature 1.39 °C above the 1981–2010 average.

Precipitation: The East Asian and South Asian summer monsoons were both unusually active, This, combined with frequent tropical cyclones, caused floods and landslides, leading to loss of life and displacement in many countries.

Ocean warmth: Sea-surface temperature changes and ocean heat directly affect the ocean-atmosphere coupling and thus regional and global circulation, as well as marine life.

Sea level: Global average sea level has risen at a rate of 3.3 mm per year since the early 1990s.

Displacement: Intense cyclones, monsoon rains and floods hit highly exposed and densely populated areas in South Asia and East Asia and led to the displacement of millions of people in China, Bangladesh, Ind Cyclone *Amphan,* one of the strongest cyclones ever recorded, hit the Sundarbans region between India and Bangladesh in May 2020 displacing 2.4 million people in India and 2.5 million people in Bangladesh.

Many weather and climate-related displacements in Asia are prolonged, with people unable to return home, integrate locally or settle elsewhere.

Agriculture and food security: Progress on food security and nutrition has slowed down. In 2020, 48.8 million people in South-East Asia and 305.7 million in South Asia are estimated to have been undernourished. Asia accounts for more than half of the global total.

The true impacts of COVID-19 on food security and nutrition are yet to be established. But compared with 2019, the number of undernourished people in 2020 increased by 6% in South-East Asia and West Asia, and by 20% in South Asia. Climate-related disasters compounded the problem.

Impact on children health: Pakistan, Bangladesh, Afghanistan and India are among four South Asian countries where children are at extremely high risk of the impacts of the climate crisis. Droughts, floods, air pollution and river erosion across the region have left millions of children homeless and hungry, and without any healthcare and water. Together, climate change and the COVID-19 pandemic have created an alarming crisis for South Asian children. South Asian children are in constant danger from riverine floods and air pollution, but also that investments in child health, nutrition, and education can make a significant difference to protect children from climate change.

These extreme weather events are expected to be exacerbated by the effects of climate change in Bangladesh (Rahman et al. 2019). These are as follows;

- Including increasing temperature and heat stress
- More frequent and longer droughts
- Increasing rainfall intensity
- Higher river flows and flood risks
- Greater riverbank erosion
- Sea level rises and salinity intrusion
- landslides

- Increasing intensity of cyclones
- Storm surges and
- Coastal flooding (Government of Bangladesh 2018).

The country has the world's highest rate of mortalities that are caused by natural disasters, with more than half a million people lost to disaster events since 1970. Most of these deaths have occurred during floods or cyclones (Nahar 2014). Not long ago, Bangladesh was hit by two major cyclones: Sidr in 2007 and Aila in 2009. Cyclone Sidr killed 3,406 people while more than 55,000 sustained physical injuries.

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Heavy rain and tidal waves caused by wind effects led to extensive physical destruction and damage to crops and livestock. After Cyclone Sidr, an assessment by the Government of Bangladesh found widespread outbreaks of diarrhea, dysentery, acute respiratory infection, and pneumonia. Children ages five or younger were the most vulnerable (Kabir et al. 2016b).

Module: 05 Vector-borne diseases and climate change

Time: 90 m

Objectives:

After completion of the Module participants will be able -

- To understand what is vector and key facts of vector borne diseases
- To understand the vector borne diseases in Bangladesh
- To understand the impact of climate change on vector borne diseases
- To understand Vector borne diseases and Bangladesh need to do

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	What is vector and key facts of vector borne diseases	25 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, video
2.	Vector borne diseases in Bangladesh	25 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
3.	Vector borne diseases Bangladesh need to do	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
4.	Sum up	5 m	Q & A and discussion	Interaction with the participants

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.

- Ask the participants to know their ideas about vector and key facts of vector borne diseases
- Ask the participants to know their ideas about vector borne diseases in Bangladesh
- Ask the participants to know their ideas about impact of climate change on vector borne diseases in Bangladesh
- Ask the participants to know their ideas vector borne disses and Bangladesh need to do
- Ask if any question and give answer
- Summarize and conclude the session.

Note for Facilitator

Vectors:

Vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans. Many of these vectors are bloodsucking insects, which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later transmit it into a new host, after the pathogen has replicated. Often, once a vector becomes infectious, they are capable of transmitting the pathogen for the rest of their life during each subsequent bite/blood meal.

Introduction to Vector-borne diseases (VBD)

Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors.

Key facts

- Vector-borne diseases account for more than 17% of all infectious diseases, causing more than 700 000 deaths annually. They can be caused by either parasites, bacteria or viruses.
- Malaria is a parasitic infection transmitted by Anopheline mosquitoes. It causes an estimated 219 million cases globally, and results in more than 400,000 deaths every year. Most of the deaths occur in children under the age of 5 years.

- Dengue is the most prevalent viral infection transmitted by Aedes mosquitoes. More than 3.9 billion people in over 129 countries are at risk of contracting dengue, with an estimated 96 million symptomatic cases and an estimated 40,000 deaths every year.
- Many of vector-borne diseases are preventable, through protective measures, and community mobilization[6].

Vector-borne diseases

Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors. Every year there are more than 700,000 deaths from diseases such as malaria, dengue, schistosomiasis, human African trypanosomiasis, leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis and onchocerciasis[6].

Vector-borne diseases

At the beginning of the 21st century, vector-borne diseases still cause a severe threat to human health. Out of about 11 million annual deaths to infectious diseases (about 19% of total annual deaths), 1.43 million can be attributed to vector-borne diseases (including malaria, trypanosomiasis, chagas disease, leishmaniasis, lymphatic filariasis, onchocerciasis, dengue and Japanese encephalitis)[7].

Vector-borne diseases

Among these, 1.30 million are caused by mosquito-borne diseases (WHO, 2004). The leader of this deadly procession is malaria, with an annual death levy of 1.27 million (WHO, 2004). Important mortality is also caused by trypanosomiasis (around 51000 deaths per year), leishmaniasis (around 51000 deaths) and dengue (19000 deaths) (WHO, 2004).

Vector-borne diseases

A study showed that at least 3000 million people of all tropical countries are exposed to the risk of dengue while 2400 million tropics and subtropics are at risk of malaria (IPCC, 2001; Githeko and Woodward, 2003).

Effect of climate change on Vector-borne diseases

Climate change increasing the potential for transmission of vector borne disease and hindering the future control of disease. Vector-borne diseases (VBD) are infections transmitted by the bite of infected arthropod species, such as mosquitoes, ticks, bugs, sand-flies and black-flies.

Distribution of vector-borne diseases is determined by a complex set of demographic, environmental and social factors. **List of vector-borne diseases, according to their vector**

Vector		**Disease caused**	**Type of pathogen**
Mosquito	*Aedes*	Chikungunya Dengue Lymphatic filariasis Zika	Virus Virus Parasite Virus
	Anopheles	Lymphatic filariasis Malaria	Parasite Parasite
	Culex	Japanese encephalitis Lymphatic filariasis	Virus Parasite
Fleas		Plague (transmitted from rats to humans) Tungiasis	Bacteria Ectoparasite
Lice		Typhus Louse-borne relapsing fever	Bacteria Bacteria
Sandflies		Leishmaniasis Sandfly fever (phlebotomus fever)	Parasite Virus

	Ticks	Crimean-Congo haemorrhagic fever Lyme disease Relapsing fever (borreliosis) Rickettsial diseases (eg: spotted fever and Q fever) Tick-borne encephalitis Tularaemia	Virus Bacteria Bacteria Bacteria Virus Bacteria

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Effect of climate change on Vector-borne diseases

Climate directly influences the development of vector of malaria-dengue. Climate also has an indirect effect on malaria-dengue through its influence on suitable vegetation and vector breeding sites. Precipitation is important because mosquitoes require water to lay their eggs, as well as for the subsequent development of larvae. Projections indicate that, in the future, malaria is most likely to extend its range into the extremes of established endemic areas.

Effect of climate change on Vector-borne diseases

Number of water and food-borne parasitic infections, as well. Overall, increased precipitation is associated with increased burdens of disease for bacteria, viruses, and parasites, though the causes of these increases differ by pathogen and ecologic setting. Rahman (2008)[1]

Effect of climate change on Vector-borne diseases

Other vector-borne diseases in Bangladesh are also likely to be affected by climatic shifts. For instance, increases in mean temperatures may provide a better breeding environment for sand flies that transmit Visceral Leishmaniasis (Kala-azar) (Hossain et al., 2011).

Effect of climate change on Vector-borne diseases

In the South-East Asian Region, kala-azar occurs in India, Bangladesh, and Nepal with a small focus reported in Bhutan. In this region about 200 million people are “at risk.” Fifty-two districts in India, 12 in Nepal, and 45 in Bangladesh are endemic.

Effect of climate change on Vector-borne diseases

Environmental changes often modify the transmission patterns of vector-borne diseases. Increases in temperature due to climate change provide a better breeding environment for vectors, including the sand fly, in places where temperatures were previously below optimum, and so, a higher rate of human VL infection may result[6].

Effect of climate change on Vector-borne diseases

By 2100 it is estimated that average global temperatures will have risen by 1.0-3.5 degrees C, increasing the likelihood of many vector-borne diseases in new areas. The greatest effect of climate change on transmission is likely to be observed at the extremes of the range of temperatures at which transmission occurs.

Effect of climate change on Vector-borne diseases

Kala-azar or visceral leishmaniasis (VL) is a parasitic disease caused by Leishmania donovani. Environmental changes often modify the transmission patterns of vector-borne diseases. Increases in temperature due to climate change provide a better breeding environment for vectors, including the sand fly, in places where temperatures were previously below optimum, and so, a higher rate of human VL infection may result.

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Vector-borne diseases

The burden of these diseases is highest in tropical and subtropical areas, and they disproportionately affect the poorest populations. Since 2014, major outbreaks of dengue, malaria, chikungunya, yellow fever and Zika have afflicted populations, claimed lives, and overwhelmed health systems in many countries. Other diseases such as Chikungunya, leishmaniasis and lymphatic filariasis cause chronic suffering, life-long morbidity, disability and occasional stigmatisation.

Vector-borne diseases

As vectorborne diseases are highly susceptible to environmental conditions, it would therefore appear they are likely to respond rapidly to a change in climate (Confalonieri et al., 2007). If the public health infrastructure does not anticipate the effects of climate change on infectious diseases, millions of people could die. Climate change is a global issue and must be dealt with before things go irreversibly wrong.

Vector-borne diseases

Even if we were certain about future local climates, there is still uncertainty over what impact these climates would have on health. A little research had been done on the impact of climate change on vector-borne disease risk and governance system in Bangladesh to minimize this impact.

Vector-borne diseases: Bangladesh need to do.

Bangladesh government is determined to combat vector borne diseases, which is reflected through various programs undertaken by the Ministry of Health and Family Planning. WHO plays an important role in this in this programs. Therefore future attempts should be taken to explore a more specific model to predict effect of climate change (temperature, humidity and rainfall) on these vector borne diseases –

- To ensure complete management of the diseases and outbreaks for reducing mortality rate and prevention at national, district and upazilla level
- To implement integrated vector management program
- To develop a strong national public health system able to maintain public health events.

Vector-borne diseases: Bangladesh need to do.

For effective vector-borne diseases control we must work together to raise awareness about the threat posed by vector-borne diseases and to formulate evidence-based strategies and policies to prevent vector borne diseases.

WHO supports developing countries in the confirmation of outbreaks through its collaborating network of laboratories. The collaborating networks in Bangladesh are ICDDR,B, BIRDEM and NIPSOM. Bangladesh government should launch healthcare programs in collaboration with international organizations such as WHO, ADB, Unicef, NGOs etc. to successfully complete the aforementioned tasks.

Reading Materials

Introduction to Vector-borne diseases (VBD)

Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors.

Key facts

- Vector-borne diseases account for more than 17% of all infectious diseases, causing more than 700 000 deaths annually. They can be caused by either parasites, bacteria or viruses.
- Malaria is a parasitic infection transmitted by Anopheline mosquitoes. It causes an estimated 219 million cases globally, and results in more than 400,000 deaths every year. Most of the deaths occur in children under the age of 5 years.
- Dengue is the most prevalent viral infection transmitted by Aedes mosquitoes. More than 3.9 billion people in over 129 countries are at risk of contracting dengue, with an estimated 96 million symptomatic cases and an estimated 40,000 deaths every year.
- Many of vector-borne diseases are preventable, through protective measures, and community mobilization.

Vectors

Vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans. Many of these vectors are bloodsucking insects, which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later transmit it into a new host, after the pathogen has replicated. Often, once a vector becomes infectious, they are capable of transmitting the pathogen for the rest of their life during each subsequent bite/blood meal.

Vector-borne diseases

Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors. Every year there are more than 700,000 deaths from diseases such as malaria, dengue, schistosomiasis, human African trypanosomiasis, leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis and onchocerciasis.

The burden of these diseases is highest in tropical and subtropical areas, and they disproportionately affect the poorest populations. Since 2014, major outbreaks of dengue, malaria, chikungunya, yellow fever and Zika have afflicted populations, claimed lives, and overwhelmed health systems in many countries. Other diseases such as Chikungunya,

leishmaniasis and lymphatic filariasis cause chronic suffering, life-long morbidity, disability and occasional stigmatisation.

Distribution of vector-borne diseases is determined by a complex set of demographic, environmental and social factors.

List of vector-borne diseases, according to their vector

The following table is a non-exhaustive list of vector-borne disease, ordered according to the vector by which it is transmitted. The list also illustrates the type of pathogen that causes the disease in humans.

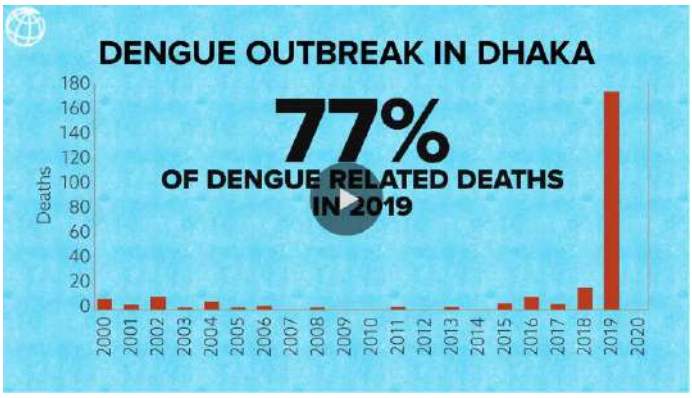
Vector		**Disease caused**	**Type of pathogen**
Mosquito	*Aedes*	Chikungunya Dengue Lymphatic filariasis Yellow Fever Zika	Virus Virus Parasite Virus Virus
	Anopheles	Lymphatic filariasis Malaria	Parasite Parasite
	Culex	Japanese encephalitis Lymphatic filariasis West Nile fever	Virus Parasite Virus
Aquatic snails		Schistosomiasis (bilharziasis)	Parasite
Blackflies		Onchocerciasis (river blindness)	Parasite
Fleas		Plague (transmitted from rats to humans) Tungiasis	Bacteria Ectoparasite
Lice		Typhus Louse-borne relapsing fever	Bacteria Bacteria
Sandflies		Leishmaniasis Sandfly fever (phlebotomus fever)	Parasite Virus

Ticks	Crimean-Congo haemorrhagic fever Lyme disease Relapsing fever (borreliosis) Rickettsial diseases (eg: spotted fever and Q fever) Tick-borne encephalitis Tularaemia	Virus Bacteria Bacteria Bacteria Virus Bacteria
Triatome bugs	Chagas disease (American trypanosomiasis)	Parasite
Tsetse flies	Sleeping sickness (African trypanosomiasis)	Parasite

Effect of climate change on Vector-borne diseases

By 2100 it is estimated that average global temperatures will have risen by 1.0-3.5 degrees C, increasing the likelihood of many vector-borne diseases in new areas. The greatest effect of climate change on transmission is likely to be observed at the extremes of the range of temperatures at which transmission occurs.

Being a low-lying river delta with a long coastline and floodplains that occupy 80 percent of the country, Bangladesh's extreme vulnerability to the adverse effects of climate change is well documented. But climate change in Bangladesh is not just about cyclones and floods. Changing and erratic weather pattern have also affected our physical and mental health. The climate change in Bangladesh have started to impact health with an increase in respiratory diseases, mosquito-borne diseases like dengue, along with deteriorating mental health conditions.



https://drive.google.com/file/d/1T_6-__DnyxaKjq8EF_FQBC9F1ePE3YvF/view?usp=sharing

Wide scale change in ecology may occur due to warm climate that may affect the disease pattern. Climate change may have an effect on health in three major ways; by creating conditions conducive to outbreaks of infectious diseases; increasing the potential for transmission of vector borne disease and hindering the future control of disease. Vector-borne diseases (VBD) are

infections transmitted by the bite of infected arthropod species, such as mosquitoes, ticks, bugs, sand-flies and black-flies.

Climate directly influences the development of vector of malaria-dengue. Climate also has an indirect effect on malaria-dengue through its influence on suitable vegetation and vector breeding sites. Precipitation is important because mosquitoes require water to lay their eggs, as well as for the subsequent development of larvae. Projections indicate that, in the future, malaria is most likely to extend its range into the fringes of established endemic areas. It is also reported that the intensity and extent of malaria's potential transmission would change significantly.

number of water and food-borne parasitic infections, as well. Overall, increased precipitation is associated with increased burdens of disease for bacteria, viruses, and parasites, though the causes of these increases differ by pathogen and ecologic setting. Rahman (2008)[1] reported that changes in precipitation patterns are likely to compromise the supply of safe water, thus increasing the risk of waterborne diseases. They are also associated with floods and water logging that increase the incidence of diarrhea, cholera and skin and eye diseases.

Other vector-borne diseases in Bangladesh are also likely to be affected by climatic shifts. For instance, increases in mean temperatures may provide a better breeding environment for sand flies that transmit Visceral Leishmaniasis (Kala-azar) (Hossain et al., 2011).

Kala-azar or visceral leishmaniasis (VL) is a parasitic disease caused by Leishmania donovani. On the Indian subcontinent, it is transmitted by the sand fly, Phlebotomus argentipes. Kala-azar is found in about 88 tropical and sub-tropical countries with approximately 350 million people living in affected areas and at risk of infection. About 500,000 cases occur annually. More than 90% of the world's VL cases are in India, Bangladesh, Nepal, Sudan, and Brazil, affecting largely the socially marginalized and the poorest communities. In the South-East Asian Region, kala-azar occurs in India, Bangladesh, and Nepal with a small focus reported in Bhutan. In this region about 200 million people are "at risk." Fifty-two districts in India, 12 in Nepal, and 45 in Bangladesh are endemic. Most of the SEAR countries are vulnerable to the consequences of climate change. The ultimate effects of climate change are increased flooding, the breakdown of sanitation systems, increased salinity, more vector growth, and more water- and food-borne diseases, which ultimately impact human health. Environmental changes often modify the transmission patterns of vector-borne diseases. Increases in temperature due to climate change provide a better breeding environment for vectors, including the sand fly, in places where temperatures were previously below optimum, and so, a higher rate of human VL infection may result.

(Hossain et al., 2011). Kala Azar in South Asia: Current status and challenges ahead. n book: Kala Azar in South Asia (pp.127-137)

Adaptation is a form of risk management. Risk is sometimes defined as the likelihood of an event's occurrence multiplied by a measure of its consequences for human and natural systems. But because the probabilities and consequences of climate change threats are often not known with precision, and because different people often value the same consequences differently, it is useful to define risk more broadly as "the potential for adverse consequences when something of value is at stake, and the outcome is uncertain."7 Risk arises from the combination of exposure to climate hazards, sensitivity to those hazards, and adaptive capacity. Adaptation can, however, provide significant societal benefits, reducing by more than half the cost of climate impacts in some sectors *(*Ch. 29: Mitigation*)*.8

Adaptation involves managing both short- and long-term risks. Many important climate-influenced effects—storm intensity, sea level, frequency of heat waves—have already changed due to past greenhouse gas (GHG) emissions and will continue to change in the decades ahead.3,4 Because several GHGs, in particular carbon dioxide, reside in the atmosphere for decades or longer, many climate-influenced effects are projected to continue changing through 2050, even if GHG emissions were to stop immediately. Thus, climate risk management requires adaptation for the next several decades, independent of the extent of GHG emission reductions. After 2050, the magnitude of changes, and thus the demands on adaptation, begins to depend strongly on the scale of GHG emissions reduction today and over the coming decades.4,9

Introduction Climate Change and Vector-Borne Diseases in Bangladesh Page 2 attributed to climate change (IPCC, 2007). The consequences of climate change to health are both direct and indirect with some being already experienced and others yet to come. Climate change is likely to have various effects on health, including changes in distribution and seasonal transmission of vector-borne diseases (McMichael and Githeko, 2001).

Vector-borne diseases are infectious diseases spread by intermediate organisms, such as insects and snails that transmit viruses, parasites and bacteria to human .they are most commonly found in tropical areas and places where access to safe drinking-water and sanitation systems is problematic.

At the beginning of the 21st century, vector-borne diseases still cause a severe threat to human health. Out of about 11 million annual deaths to infectious diseases (about 19% of total annual deaths), 1.43 million can be attributed to vector-borne diseases (including malaria, trypanosomiasis, chagas disease, leishmaniasis, lymphatic filariasis, onchocerciasis, dengue and Japanese encephalitis).

Among these, 1.30 million are caused by mosquito-borne diseases (WHO, 2004). The leader of this deadly procession is malaria, with an annual death levy of 1.27 million (WHO, 2004). Important mortality is also caused by trypanosomiasis (around 51000 deaths per year), leishmaniasis (around 51000 deaths) and dengue (19000 deaths) (WHO, 2004).

A study showed that at least 3000 million people of all tropical countries are exposed to the risk of dengue while 2400 million tropics and subtropics are at risk of malaria (IPCC, 2001; Githeko and Woodward, 2003).

One concern to human health in the future is the potential for an increase in the incidence and intensity of the transmission of some vector-borne diseases (Confalonieri et al., 2007). According to IPCC (2001), global warming would cause increase of vector borne and water borne diseases in the tropics (IPCC, 2001). The spread of diseases by insect vectors is influenced both directly and indirectly by a range of environmental variables in a variety of different ways and these effects can be either immediate or act in a cumulative way. Development rates, activity levels and survival of individual insects and timing of emergence, distributions, abundance levels and migrations of populations are determined to differing, but often very significant, extents by weather and climate (Martens et al., 1995; Chan et al., 1999; Sutherst, 2004). The pathogen spread by the vector is itself also regulated by climate, generally reproducing at a faster rate under warmer conditions (Mellor, 2000).

The effect of temperature on the duration of the sporogonic cycle of the malaria parasite and vector survival is mostly important (Tanser et al., 2003). Precipitation changes are also known to affect the reproduction, development, behavior, and population dynamics of arthropod

Chapter 1 Introduction Climate Change and Vector-Borne Diseases in Bangladesh Page 3 vectors, their pathogens, and non-human vertebrate reservoirs (Gage et al., 2008).

As vectorborne diseases are highly susceptible to environmental conditions, it would therefore appear they are likely to respond rapidly to a change in climate (Confalonieri et al., 2007). If the public health infrastructure does not anticipate the effects of climate change on infectious diseases, millions of people could die. Climate change is a global issue and must be dealt with before things go irreversibly wrong.

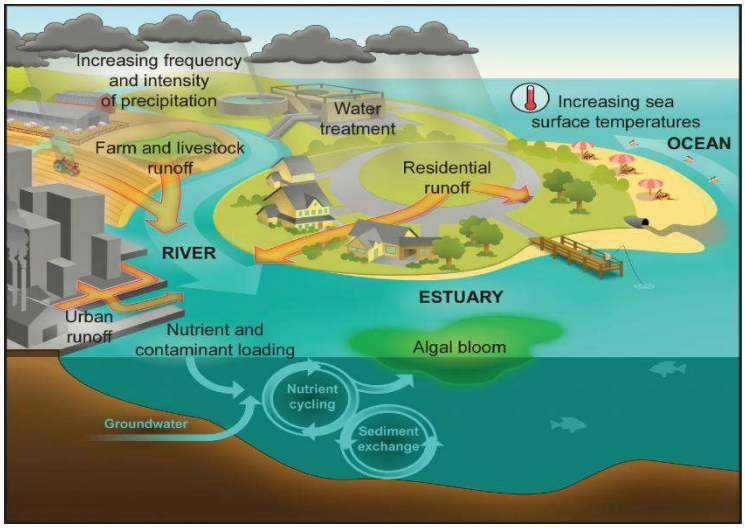
There were some researches and studies on climate change and its impacts in Bangladesh at different times by both government and nongovernment organizations/institutions. But research on the impacts of climate change on human health in Bangladesh has not gained much focus and is still far from certain. In part, this uncertainty reflects difficulties in predicting the local effects of global changes in climate on human health.

Even if we were certain about future local climates, there is still uncertainty over what impact these climates would have on health. A little research had been done on the impact of climate change on vector-borne disease risk and governance system in Bangladesh to minimize this impact.

The focus of this study is to determine the possible link between climate change and vector borne disease, and to find out possible governance system for the minimization of vector borne diseases due to climate change in Bangladesh.

Rahman, A. (2008)[1]. Climate change and its impact on health in Bangladesh. Regional Health Forum. Volume 12, Number 1. Pp. 16-26.

Module: 06 Water-borne diseases and climate change



Time: 90 m

Objectives:

- To understand what is vector and key facts of vector borne diseases
- To understand the vector borne diseases in Bangladesh
- To understand the impact of climate change on vector borne diseases
- To understand Vector borne diseases and Bangladesh need to do

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	What is vector and key facts of vector borne diseases	25 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, video
2.	Vector borne diseases in Bangladesh	25 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
3.	Vector borne diseases Bangladesh need to do	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
4.	Sum up	5 m	Q & A and discussion	Interaction with the participants

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about vector and key facts of vector borne diseases

- Ask the participants to know their ideas about vector borne diseases in Bangladesh
- Ask the participants to know their ideas about impact of climate change on vector borne diseases in Bangladesh
- Ask the participants to know their ideas vector borne disses and Bangladesh need to do
- Ask if any question and give answer
- Summarize and conclude the session.

Note for facilitators

Water-borne diseases

Water-borne diseases are caused by water that is contaminated with microorganisms. The microbes—typically bacteria, viruses, protozoa, and parasites—are usually found in the intestinal tracts of humans and other creatures. In most cases, the water becomes contaminated by feces that carry the microbes.

Water-borne diseases

Over 1 billion people worldwide do not have access to safe drinking water, and 3.4 million people die each year due to water-borne diseases, according to the World Health Organization (WHO).

Indeed, water-borne diseases are the most common cause of disease and death in the world, according to the WHO.

Water-borne diseases

As noted above, water-borne diseases are caused by a wide range of pathogens, including

- Bacteria
- Viruses
- Parasites, and
- Protozoa.

Examples of bacteria that are important water-borne pathogenic organisms include

- *Vibrio cholerae* (the bacteria that causes cholera),
- Various species *Campylobacter*, *Salmonella*, *Shigella and*
- A type of *Escherichia coli* designated O157:H7.

Water-borne diseases

Amebiasis is a common water-borne disease that is caused by the parasite Entamoeba histolytica. This parasite is normally found in feces and can cause disease when fecal-contaminated water is consumed. About one of every 10 people who consume E. histolytica—which translates to millions of people worldwide—becomes ill.

Effect of climate on Water-borne diseases:

Climate change is making heavy intense downpours, droughts and rising water temperatures more common. This can alter the quality of our drinking and recreational water. Bacteria and viruses thrive in these new conditions and when they come into contact with humans, can cause numerous illnesses.

Effect of climate on Water-borne diseases:

Climate change increases the frequency and intensity of heavy rainfall. This leads to runoff and to flooding, especially in river and coastal areas. Drinking water can be contaminated by chemicals, gasoline, coal ash, sewage and more.

- Extreme precipitation events have been linked to increased levels of pathogens in treated drinking water, and cases of gastrointestinal illness in children.
- Groundwater wells receive limited water treatment. This makes them more susceptible to water contamination from extreme precipitation events and increases the risk of waterborne illnesses in those who consume it.

Flooding and Runoff Contaminate Water

Contamination of drinking water by bacteria, viruses, and protozoa can trigger outbreaks of illnesses such as the diarrheal diseases legionella, campylobacter, and cholera
When precipitation falls as more intense storms or as hurricanes that can cause flooding and jeopardize water quality.

- In rural areas, water runoff picks up animal wastes, pesticides, and fertilizers.
- In cities, runoff both carries pollutants and overwhelms sewage systems, causing untreated sewage to flow into drinking and recreational water source.

Climate Change-Induced Water-Related Diseases in Bangladesh

Waterborne diseases are already responsible for 24% of all deaths (Reid and Sims 2007). Increased unavailability of freshwater forces people to drink contaminated water leading to dysentery, diarrhea, and other waterborne diseases. Hunter et al. (2010) indicated that inadequate access to safe drinking water is also associated with several non-diarrhea and noninfectious diseases.

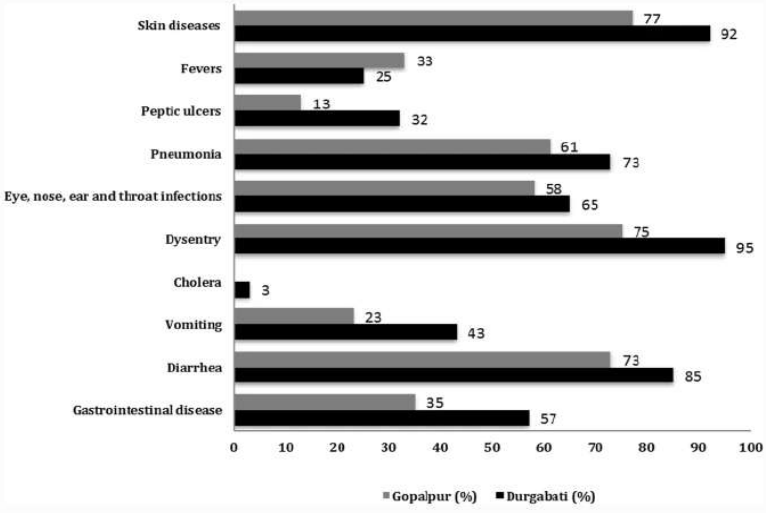
Climate Change-Induced Water-Related Diseases in Bangladesh

A survey was carried out in two villages of Shymnagar upazila on the southwestern coast to investigate the present status of safe water sources and health care facilities and their impacts on the local community. The results show that the local community believes that climate change is having substantial impacts on freshwater sources and health. More than 70% of the respondents identified diarrhea, dysentery, and skin diseases as the prime waterborne health risks that occur through climate-related safe water scarcity.

Climate Change-Induced Water-Related Diseases in Bangladesh

Climate Change, Water Scarcity, and Health Adaptation in Southwestern Coastal Bangladesh

Fig. 6



Waterborne diseases in the two study villages of southwestern coastal Bangladesh

Climate Change-Induced Water-Related Diseases in Bangladesh

Respondents in both villages have been suffering from various diseases caused by drinking insufficient amounts of water or water with high salinity (Fig. 6). Various water-related diseases such as skin diseases, fevers, peptic ulcers, pneumonia, eye, nose, ear and throat infections, dysentery, vomiting, diarrhea, and gastrointestinal diseases have become a part of live for the village people. More than 90% of the respondents in Durgabati village mentioned that they are suffering from dysentery as well as skin diseases due to the use of contaminated water for drinking.

Climate Change-Induced Water-Related Diseases in Bangladesh

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Adaptation to overcome the waterborne disses due climate change

It has been suggested to follow pathways to health adaptation to climate change effects and safe water scarcity through locally available adaptive practices such as the use of pond sand filters, rainwater harvesting, and importing potable water with the active participation of the government, nongovernmental organizations, and communities.

Introduction to Water-borne diseases

Introduction:

Water-borne diseases are caused by water that is contaminated with microorganisms. The microbes—typically bacteria, viruses, protozoa, and parasites—are usually found in the intestinal tracts of humans and other creatures. In most cases, the water becomes contaminated by feces that carry the microbes.

Over 1 billion people worldwide do not have access to safe drinking water, and 3.4 million people die each year due to water-borne diseases, according to the World Health Organization (WHO). Indeed, water-borne diseases are the most common cause of disease and death in the world, according to the WHO. While this is largely a problem in developing and underdeveloped countries, developed nations, including the United States, are not immune.

As noted above, water-borne diseases are caused by a wide range of pathogens, including bacteria, viruses, parasites, and protozoa. Examples of bacteria that are important water-borne pathogenic organisms include *Vibrio cholerae* (the bacteria that causes cholera), various species *Campylobacter*, *Salmonella*, *Shigella*, and a type of *Escherichia coli* designated O157:H7.

Amebiasis is a common water-borne disease that is caused by the parasite Entamoeba histolytica. This parasite is normally found in feces and can cause disease when fecal-contaminated water is consumed. About one of every 10 people who consume E. histolytica—which translates to millions of people worldwide—becomes ill. Their symptoms can be mild (diarrhea,stomachache, and cramping), but, in some people, a severe form of amebiasis called amebic dysentery develops. The destruction of cells lining the intestinal tract produces bloody diarrhea. More rarely, the parasite can spread to the liver, lungs, or the brain.

Effect of climate on Water-borne diseases:

Climate change is making heavy intense downpours, droughts and rising water temperatures more common. This can alter the quality of our drinking and recreational water. Bacteria and viruses thrive in these new conditions and when they come into contact with humans, can cause numerous illnesses. Lack of water can also impact human health, especially in drought conditions.

As climate change continues, water-borne illnesses are likely to become more common. That's because climate change increases precipitation, storm surges, and sea temperatures. These environmental factors contribute to flooding and runoff that can spread sewage, chemicals and disease agents. They also favor the growth, survival and spread of bacteria, viruses and toxins created by harmful algae. As a result, more people will likely be exposed to water-borne illnesses through ingestion, inhalation and skin contact, as well as consumption of contaminated fish and shellfish.

Climate change increases the frequency and intensity of heavy rainfall. This leads to runoff and to flooding, especially in river and coastal areas. Drinking water can be contaminated by chemicals, gasoline, coal ash, sewage and more.

- Extreme precipitation events have been linked to increased levels of pathogens in treated drinking water, and cases of gastrointestinal illness in children.
- Groundwater wells receive limited water treatment. This makes them more susceptible to water contamination from extreme precipitation events and increases the risk of waterborne illnesses in those who consume it.

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When precipitation falls as more intense storms or as hurricanes that can cause flooding and jeopardize water quality.

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Climate Change-Induced Water-Related Diseases

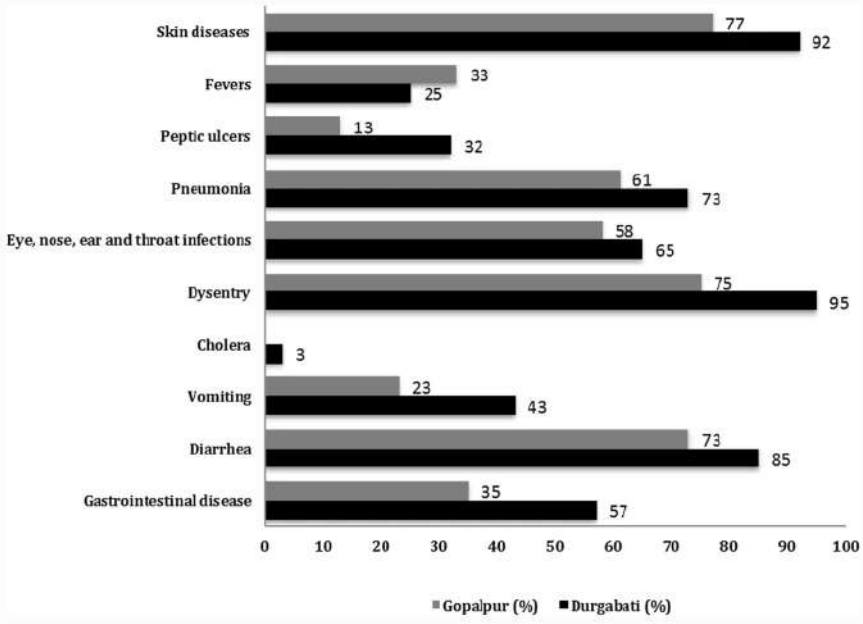
A survey was carried out in two villages of Shymnagar upazila on the southwestern coast to investigate the present status of safe water sources and health care facilities and their impacts on the local community. The results show that the local community believes that climate change is having substantial impacts on freshwater sources and health. More than 70% of the respondents identified diarrhea, dysentery, and skin diseases as the prime waterborne health risks that occur through climate-related safe water scarcity.

By synthesizing the ground data, we suggest pathways to health adaptation to climate change effects and safe water scarcity through locally available adaptive practices such as the use of pond sand filters, rainwater harvesting, and importing potable water with the active participation of the government, nongovernmental organizations, and communities.

As water scarcity is increasing worldwide, water-related diseases are increasing, especially in developing countries (Hunter et al. 2010). A recent study in India showed that domestic water scarcity is strongly associated with various kinds of health damage caused by infectious diseases (Motoshita et al. 2011). Increased flooding as well as drought result in a decline in the availability of clean water. In Bangladesh, waterborne diseases are already responsible for 24% of all deaths (Reid and Sims 2007). Increased unavailability of freshwater forces people to drink contaminated water leading to dysentery, diarrhea, and other waterborne diseases. Hunter et al. (2010) indicated that inadequate access to safe drinking water is also associated with several non-diarrhea and noninfectious diseases.

Respondents in both villages have been suffering from various diseases caused by drinking insufficient amounts of water or water with high salinity (Fig. 6). Various water-related diseases such as skin diseases, fevers, peptic ulcers, pneumonia, eye, nose, ear and throat infections, dysentery, vomiting, diarrhea, and gastrointestinal diseases have become a part of live for the village people. More than 90% of the respondents in Durgabati village mentioned that they are suffering from dysentery as well as skin diseases due to the use of contaminated water for drinking.

Fig. 6



Waterborne diseases in the two study villages of southwestern coastal Bangladesh

Case study:

Climate change may affect human health through multiple and interactive pathways that include safe water scarcity. However, impacts of climate change-induced water scarcity on health and well-being are complex. About 80% of illnesses in developing countries are attributed to unsafe drinking water and waterborne diseases. In Southwestern Bangladesh, lack of safe drinking water is a severe crisis due to climate change. The study investigated the impacts of climate change on water resources and human health in a coastal area. A questionnaire survey was carried out in two villages of Shymnagar upazila on the southwestern coast to investigate the present status of safe water sources and health care facilities and their impacts on the local community. The results show

that the local community believes that climate change is having substantial impacts on freshwater sources and health. More than 70% of the respondents identified diarrhea, dysentery, and skin diseases as the prime waterborne health risks that occur through climate-related safe water scarcity. By synthesizing the ground data, we suggest pathways to health adaptation to climate change effects and safe water scarcity through locally available adaptive practices such as the use of pond sand filters, rainwater harvesting, and importing potable water with the active participation of the government, nongovernmental organizations, and communities.

1. Analysis the scenario and prepare an adaptation plan for the above-mentioned area.

Climate change may affect human health through multiple and interactive pathways that include safe water scarcity. However, impacts of climate change-induced water scarcity on health and well-being are complex. About 80% of illnesses in developing countries are attributed to unsafe drinking water and waterborne diseases. In Southwestern Bangladesh, lack of safe drinking water is a severe crisis due to climate change. The study investigated the impacts of climate change on water resources and human health in a coastal area. A questionnaire survey was carried out in two villages of Shymnagar upazila on the southwestern coast to investigate the present status of safe water sources and health care facilities and their impacts on the local community. The results show that the local community believes that climate change is having substantial impacts on freshwater sources and health. More than 70% of the respondents identified diarrhea, dysentery, and skin diseases as the prime waterborne health risks that occur through climate-related safe water scarcity.

By synthesizing the ground data, survey suggest pathways to health adaptation to climate change effects and safe water scarcity through locally available adaptive practices such as the use of pond sand filters, rainwater harvesting, and importing potable water with the active participation of the government, nongovernmental organizations, and communities[9].

Bangladeshi people are still not concerned enough about the risks of contaminated water. As a result, water-borne disease outbreak occurs often. The government and private sectors should team up to educate people and provide solutions to eradicate this problem. We at The Water Shop BD also concern ourselves with providing the Bangladeshi crowd with adequate knowledge and solutions for safe drinking water.

Module 07: Food security and malnutrition

Time: 45 m

Objectives:

After completion of the Module participants will be able -

- To understand the food security and what is and cause
- To understand the elements of food security
- To understand the malnutrition
- Effect of climate change on malnutrition associated diseases
- Climate change and food security- present and
- Climate change and food security -future

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	Food security and what is and cause	7 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, video
2.	Elements of food security	8 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia
3.	Malnutrition and associate diseases due climate change	10 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia
4.	Climate change and food security- present	10 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia
5.	Climate change and food security- future	5 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia
4.	Sum up	5 m	Q & A and discussion	Interaction with the trainee

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about food security, causes and elements of food security

- Ask the participants to know their ideas about the malnutrition and effect of climate change on malnutrition associated diseases
- Ask the participants to know their ideas about the food security and malnutrition present and future situation
- Ask if any question and give answer.
- Summarize and conclude the session.

Note for Facilitator

Food security what it is

Food security is the measure of the availability of food and individuals' ability to access it. According to the United Nations' Committee on World Food Security, food security is defined as meaning that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life[10].

Food security what it is

"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" - (World Food Summit– 1996)

Causes of food security

Over the coming decades, a changing climate, growing global population, rising food prices, and environmental stressors will have significant impacts on food security.

Adaptation strategies and policy responses to global change, including options for handling water allocation, land use patterns, food trade, postharvest food processing, and food prices and safety are urgently needed[10].

There are four elements of food security, namely –

- Food availability (manufacture and delivery)
- Food access (affordability, distribution, and preference)
- Food utilization (dietary value, social value, and food safety) and
- Food stability (government food security strategies) (World Food Program, 2016; Anik et al. 2012).

WHO effected most due to food insecurity?

One of the most damaging effects of diminishing food security is that the worst impact of the cascade of risks is borne by the most vulnerable groups of the population. The poorest segment of the population, who spend the largest share of income on food, are likely to be worst affected by any crisis in food availability.

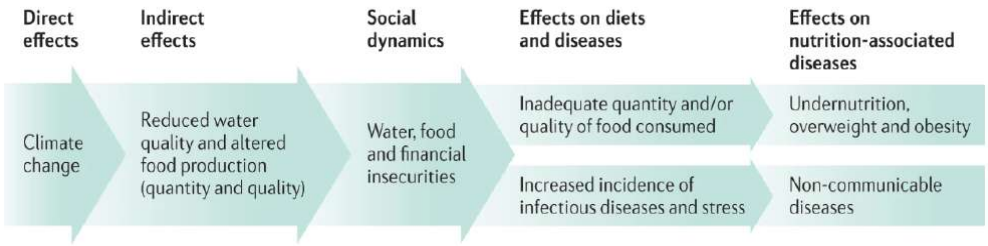
Bangladesh is severely vulnerable to climate change and its devastation on coastal livelihood and food security has been substantiated. Climate induced hazards will lead to food insecurity directly and indirectly by affecting the coastal biophysical and socioeconomic states. It is found that the potential impacts on coastal agricultural, livestock and fisheries sectors those are the main source of livelihood and food security to coastal people.

Malnutrition/undernutrition:

More than three lakh children, aged less than five years, suffered from severe malnutrition across the globe, reads a report by UNICEF. Bangladesh is the fifth worst among countries where children suffer from severe malnutrition, according to the report.

Fig. 1: Effects of climate change on nutrition-associated diseases.

From: Climate change and nutrition-associated diseases



The main ways in which climate change influences diet and nutrition-associated diseases.

(Effects of climate change on nutrition-associated diseases Jessica C. Fanzo & Shauna M. Downs)

Climate change and food security: Present

Bangladesh is among the most precarious and unpredictable countries due to climate risks (Bangladesh Country Study, 2013). It is regularly stricken by annual flooding, or shortage of water during dry seasons; it frequently suffers from cyclones, storm surges, along with changing groundwater aquifer situations.

Climate change and food security: Present

Among the numerous potential unfavorable outcomes of climate change, the risks posed to the agriculture sector and food industry are among the most disruptive to the health of the citizens, to the economy, and growth in Bangladesh.

Climate change and food security: Present

The recent study by Parvin et al. (2013: 809) in one of the coastal districts of Bangladesh (e.g. Khulna) reveals that "climate change (mostly seasonal variability and salinity intrusion) is playing prime role behind their reduction of income, loss of employment and reduction of crop production".

Climate change and food security: Present

Their study further observes that the due to decrease in „both the availability and accessibility to food" since last 10-20 years, „majority of the families (75 percent) have claimed that their food consumption both in quality and quantity (63percent) has deteriorated" (ibid).

Climate change and food security: Present

The significant amount of hardship was felt especially after two cyclones SIDR in 2007 and later Aila in 2009 which has not only hampered agricultural production but also made it difficult to find suitable job to ensure food security for their family and predominantly affected their „food consumption pattern" (Parvin et al. 2013: 810).

Climate change and food security: Present

The country wide impact of climate change is also visible as „domestic food grain production remains susceptible to floods and droughts" which is accompanied by „non increase in production other than cereals" (Hossain et al. 2005:104).

Climate change and food security: Present

The contemporary challenge for Bangladesh is to improve productivity, especially as demand for food increases with the growing population, and improved incomes, whereas climate conditions are depleting. On the other hand, overuse, decline and changes in resource quality place further pressures on the scarce land and water resources.

Climate change and food security: Future

Bangladesh mostly because of coastal erosion and flooding due to the impact of climate changes (Islam, 2012: 127-128). According to Parvin et al. (2013: 804) "it is also estimated that by 2050 major two type rice (pre monsoon and dry season) production will decrease due to salinity and flood in Bangladesh".

Climate change and food security: Future

From present scenario to future projection climate change is an extra burden on the effort to secure food for all citizens in the country like Bangladesh for numerous factors. In short, these factors are:

- Uncontrolled farming environment
- Rice based agriculture greatly depends on availability of fresh surface and ground water,
- Lack of stress tolerant varieties,
- Seasonal farming,
- Changed cropping pattern,
- Excessive and unplanned urbanization,
- Indiscriminate use of natural resources,
- Unplanned industrial growth,
- Imbalanced use of agricultural inputs and extreme farming.

Climate change and food security: Future

Agricultural production is anticipated to be extensively harmed by the rapid expanse of soil salinity that arose from sea levels rising, tidal flooding, and intensifying storm gushes.

Climate change and food security: Future

Food security will take a dark plunge because 30 percent of cultivable land is located in coastal areas. A study by the World Bank has suggested that increased soil salinity will lead to a 15.6 percent decline in the harvest of high-yield rice. It can potentially lead to a shortage of irrigation water for farming during the dry season and depleted source of revenue for farmers (World Bank, 2010).

Climate change and food security: Future

Food security will take a dark plunge because 30 percent of cultivable land is located in coastal areas. A study by the World Bank has suggested that increased soil salinity will lead to a 15.6 percent decline in the harvest of high-yield rice. It can potentially lead to a shortage of irrigation water for farming during the dry season and depleted source of revenue for farmers (World Bank, 2010).

Climate change and food security: Future

Agriculture in Bangladesh is largely dependent on weather. One cyclone may destroy a significant volume of the seasonal harvest. Cyclone Sidr destroyed nearly 95 percent crops in coastal districts when it crashed into Bangladesh in 2007 (ADB, 2013).

Food security will be immensely jeopardized due to frequent and intensified extreme weather incidents resulting from climate change.

Climate change and food security: Need to do in Future

- A comprehensive climate change policy addressing all these issues has no alternatives in this regard.
- Investment on the need analysis should be increased. The contemporary technologies should be developed and disseminated to the farmers. Farmers should be encouraged to cultivate diversified crops. Besides, more studies should be conducted on the climate change and the strategies to cope with it.
- Investment in sustainable agricultural and fisheries' productivity growth should be ensured to get sustainable supply of food over the long term. This includes investment in innovations, such as climate-resilient varieties that can enable the sectors to respond to the challenges posed by climate change (OECD, 2017).

Since most of the farmers in Bangladesh are smallholders (Ahmed *et al.*, 2013), political strategies, focused investments, and planned measures should be implemented to enable these farmers to develop their farming activities and use new innovations (FAO, 2011b, Vorley *et al.*, 2012).

Reading Materials

Food security what it is and cause:

Food security is the measure of the availability of food and individuals' ability to access it. According to the United Nations' Committee on World Food Security, food security is defined as meaning that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life[10].

Over the coming decades, a changing climate, growing global population, rising food prices, and environmental stressors will have significant yet uncertain impacts on food security. Adaptation strategies and policy responses to global change, including options for handling water allocation, land use patterns, food trade, postharvest food processing, and food prices and safety are urgently needed[10].

There are four elements of food security, namely - food availability (manufacture and delivery), food access (affordability, distribution, and preference), food utilisation (dietary value, social value, and food safety), and food stability (government food security strategies) (World Food Program, 2016; Anik et al. 2012). One of the most damaging effects of diminishing food security is that the worst impact of the cascade of risks is borne by the most vulnerable groups of the population. The poorest segment of the population, who spend the largest share of income on food, are likely to be worst affected by any crisis in food availability.

Bangladesh is severely vulnerable to climate change and its devastation on coastal livelihood and food security has been substantiated. Climate induced hazards will lead to food insecurity directly and indirectly by affecting the coastal biophysical and socioeconomic states. This review article found the potential impacts on coastal agricultural, livestock and fisheries sectors those are the main source of livelihood and food security to coastal people. Furthermore, most of the rural coastal people are hard poor in which women are major in portion and contribute to ensure food security for the entire family. Scrutinizing on ‘vulnerability’ revealed that it is not gender neutral and socio-economically underprivileged groups and marginal people are invaded disproportionately in which women is ranking in the top of the order. Hence, existing gender-poverty nexus along with socio-economic and political aspects make women more endangered to

climate vulnerability and food security. It also found that existing policies and adaptation mechanisms failed to address the influence of powers on marginalize women and growing trend of feminization of food insecurity. In addition, also found the necessity for immediate pertinent caucus before the onset of this imminent concernment by aggregating gender and identified vulnerable groups. (*Hossain, M., & Majumder, A. (2018). Impact of climate change on agricultural production and food security: a review on coastal regions of Bangladesh*.)

Malnutrition/undernutrition:

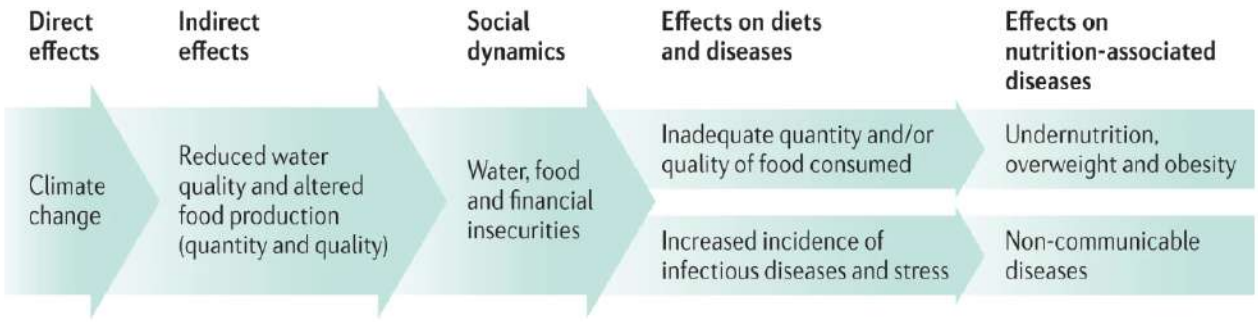
More than three lakh children, aged less than five years, suffered from severe malnutrition across the globe, reads a report by UNICEF. Bangladesh is the fifth worst among countries where children suffer from severe malnutrition, according to the report.

Climate change has multiple negative effects on global public health; reduced quality and quantity of crops result in increased food and financial insecurities leading to malnutrition (undernutrition and obesity) and diet-related non-communicable diseases, such as diabetes mellitus and cardiovascular diseases. In addition, food systems substantially contribute to greenhouse gas emissions and a shift towards sustainability is required to preserve human and planetary health. *(Effects of climate change on nutrition-associated diseases Jessica C. Fanzo & Shauna M. Downs)*

It has been revealed from studies that the impact of climate change on the nutritional status of very young children between the ages of 0–3 years by using weather data from the last half century merged with rich information on child, mother, and household characteristics in rural coastal Bangladesh. Researchers evaluate the health consequences of rising temperature and relative humidity and varying rainfall jointly employing alternate functional forms. Leveraging models that control for annual trends and location-specific seasonality, and that allow the impacts of temperature to vary non-parametrically while rainfall and humidity have flexible non-linear forms, they find that temperatures that exceed 25 °C (the "comfortable" benchmark) in the month of birth exert negative effects on children's nutritional status as measured by mid upper arm circumference. Humidity has a positive impact which persists when child, mother and household controls are included. We find that exposure to changing climate in utero also matters. Explanations for these results include consequences of weather fluctuations on the extent of pasture, cropland, and rainfed lands planted with rice and other crops, and on mother's age at first marriage. Our results underline that climate change has real consequences for the nutritional health of very young populations in vulnerable areas. (*The impact of climate change on children's nutritional status in coastal Bangladesh by S.M. ManzoorAhmed Hanifia [a], NidhiyaMenonb [b], Agnes Quisumbingc [c]*)

Fig. 1: Effects of climate change on nutrition-associated diseases.

From: Climate change and nutrition-associated diseases



The main ways in which climate change influences diet and nutrition-associated diseases.

(Effects of climate change on nutrition-associated diseases Jessica C. Fanzo & Shauna M. Downs)

Climate change and food security: Present

Bangladesh is among the most precarious and unpredictable countries due to climate risks (Bangladesh Country Study, 2013). It is regularly stricken by annual flooding, or shortage of water during dry seasons; it frequently suffers from cyclones, storm surges, along with changing groundwater aquifer situations. Most of the land mass comprises of floodplains, and up to 30 percent of the country experiences annual flooding during the monsoon season, while 60 percent of the country is susceptible to extreme floods (UNESCAP, 2013).

Among the numerous potential unfavorable outcomes of climate change, the risks posed to the agriculture sector and food industry are among the most disruptive to the health of the citizens, to the economy, and growth in Bangladesh. Agriculture comprises a vital economic sector in Bangladesh, amounting for nearly 20 percent of the GDP and 65 percent of the labour force (World Bank, 2010). The performance of this sector has significant effect on economic growth, trade balance, budgetary position of the government, the intensity and patterns of poverty and malnourishment in the country. Furthermore, agriculture sector is the contingent source of income and employment for most of the poverty-stricken rural residents.

The recent study by Parvin et al. (2013: 809) in one of the coastal district of Bangladesh (e.g. Khulna) reveals that "climate change(mostly seasonal variability and salinity intrusion) is playing prime role behind their reduction of income, loss of employment and reduction of crop production". Their study further observes that the due to decrease in „both the availability and accessibility to food" since last 10-20 years, „majority of the families (75 percent) have claimed that their food consumption both in quality and quantity (63percent) has deteriorated" (ibid). The

significant amount of hardship was felt especially after two cyclones SIDR in 2007 and later Aila in 2009 which has not only hampered agricultural production but also made it difficult to find suitable job to ensure food security for their family and predominantly affected their „food consumption pattern" (Parvin et al. 2013: 810). The country wide impact of climate change is also visible as „domestic food grain production remains susceptible to floods and droughts" which is accompanied by „non increase in production other than cereals" (Hossain et al. 2005:104).

The contemporary challenge for Bangladesh is to improve productivity, especially as demand for food increases with the growing population, and improved incomes, whereas climate conditions are depleting. On the other hand, overuse, decline and changes in resource quality place further pressures on the scarce land and water resources.

Climate change and food security: Future

Bangladesh mostly because of coastal erosion and flooding due to the impact of climate changes (Islam, 2012: 127-128). According to Parvin et al. (2013: 804) "it is also estimated that by 2050 major two type rice (pre monsoon and dry season) production will decrease due to salinity and flood in Bangladesh". Moreover, IPCC (2012) in its latest report warns that "higher sea levels will lead to an increased frequency of coastal flooding even if cyclone frequency or intensity remains unchanged" and "an increased exposure to both temperature extremes, and severe droughts, might be expected" (IPCC, 2012inBlack et al., 2013:33).

Thus, from present scenario to future projection climate change is an extra burden on the effort to secure food for all citizens in the country like Bangladesh for numerous factors. In short, these factors are: uncontrolled farming environment, rice based agriculture greatly depends on availability of fresh surface and ground water, lack of stress tolerant varieties, seasonal farming, changed cropping pattern, excessive and unplanned urbanization, indiscriminate use of natural resources, unplanned industrial growth, imbalanced use of agricultural inputs and extreme farming. A comprehensive climate change policy addressing all these issues has no alternatives in this regard.

Agricultural production is anticipated to be extensively harmed by the rapid expanse of soil salinity that arose from sea levels rising, tidal flooding, and intensifying storm gushes. More than half the area of Bangladesh is barely five meters above sea level, posing ominous threats to its coastal population. According to scientists, sea levels could soar 50 to 130 cm by the year 2100 (Ismail, 2016). Despite the most effective measures, for example, the execution of the 2015 Paris Agreement, sea levels are predicted to surge by 20 to 60 cm by 2100.

Food security will take a dark plunge because 30 percent of cultivable land is located in coastal areas. A study by the World Bank has suggested that increased soil salinity will lead to a 15.6 percent wane in the harvest of high-yield rice. It can potentially lead to a shortage of irrigation

water for farming during the dry season and depleted source of revenue for farmers (World Bank, 2010).

Agriculture in Bangladesh is largely dependent on weather. One cyclone may destroy a significant volume of the seasonal harvest. Cyclone Sidr destroyed nearly 95 percent crops in coastal districts when it crashed into Bangladesh in 2007 (ADB, 2013). Food security will be immensely jeopardized due to frequent and intensified extreme weather incidents resulting from climate change.

Improving food security

The achievement of food self-sufficiency continues to be a key development agenda for the country. The UN Sustainable Development Goal 2 aims to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture."

Climate Resilient Crops and climate smart agriculture is an initiative for improving the food security. Climate-smart agriculture is an approach for developing agricultural strategies to secure sustainable food security under climate change. This concept refers to climate responsive agriculture which can sustain productivity amid a changing climate, enhance resilience and reduce greenhouse gases.

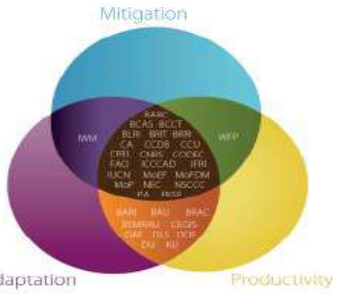
The climate-smart agriculture (CSA) concept reflects an ambition to improve the integration of agriculture development and climate responsiveness. It aims to achieve food security and broader development goals under a changing climate and increasing food demand. CSA initiatives sustainably increase productivity, enhance resilience, and reduce/remove greenhouse gases (GHGs), and require planning to address tradeoffs and synergies between these three pillars: productivity, adaptation, and mitigation *(FAO, 2010. "Climate-Smart" Agriculture. Policies, practices and financing for food security, adaptation and mitigation. Rome: Food and Agriculture Organization of the United Nations (FAO).*).

Besides this to improving the food security the national growth and poverty reduction policies and strategies need to integrate and expand efficient adaptation measures for a sustainable growth pathway. At the local level, the communities in the vulnerable parts of the country need coping mechanisms to adjust to adverse climate hazards. In addition to the current strategies and policies addressing this urgent issue, innovative, unique, and contextual adaptive measures need to be devised.

As Bangladesh is one of the countries most affected by climate change, a large number of Non-Governmental Organizations (NGOs), bilateral, and multi-national organizations have initiated projects on climate change mitigation and adaptation in the country. The Delta Plan 2100, for example, funded by the Dutch Government, is a roadmap to alleviate the effects of sea level rise, including the infusion of salinity into Bangladesh's coastal rivers and canals. Meanwhile, the CGIAR has had offices in Bangladesh for decades including the International Rice Research

Institute, the International Center for Maize and Wheat Improvement (CIMMYT), WorldFish, and the International Food Policy and Research Institute (IFPRI). WorldFish and CIMMYT are both currently undertaking projects for the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS) in Bangladesh, coordinated from the regional International Centre for Tropical Agriculture offices in Delhi. Furthermore, BRAC, the largest international NGO in Bangladesh, is working on a modified System of Rice Intensification (SRI) and information sharing and awareness building about climate change adaptation. BRAC is also pursuing CSA practices promoting cultivation of sunflower in saline soils in southern districts of Bangladesh well as buy back sunflower seeds from farmers for oil extraction. The institutions highlighted in the diagram represent those larger entities that have historically embedded CSA goals (i.e. adaptation, productivity and mitigation) into their research or development agendas. Of the 33 governmental, NGO, and private sector institutes listed, the International Center for Climate Change and Development (ICCCAD) occupies a central coordinating role, especially between the GoB and other actors. Still, coordination of climate change action between actors in the country remains problematic. The Government of Bangladesh plays an active role in international forums on climate change, becoming a signatory member of the United Nations Framework Convention on Climate Change and the Kyoto Protocol, and through its commitment to the Bali Action Plan and the Paris Climate Agreement. In 1995, the National Environment Management Action Plan (NEMAP) for Bangladesh was formulated, addressing the country-specific climate change challenges identified in the country's Intergovernmental Panel for Climate Change Second Assessment Report. Later, two policies were approved by the GoB: the National Adaptation Programme of Action (NAPA) in 2005 and the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) later in 2009. The NEMAP, NAPA, and finally the BCCSAP were formulated through robust participatory processes involving civil society, NGOs, and other stakeholders. All the ministries and ministerial departments refer to these policies when planning and executing their work.

Institutions for CSA in Bangladesh



BARC Bangladesh agricultural Research Council **BARI** Bangladesh Agricultural Reseach Institute **BAU** Bangladesh Agricultural University **BCAS** Bangladesh Center for Advanced Studies **BCCT** Bangladesh Climate Change Trust **BINA** Bangladesh Institute of Nuclear Research **BJRI** Bangladesh Jute Research Institute **BLRI** Bangladesh Livestock Research Institute **BRAC** Bangladesh Rural Advancement Committee **BRRI** Bangladesh Rice Reseach Institute **BRIT** Bangladesh Resource Improvement Trust **BSMRAU** Bangobhondo Sheik Mujibur Rahman Agriculture University **CA** Christian Aid **CCDB** Christian Commission for Development in Bangladesh **CCU** Climate Change Unit **CEGIS** Center for Environmental and Geographic Information Services **CNRS** Center for Natural Resource Studies **CODEC** Community Development Centre **CREL** Climate Resilient Ecosystems and Livelihoods **DAE** Department of Agriculture Extension **DLS** Department of Livestock Services **DOF** Department of Fisheries **DU** Dhaka University **FAO** Food and Agriculture Organization of the United Nations **ICCCAD** International Center for Climate Change and Development **IFRI** International Food Policy Research Institute **IWM** International Water Modeling **IUCN** International Union for Conservation of Nature **KU** Khulna University **MoEF** Ministry of Environment and Forests **MoFDM** Ministry of Food and Disaster Management **MoP** Ministry of Planning **NEC** National Environment Committee **NSCCC** National Steering Committee on Climate Change **PA** Practical Action **PKSF** Palli Karma-Sahayak Foundation **WFP** World Food Program

Module: 08 Air pollution

Time: 60 m

Objectives:

- To understand what is vector and key facts of vector borne diseases
- To understand the vector borne diseases in Bangladesh
- To understand the impact of climate change on vector borne diseases
- To understand Vector borne diseases and Bangladesh need to do

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	What is vector and key facts of vector borne diseases	25 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, video
2.	Vector borne diseases in Bangladesh	25 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
3.	Vector borne diseases Bangladesh need to do	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
4.	Sum up	5 m	Q & A and discussion	Interaction with the participants

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about vector and key facts of vector borne diseases
- Ask the participants to know their ideas about vector borne diseases in Bangladesh
- Ask the participants to know their ideas about impact of climate change on vector borne diseases in Bangladesh
- Ask the participants to know their ideas vector borne disses and Bangladesh need to do

- Ask if any question and give answer
- Summarize and conclude the session.

Note for facilitators

Air pollution:

Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution (WHO).

Air pollution:

Air pollution is caused when harmful gases and chemicals are released into the air. These pollutants include Particulate Matter (very small particles that get into our respiratory system), nitrogen oxide and sulphur dioxide.

Air pollution:

From smog hanging over cities to smoke inside the home, air pollution poses a major threat to health across the globe. Almost all of the global population (99%) are exposed to air pollution levels that put them at increased risk for diseases including

- Heart disease,
- Stroke,
- Chronic obstructive pulmonary disease
- Cancer and pneumonia

Air pollution:

3.8 million deaths every year as a result of household exposure to smoke from dirty cookstoves and fuels (WHO)

Air pollution:

The main causes of air pollution can be categorized by source:

- Mobile: Cars, buses, planes, trucks and trains.
- Stationary: Power plants, oil refineries, brickfield, industrial facilities and factories.
- Area: Agricultural areas, cities and wood-burning fireplaces.
- Natural: Wind-blown dust, wildfires and volcanoes.

Health impacts of air pollution

Short-term effects are temporary and range from simple discomfort, such as irritation of the eyes, nose, skin, throat, wheezing, coughing and chest tightness, and breathing difficulties, to more serious states, such as asthma, pneumonia, bronchitis, and lung and heart problems. Short-term exposure to air pollution can also cause headaches, nausea, and dizziness.

Health impacts of air pollution

These problems can be aggravated by extended **long-term** exposure to the pollutants, which is harmful to the neurological, reproductive, and respiratory systems and causes cancer and even rarely deaths. The long-term effects are chronic, lasting for years or the whole life and can even lead to death. Furthermore, the toxicity of several air pollutants may also induce a variety of cancers in the long term.

Health impacts of air pollution

Neurological effects have been observed in adults and children after extended-term exposure to air pollutants. It is important to state that impact on the immune system, causing dysfunction and neuroinflammation, is related to poor air quality. Furthermore, skin is our shield against ultraviolet radiation (UVR) and other pollutants, as it is the most exterior layer of our body.

Health impacts of air pollution

Traffic-related pollutants, such as polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs), oxides, and PM, may cause pigmented spots on our skin. Another exterior organ that may be affected is the eye. Contamination usually comes from suspended pollutants and may result in irritation or dry eye syndrome.

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What are the health consequences of air pollution on populations?

Both short- and long-term exposure to air pollutants have been associated with health impacts. More severe impacts affect people who are already ill. Children, the elderly and poor people are more susceptible. The most health-harmful pollutants – closely associated with excessive premature mortality – are fine PM2.5 particles that penetrate deep into lung passageways.

Particles less than 2.5 micrometers in diameter (PM2.5) are referred to as "fine" particles and pose the greatest health risks. Because of their small size (approximately 1/30th the average width of a human hair), fine particles can lodge deeply into the lungs.

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Quality air and it's benefit:

"Air quality" refers to the condition of the air within our surroundings. Good air quality pertains to the degree to which the air is clean, clear and free from pollutants such as smoke, dust and smog, among other gaseous impurities in the air. Air quality is determined by assessing a variety of pollution indicators.

Quality air and it's benefit:

Good air quality is a requirement for preserving the exquisite balance of life on earth for humans, plants, animals and natural resources. As such, human health, plants, animals and natural resources are threatened when pollution in the air reaches high concentrations.

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Good air quality is a requirement for preserving the exquisite balance of life on earth for humans, plants, animals and natural resources. As such, human health, plants, animals and natural resources are threatened when pollution in the air reaches high concentrations.

Degradation of quality air :

Air quality can be degraded by natural or man-made sources. Natural sources include volcanic eruption, windstorm dust. Man-made sources include pollution from moving vehicles, toxic gases from industries, coal-powered plants, burning wood or other material in the open air, landfills. Both these sources can seriously affect the overall air quality and can lead to severe health problems for humans.

Table 3.1. Major sources of criteria air pollutants (Source: USEPA, with minor modifications)

Pollutant	Sources
Carbon Monoxide (CO)	Motor vehicle exhaust, kerosene, power plants with internal combustion engines or wood/biomass burning stoves.
Sulphur Dioxide (SO_2)	Coal-fired power plants, brick kilns, petroleum refineries, sulphuric acid manufacture, and smelting sulphur containing ores.
Nitrogen Dioxide (NO_2)	Motor vehicles, power plants, and other industrial, commercial, and residential sources that burn fuels (e.g. diesel generators).
Ozone (O_3)	Vehicle exhaust and certain other fumes (hydrocarbons). Formed from other air pollutants in the presence of sunlight.
Lead (Pb)	Metal refineries, lead smelters, battery manufacturers, iron and steel producers.
Particulate Matter (PM)	Diesel engines, motor vehicles, power plants, brick kilns, industries, windblown and road dust, wood/ biomass stoves, open burning.

Fig. 2.5 Source apportionment for $PM_{2.5-10}$ at various locations in Bangladesh (source: BAEC)

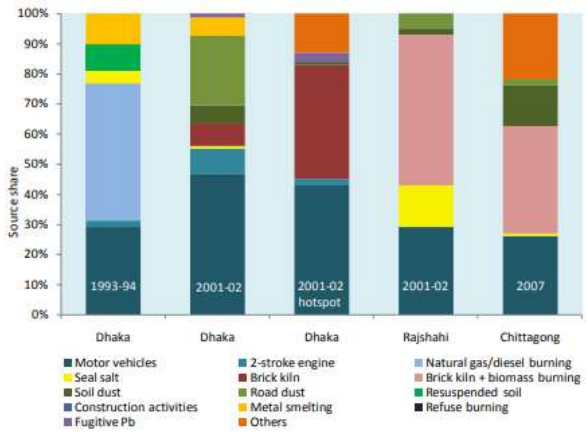


Fig. 2.6 Source apportionment for $PM_{2.5}$ at various locations in Bangladesh (source: BAEC)

TABLE 6.1. SELECTED AIR POLLUTANTS, SOURCES AND HEALTH EFFECTS

Pollutant	Sources	Health effects
Carbon monoxide	Biomass and fossil fuel combustion, cigarette smoke, vehicular emissions	Headache, nausea, dizziness, breathlessness, fatigue, low birth weight, visual disturbances, mental confusion, angina, coma, death
Ozone	Vehicular emissions, hydrocarbon release, fossil fuel combustion (primary pollutant)	Eye irritation, respiratory tract irritation, reduced exercise capacity, exacerbation of respiratory disease
Particulate matter	Biomass and fossil fuel combustion, cigarette smoke, vehicular emissions	Eye irritation, respiratory tract infections, allergies, exacerbation of respiratory and cardiovascular disease, cancer
Nitrogen oxides	Biomass and fossil fuel combustion, construction materials, industry, cigarette smoke, vehicular emissions	Eye irritation, respiratory tract infections (children are especially vulnerable), exacerbation of asthma, irritation of bronchi
Sulfur oxides	Biomass and fossil fuel combustion, industrial emissions	Respiratory tract irritation, impaired pulmonary function, exacerbation of cardiopulmonary disease
Pollen	Flowering plants	Exacerbation of allergic rhinitis, asthma and other atopic diseases

Source: adapted from Yassi et al., (2001).

The benefits of quality air are:

- Cleaner lungs-Breathe Easier
- Decreased asthma and allergies symptoms.
- Improved skin appearance.
- Helps digestion.
- Psychological and emotional stabilizer.
- Better mood and normalized sleep patterns
- Reduce chances of lung, heart, and arterial diseases

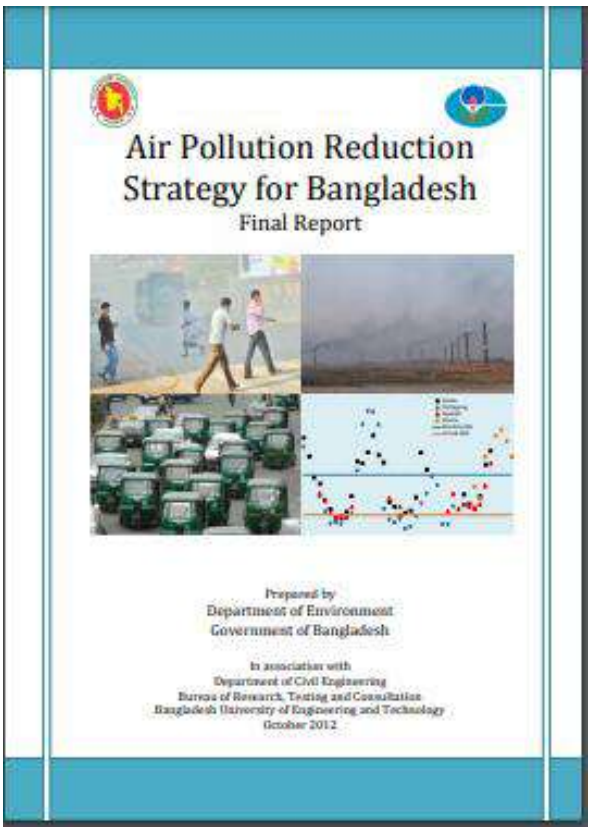


Table ES 1. Recommended strategies for air pollution reduction in Bangladesh

	Strategy	Area of application
A	Improve public transport	Large cities
B	Strengthen vehicle inspection and maintenance	All, especially large cities
C	Ban vehicles older than 20 years	Commercial vehicles, large cities
D	Encourage Diesel to CNG switch through incentives	All diesel vehicles, especially, truck & buses in large cities
E	Emissions (age) based annual registration fees	All vehicles
F	Stringent emissions standards	All new vehicles
G	Emissions based import tariff	All new vehicles
H	Comprehensive land use plan for industry locations	All industries, especially new ones
I	Cluster management	Cluster of highly polluting industries
J	Emissions (technology and fuel) based license fee	All kilns
K	Technology standards	All kilns
L	Alternate construction material	All country, especially large cites
M	Ensure adequate power supply	All country
N	Emissions standards	All new plants
O	Emissions standard for diesel generators	All new generators
P	Inspection & maintenance of diesel generators	All existing generators
Q	Technology specification	Existing steel mills, cement and glass factories
R	Inspection and maintenance	Existing steel mills, cement and glass factories
S	Emissions standards	All new and existing plants
T	Import control for quality of coal	Whole country, primarily brick and power industries
U	Better construction practices on site & during transport	All construction sites
V	Air pollution mitigation plan and its enforcement	Large construction projects
W	Timely road maintenance	All roads
X	Landscaping and gardening	All exposed soil in urban areas
Y	Encourage fuel switch	Urban slums and rural areas
Z	Improved cooking stoves	Rural areas

Introduction to air pollution

Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution (WHO).

Air pollution is caused when harmful gases and chemicals are released into the air. These pollutants include Particulate Matter (very small particles that get into our respiratory system), nitrogen oxide and sulphur dioxide.

From smog hanging over cities to smoke inside the home, air pollution poses a major threat to health across the globe. Almost all of the global population (99%) are exposed to air pollution levels that put them at increased risk for diseases including heart disease, stroke, chronic

obstructive pulmonary disease, cancer and pneumonia. WHO monitors the exposure levels and health impacts (i.e. deaths, DALYs) of air pollution at the national, regional and global level from ambient (outdoor) and household air pollution. Such estimates are used for official reporting like the world health statistics, and the Sustainable Development Goals (WHO).

3.8 million deaths every year as a result of household exposure to smoke from dirty cookstoves and fuels

The main causes of air pollution can be categorized by source:

- Mobile: Cars, buses, planes, trucks and trains.
- Stationary: Power plants, oil refineries, brickfield, industrial facilities and factories.
- Area: Agricultural areas, cities and wood-burning fireplaces.
- Natural: Wind-blown dust, wildfires and volcanoes.

Exposure to air pollution

Air pollution exposure is a well-established risk factor for several adverse respiratory outcomes, including airways diseases and lung cancer. Few studies have investigated the relationship between air pollution and interstitial lung disease (ILD) despite many forms of ILD arising from environmental exposures. There are potential mechanisms by which air pollution could cause, exacerbate, or accelerate the progression of certain forms of ILD via pulmonary and systemic inflammation as well as oxidative stress. This article will review the current epidemiologic and translational data supporting the plausibility of this relationship and propose a new conceptual framework for characterizing novel environmental risk factors for these forms of lung disease.

The interstitial lung diseases (ILDs) comprise a diverse group of entities primarily characterized by the proliferation and thickening of the pulmonary interstitium. Despite a wide range of etiologic processes, many share a common phenotype of irreversible lung fibrosis that, in some patients, leads to progressive hypoxemia, respiratory failure, and death. Inhaled environmental causes have been identified in several well-described forms of ILD, including hypersensitivity pneumonitis, asbestosis, and silicosis.

Ambient air pollution has received relatively little attention in the field of ILD but is known to contribute to a range of pulmonary and systemic diseases. Air pollution exposure is increasingly implicated in adverse health outcomes, including asthma, COPD, cardiovascular disease, and, most recently, lung cancer. We believe that a plausible argument can be made for a relationship between ambient air pollution and ILD. This article reviews the current clinical and biologic evidence linking air pollution exposure to the development and progression of ILD and proposes a new way of conceptualizing cumulative environmental risk factors in this patient population. *(Air Pollution Exposure by Kerri A. Johannson, MD, John R. Balmes, MD, FCCP, and Harold R. Collard, MD, FCCP)*

Health impacts of air pollution

Short-term effects are temporary and range from simple discomfort, such as irritation of the eyes, nose, skin, throat, wheezing, coughing and chest tightness, and breathing difficulties, to more serious states, such as asthma, pneumonia, bronchitis, and lung and heart problems. Short-term exposure to air pollution can also cause headaches, nausea, and dizziness.

These problems can be aggravated by extended **long-term** exposure to the pollutants, which is harmful to the neurological, reproductive, and respiratory systems and causes cancer and even rarely deaths. The long-term effects are chronic, lasting for years or the whole life and can even lead to death. Furthermore, the toxicity of several air pollutants may also induce a variety of cancers in the long term.

Neurological effects have been observed in adults and children after extended-term exposure to air pollutants. It is important to state that impact on the immune system, causing dysfunction and neuroinflammation, is related to poor air quality. Furthermore, skin is our shield against ultraviolet radiation (UVR) and other pollutants, as it is the most exterior layer of our body. Traffic-related pollutants, such as polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs), oxides, and PM, may cause pigmented spots on our skin. Another exterior organ that may be affected is the eye. Contamination usually comes from suspended pollutants and may result in irritation or dry eye syndrome.

What are the health consequences of air pollution on populations?

Both short- and long-term exposure to air pollutants have been associated with health impacts. More severe impacts affect people who are already ill. Children, the elderly and poor people are more susceptible. The most health-harmful pollutants – closely associated with excessive premature mortality – are fine PM2.5 particles that penetrate deep into lung passageways

What is particulate matter, or PM?

Particulate matter is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Large concentrations of particulate matter are typically emitted by sources such as diesel vehicles and coal-fired power plants. Particles less than 10 micrometers in diameter (PM10) pose a health concern because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers in diameter (PM2.5) are referred to as "fine" particles and pose the greatest health risks. Because of their small size (approximately 1/30th the average width of a human hair), fine particles can lodge deeply into the lungs.

Quality air and it’s benefit:

“Air quality” refers to the condition of the air within our surroundings. Good air quality pertains to the degree to which the air is clean, clear and free from pollutants such as smoke, dust and smog, among other gaseous impurities in the air. Air quality is determined by assessing a variety of pollution indicators.

Good air quality is a requirement for preserving the exquisite balance of life on earth for humans, plants, animals and natural resources. As such, human health, plants, animals and natural resources are threatened when pollution in the air reaches high concentrations.

Poor air quality can affect or harm human health and/or the environment. Air quality can be degraded by natural or man-made sources. Natural sources include volcanic eruption, windstorm dust. Man-made sources include pollution from moving vehicles, toxic gases from industries, coal-powered plants, burning wood or other material in the open air, landfills. Both these sources can seriously affect the overall air quality and can lead to severe health problems for humans. (*Conserve energy future, be green stay green*)

The benefits of quality air are –

- Cleaner lungs-Breathe Easier
- Decreased asthma and allergies symptoms.
- Improved skin appearance.
- Helps digestion.
- Psychological and emotional stabilizer.
- Better mood and normalized sleep patterns.
- Reduce chances of lung, heart, and arterial diseases.

Module 09: Assessing health vulnerability

Time: 60 m

Objectives: After completing participants will be able to know

- To understand the concept of health vulnerability
- To understand the steps of assessing health vulnerability in details

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	concept health vulnerability	30 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, video
2.	steps of assessing health vulnerability in details	25 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
4.	Sum up	5 m	Q & A and discussion	Interaction with the participants

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about concept health vulnerability
- Ask if any question and give answer
- Summarize and conclude the session.

Note for facilitators

Concept of health vulnerability

A useful definition of 'vulnerability' in the public health context is the "the degree to which a [11] system is susceptible to injury, damage, or harm". This broad definition emphasizes the importance of well-functioning institutions and the accessibility to quality healthcare that [12, 13]safeguards individual and population health.

Concept of health vulnerability

The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as 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.

Concept of health vulnerability

• Sensitivity, which includes the extent to which health, or the natural or social systems on which health outcomes depend, are sensitive to 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

• The exposure to the weather or climate-related hazard, including the character, magnitude and rate of climate variation;

Concept of health vulnerability

Populations, subgroups, and systems that cannot or will not adapt are more vulnerable, as are those that are more susceptible to weather and climate changes. Understanding a population's capacity to adapt to new climate conditions is crucial to realistically assessing the potential health and other effects of climate change.

Concept of health vulnerability

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 (Woodward et al., 1998).

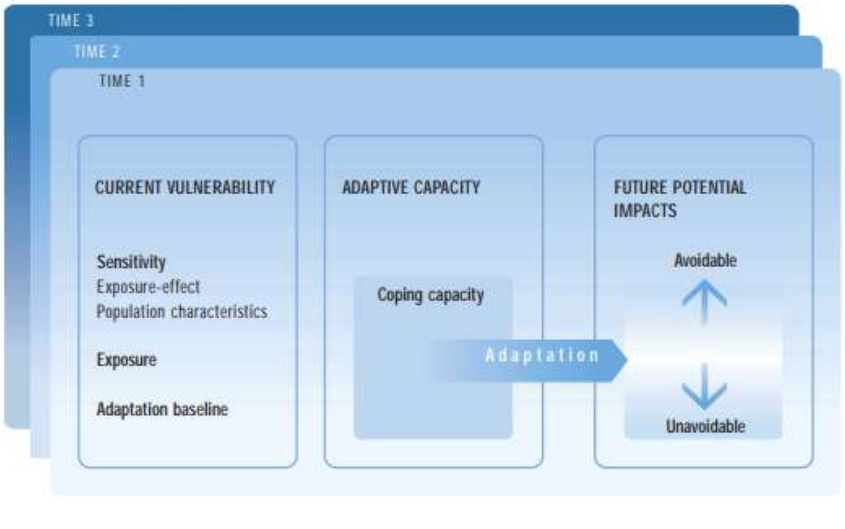
Concept of health vulnerability

These factors are not uniform across a region or country or across time and differ based on geography, demography and socioeconomic factors. 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.

Amis of health vulnerability

The primary goal of building adaptive capacity is to reduce future vulnerability to climate variability and change. Coping capacity describes what could be implemented now to minimize negative effects of climate variability and change. In other words, coping capacity encompasses the interventions that are feasible to implement today (in a specific population), and adaptive capacity encompasses the strategies, policies and measures that have the potential to expand future coping capacity.

Fig. 2.1. Schematic of relationships between vulnerability, adaptive capacity and potential health impact

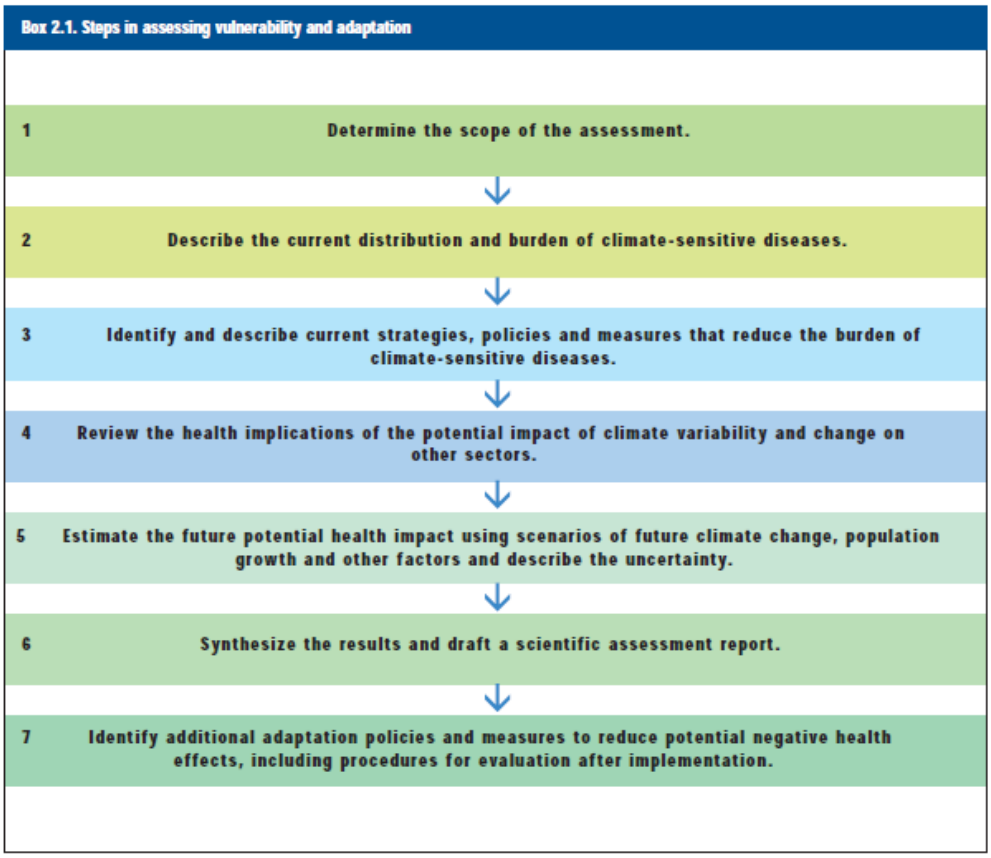


Source: Ebi et al., (forthcoming).

Concept of health vulnerability

Increasing the adaptive capacity of a population shares similar goals with sustainable development – increasing the ability of countries, communities and individuals to effectively and efficiently cope with the changes and challenges of climate change.

Steps to assessing health vulnerability



1. **Determine the scope of the assessment The first step is to specify the scope of the assessment in relation to:**

   • the health and community security issues of concern today and of potential risk in the future;
   • the geographical region to be covered by the assessment; and
   • the time period.

2. **The current burden of the climate-sensitive diseases can be described using the following indicators and outcomes:**

   • The current incidence and prevalence of the disease and the trend (is the disease increasing or decreasing), which may be available from routine statistics from the appropriate national agency; and
   • The attributable burden of a disease to climate and/or weather, such as what proportion of all cardiovascular deaths are attributable to high or low temperatures, or the number of deaths caused by floods. For vector-borne diseases, having a map showing the current geographical distribution of human cases and vectors may be useful. Finally, environmental and socioeconomic conditions also influence human vulnerability and need to be considered within the assessment.

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4. **Review the health implications of the potential impact of climate variability and change on other sectors**

Climate change is likely to affect natural and human systems. Assessments should therefore be integrated across the concerned scientific disciplines and non-health sectors included. International agencies (the IPCC) or regional or national authorities may have assessed the potential impact of climate change on the environment (habitat and land use) at the relevant spatial scale.These effects should be included in the assessments to better understand issues such as the health implications of the direct impact of climate change on the food supply and the risk of disasters (such as coastal or river flooding).

5. Estimate the future potential health impact

Climate variability and change are adversely affecting human health and well-being and will continue to do so. The inherent inertia in the climate system means that the impact of current greenhouse gas emissions will be delayed for decades to centuries.The IPCC projections for the increase in mean surface temperature for the 21st century range from 1.4°C to 5.8°C.As a consequence, anthropogenic warming is projected, on average, to range from 0.1°C to 0.5°C per decade during this century. Even larger changes may be expected beyond the 21st century.

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This step synthesizes the quantitative and qualitative information collected in the previous steps to identify changes in risk patterns and opportunities and to identify links between sectors, vulnerable groups and stakeholder responses. Convening an interdisciplinary panel of experts with relevant expertise is one approach to developing a consensus assessment. Chapter 6 provides guidance for describing the level of evidence behind a consensus statement. Once synthesized, the information should be peer-reviewed and published.

Defining key terms around health vulnerability

A useful definition of 'vulnerability' in the public health context is the "the degree to which a [11] system is susceptible to injury, damage, or harm". This broad definition emphasizes the importance of well-functioning institutions and the accessibility to quality healthcare that[12,13] safeguards individual and population health.

"Vulnerability is a function of the character, magnitude, and rate of climate variations to which a system is exposed, its sensitivity, and its adaptive capacity" [12] . The following diagram (Figure 2) illustrates the key connections between exposure, sensitivity, and adaptive capacity that collectively determine vulnerability to the health system resulting from climate change.

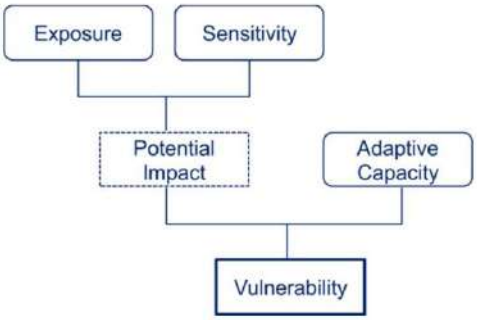


Figure 2. Vulnerability determined by exposure, sensitivity, and adaptive capacity (Source: Australian Greenhouse Office, 2005)

A climate vulnerability assessment identifies where health susceptibilities exist due to climate change, which will continue to alter the magnitude, frequency, duration, and geographic

The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as the degree to which individuals and systems are susceptible to or unable to cope with the adverse effects of

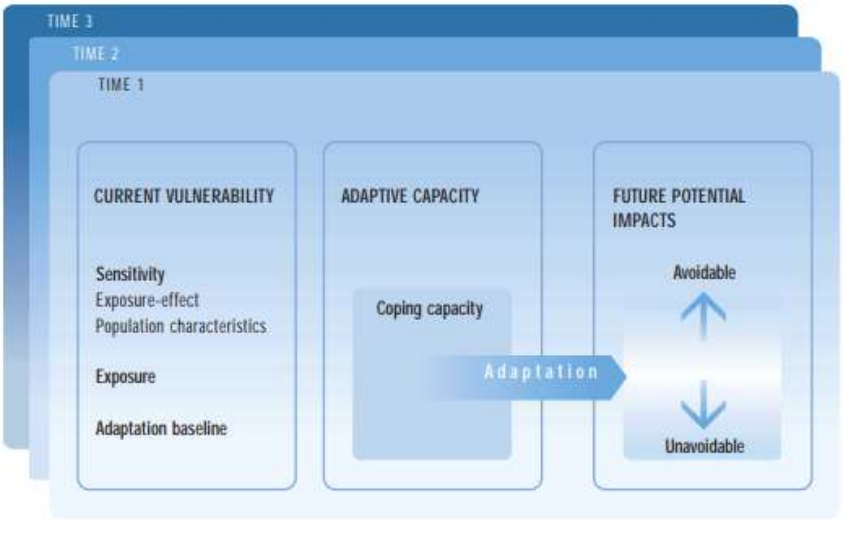
climate change, including climate variability and extremes. The vulnerability of human health to climate change is a function of:

• sensitivity, which includes the extent to which health, or the natural or social systems on which health outcomes depend, are sensitive to 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;

• the exposure to the weather or climate-related hazard, including the character, magnitude and rate of climate variation;

Populations, subgroups, and systems that cannot or will not adapt are more vulnerable, as are those that are more susceptible to weather and climate changes. Understanding a population's capacity to adapt to new climate conditions is crucial to realistically assessing the potential health and other effects of climate change. 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 (Woodward et al., 1998). These factors are not uniform across a region or country or across time and differ based on geography, demography and socioeconomic factors. 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.

Fig. 2.1. Schematic of relationships between vulnerability, adaptive capacity and potential health impact



Source: Ebi et al., (forthcoming).

The primary goal of building adaptive capacity is to reduce future vulnerability to climate variability and change. Coping capacity describes what could be implemented now to minimize negative effects of climate variability and change. In other words, coping capacity encompasses

the interventions that are feasible to implement today (in a specific population), and adaptive capacity encompasses the strategies, policies and measures that have the potential to expand future coping capacity. Increasing the adaptive capacity of a population shares similar goals with sustainable development – increasing the ability of countries, communities and individuals to effectively and efficiently cope with the changes and challenges of climate change.

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 (Smit & Pilifosova, 2001):

• 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. A framework more familiar in public health is the prerequisites required for prevention (Last, 1998):

• awareness that a problem exists

• understanding of the causes

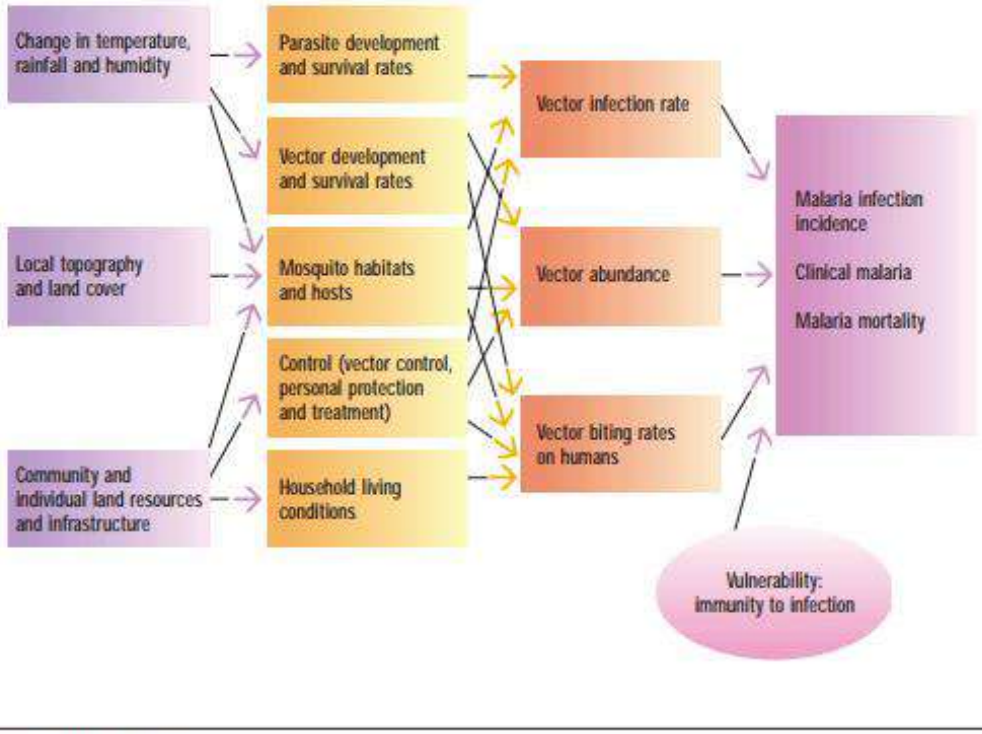
• a sense that the problem matters

• the capability to intervene or influence

• the political will to deal with the problem.

Vulnerability to diseases and injury resulting from CC

Fig. 4.2. Causal web for the associations between climate and one vector-borne disease (malaria)



Source: McMichael et al., in press.

TABLE 6.1. SELECTED AIR POLLUTANTS, SOURCES AND HEALTH EFFECTS

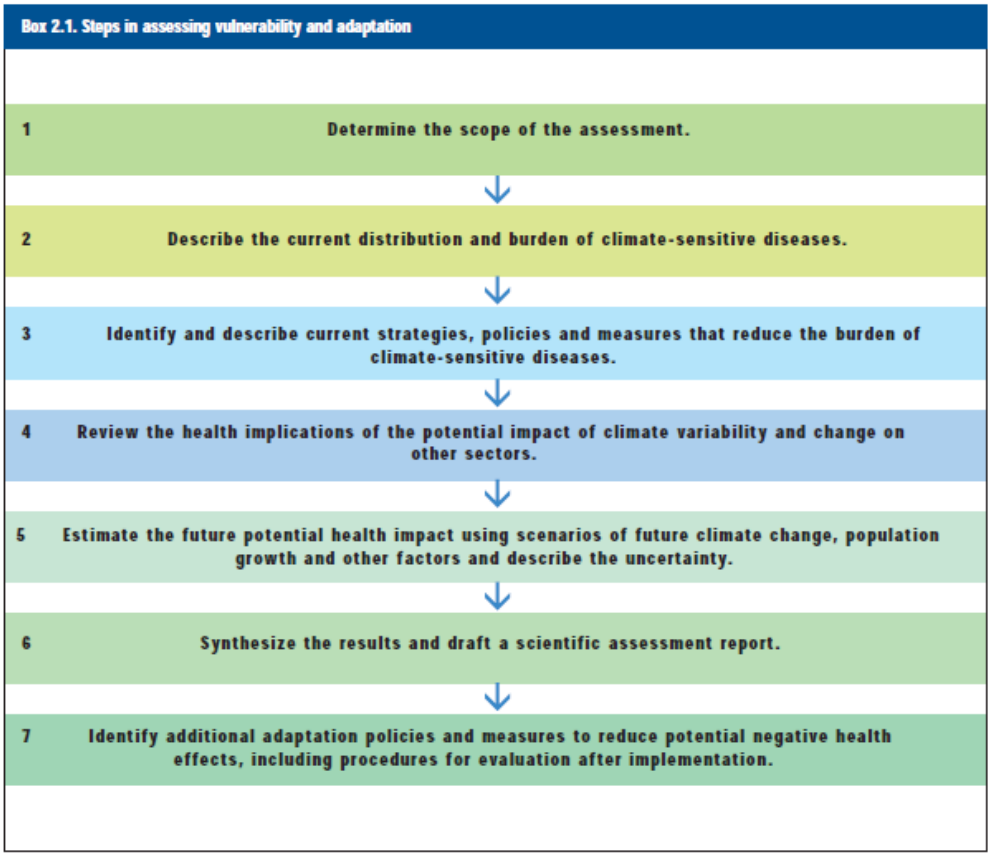
Pollutant	Sources	Health effects
Carbon monoxide	Biomass and fossil fuel combustion, cigarette smoke, vehicular emissions	Headache, nausea, dizziness, breathlessness, fatigue, low birth weight, visual disturbances, mental confusion, angina, coma, death
Ozone	Vehicular emissions, hydrocarbon release, fossil fuel combustion (primary pollutant)	Eye irritation, respiratory tract irritation, reduced exercise capacity, exacerbation of respiratory disease
Particulate matter	Biomass and fossil fuel combustion, cigarette smoke, vehicular emissions	Eye irritation, respiratory tract infections, allergies, exacerbation of respiratory and cardiovascular disease, cancer
Nitrogen oxides	Biomass and fossil fuel combustion, construction materials, industry, cigarette smoke, vehicular emissions	Eye irritation, respiratory tract infections (children are especially vulnerable), exacerbation of asthma, irritation of bronchi
Sulfur oxides	Biomass and fossil fuel combustion, industrial emissions	Respiratory tract irritation, impaired pulmonary function, exacerbation of cardiopulmonary disease
Pollen	Flowering plants	Exacerbation of allergic rhinitis, asthma and other atopic diseases

Source: adapted from Yassi et al., (2001).

TABLE 7.1. PATHWAYS BY WHICH ABOVE-AVERAGE RAINFALL CAN AFFECT HEALT

Event	Type	Description	Potential health impact
Heavy precipitation event	Weather	Extreme event	•Increased or decreased mosquito abundance (decreased if breeding sites are washed away)
Flood	Hydrological	River or stream overflows its banks	• Changes in mosquito abundance • Contamination of surface water
Flood	Socioeconomic	Property or crops damaged	• Changes in mosquito abundance • Contamination of water with faecal matter and rat urine (leptospirosis)
Flood	Catastrophic flood disaster	People killed or injured More than 10 people killed and/or 200 affected and/or government call for external assistance	• Changes in mosquito abundance • Contamination of water with faecal matter and rat urine, and increased risk of respiratory and diarrhoeal disease • Deaths (drowning) • Injuries • Health effects associated with population displacement • Loss of food supply • Psychosocial effects

Steps to assessing health vulnerability



1. **Identify Scope of Assessment**

A. Identify climate-related exposures
B. Identify climate-sensitive health outcomes

2. **Identify known risk factors for potential health outcome**

- For the health outcome(s) identified as being climate sensitive, a list of risk factors known to contribute to higher rates of disease and injury can be identified from scientific literature and consultation from disease subject matter experts. Potential health risk factors includes social (e.g., education, social isolation), economic (e.g., income, social assistance), housing (e.g., housing type and age, prevalence of air conditioning), and neighborhood (e.g., land cover, parks, proximity to road) information.

3. **Acquire spatial information on health outcomes and risk factors**

- To conduct the vulnerability assessment, data on health outcomes and risk factors are needed, preferably at smallest possible administrative unit (e.g., census block group, census tract, county). Analysis at larger geographic areas may mask the neighborhood level variations of health risk factors, but data availability and requirements of computer resources for analyses may limit the spatial scope of the assessment. Therefore, aggregating data at a less detailed scale (e.g., county) may be the only feasible option.

4. Assess adaptive capacity

- In conducting a vulnerability assessment, adaptive capacity can be broadly defined as the ability of a system (e.g., government, infrastructure, civil society, institutions, social capital in community networks) to adjust, limit, and cope with the potential hazards, due to climate change 13 . Assessing adaptive capacity is the evaluation of a system's ability to cope with the hazards resulting from climate change, which may be measured by access to financial resources (e.g., federal aid programs), health infrastructure (e.g., hospitals or ambulatory services, cooling centers), or access to technology (air conditioning) 24 . Adaptive capacity also refers to the ability of a system to reduce hazardous exposures 25, which can be measured by the implementation of government programs, initiatives, or policies.

5. Assessment of vulnerability Both qualitative and quantitative methods can be used on a vulnerability assessment.

- An example of a qualitative assessment would be a series of questions asked about an organization's leadership ability and the accessibility of resources to cope with changes due to climate change 28 , or in depth assessments of health infrastructure (hospitals, nursing homes) and their adaptive 11 capacity to climate change. However, the primary focus of this document will be on quantitative assessment approaches. Two quantitative approaches commonly used to assess vulnerability 29-31 23 using GIS are 1) overlay analysis of risk factors and 2) spatial regression .

4. Determine the scope of the assessment The first step is to specify the scope of the assessment in relation to:

   • the health and community security issues of concern today and of potential risk in the future;
   • the geographical region to be covered by the assessment; and
   • the time period.

5. The current burden of the climate-sensitive diseases can be described using the following indicators and outcomes:

• the current incidence and prevalence of the disease and the trend (is the disease increasing or decreasing), which may be available from routine statistics from the appropriate national agency; and
• the attributable burden of a disease to climate and/or weather, such as what proportion of all cardiovascular deaths are attributable to high or low temperatures, or the number of deaths caused by floods. For vector-borne diseases, having a map showing the current geographical distribution of human cases and vectors may be useful. Finally, environmental and socioeconomic conditions also influence human vulnerability and need to be considered within the assessment.

3. Identify and describe current strategies, policies and measures that reduce the burden of climate-sensitive diseases

The key questions to address for a specific health outcome include the following.

• What is being done now to reduce the burden of disease? How effective are these policies and measures?
• What could be done now to reduce current vulnerability? What are the main barriers to implementation (such as technology or political will)?
• What strategies, policies, and measures should begin to be implemented to increase the range of possible future interventions?

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

Climate change is likely to affect natural and human systems. Assessments should therefore be integrated across the concerned scientific disciplines and non-health sectors included. International agencies (the IPCC) or regional or national authorities may have assessed the potential impact of climate change on the environment (habitat and land use) at the relevant spatial scale.These effects should be included in the assessments to better understand issues such as the health implications of the direct impact of climate change on the food supply and the risk of disasters (such as coastal or river flooding).

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6. Synthesize the results and draft a scientific assessment report

This step synthesizes the quantitative and qualitative information collected in the previous steps to identify changes in risk patterns and opportunities and to identify links between sectors, vulnerable groups and stakeholder responses. Convening an interdisciplinary panel of experts with relevant expertise is one approach to developing a consensus assessment. Chapter 6 provides guidance for describing the

level of evidence behind a consensus statement. Once synthesized, the information should be peer-reviewed and published.

Value judgements have to be made in summarizing the assessment. In particular, decisions should be taken about (Lehto & Ritsatakis, 1999):

- how to balance near-term and long-term effects;
- how to weight the different potential effects in different population groups; • how to balance the more certain, quantifiable potential effects with those that are less certain and not quantifiable, as well as the qualitative effects; and
- how to balance the interests of the various stakeholder groups: experts, people potentially affected and decision-makers

7. Identify additional adaptation policies and measures, including procedures for evaluation after implementation

Identify possible adaptation measures that could be undertaken over the short term to increase the capacity of individuals, communities and institutions to effectively cope with the weather or climate exposure of concern.These measures should be possible to institute within the population's access to material resources, technology and human and social capital. For example, if heat-related morbidity and mortality are health issues in an urban area and if an early warning system for heat-waves is not in place, then would implementing such a system be likely to benefit population health? Strengths and weaknesses as well as opportunities and threats to implementation should be evaluated and priorities set

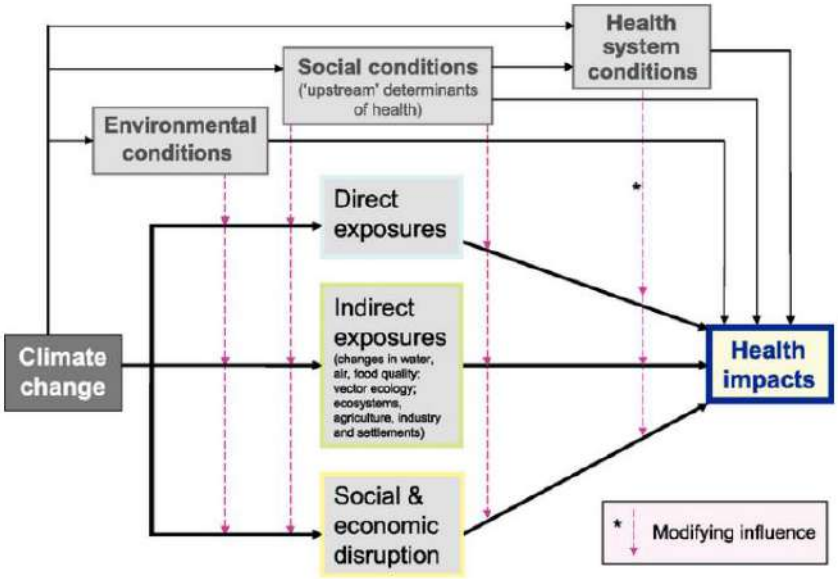
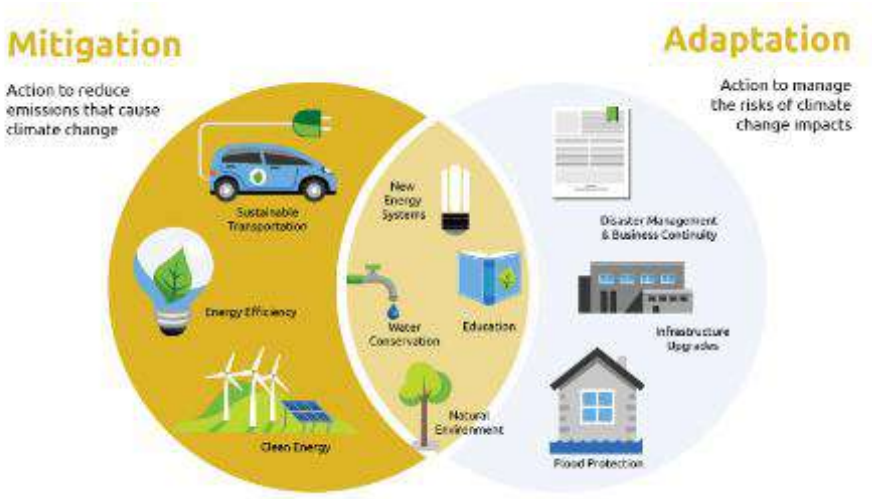


TABLE 3.1. ASSESSMENT OF HEALTH VULNERABILITY AND ADAPTATION: PLANNED KEY MANAGEMENT DELIVERABLES

Policy development	Partnership development	Knowledge generation and exchange
Facilitate the organization of interdisciplinary fora of policy-makers and decision-makers to identify policy questions and research needs	Secure external funding, technical assistance and data sources to initiate and conduct interdisciplinary assessment of health vulnerability and adaptation	Assess the utility and efficiency of various methods and tools to conduct the assessment and identify capacity limitations, resource needs and information gaps
Facilitate the development of comprehensive, interdisciplinary assessment of health vulnerability and adaptation at the national level	Facilitate the organization of key national and international stakeholders for an overarching steering group and interdisciplinary fora of researchers, policy analysts and decision-makers for working groups	Facilitate the organization of interdisciplinary fora of researchers, policy analysts and decision-makers to identify research needs for generating knowledge and for promoting formal and informal dialogue
Organize interdisciplinary fora to set up a structured dialogue to bring research results forward to inform policy on health and well-being	Provide training resources and services for working group assessors and researchers	Develop effective ways of communicating research results to facilitate decision-making
Develop integrated health and well-being policies for climate change that effectively manage the risks to health	Facilitate electronic access to the knowledge generated, surveillance and monitoring data, information sources and opportunities for dialogue	Assess and synthesize research findings
Facilitate the development of monitoring and evaluation mechanisms to respond to changing climate conditions, evolving health impact concerns and opportunities for adaptation	Facilitate the organization of a multidisciplinary network of researchers to conduct peer review of assessment findings	Develop mechanisms for storing and retrieving information

Module: 10 Adaptation and Mitigation to climate change



Time: 75 m

Objectives: After completing the module participants will be able:

- To understand the adaptation what it is
- To understand the different adaptation strategy
- To understand the mitigation what it is
- To understand the different mitigation techniques

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	What is adaptation?	5 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, video
2.	Different adaptation strategy	30 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio

3.	Challenges to ensure proper adaptation strategy	10 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
3.	What is mitigation	5 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
4.	Mitigation technique	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
5.	Sum up	5 m	Q & A and discussion	Interaction with the participants

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about adaptation
- Ask the participants to know their ideas about different adaptation strategies
- Ask the participants to know their ideas about mitigation
- Ask the participants to know their ideas about mitigation techniques
- Ask if any question and give answer
- Summarize and conclude the session.

Note for facilitators

What is adaptation?

Climate change adaptation means altering our behavior, systems, and—in some cases—ways of life to protect our families, our economies, and the environment in which we live from the impacts of climate change.

Adaptation?

Adaptation to climate change is therefore the process through which people reduce the negative effects of climate on their health and well-being and adjust their lifestyles to the new situation around them. In a nutshell adaptation is being better prepared or adapting to climate change, not fighting it, but learning to live with it (Rahman, 2008).

Effective adaptation practice

Effective adaptation practices would reduce the adverse effects on livelihood, health, agriculture, and the environment- particularly in the coastal areas. To cope with climate change impacts, diverse scientific and indigenous knowledge is being utilized. Nevertheless, various barriers are hindering sustainable adaptation. This review focuses on identifying the existing and likely adaptation strategies as well as the barriers to coping with the impacts of climate change in Bangladesh[16].

Adaptation to climate change-related health problems in Bangladesh.

Issues	Health coping strategies
Access to healthcare	Deciding between qualified and unqualified providers
Mental health	Discuss with relatives, friends, and neighbors, avoid self-medication and traditional practices
Extreme weather events	Preparation in advance for food and medications, availability of safe water, assurance of accessible public health service during a post-disaster situation
Vector-borne disease	Netting around beds, avoiding being outdoors at dawn and dusk
Food-borne disease	Maintenance of hygiene during preparation and consumption of foods
Waterborne disease	Precautions regarding health impacts of algal blooms
Disruption of air quality	Regular monitoring and warning during high pollution days
Heatwaves/ Cold waves	Health warning approach in community level, preparedness initiatives during emergency periods[16]

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Different Adaptation Strategies

There are a number of basic strategies that can be taken in response to climate change that categorize various ways to adapt to the altered situation. All of these strategies may be the right thing depending on time and place. However, the choice of strategy should ideally be one that allows the community to remain in situ and maintain similar or improved income if at all possible.

Health

Human health is another area where climate change awareness and various adaptation measures will be needed. The main threat will be an increase in waterborne diseases and heat stress. However, medical workers must monitor diseases such as Kala-azar, spread by the sand fly in dry areas in Rajshahi Division, that may become commoner in drought conditions and dengue fever and malaria that may spread throughout Bangladesh during summer. Regular cleaning-up of sites where disease vectors like mosquitoes are found such as stagnant or polluted water will also be helpful to improve community.

Health

Bangladesh is already vulnerable to outbreaks of cholera and other waterborne diseases but the effects of climate change will make these more common. Adaptation measures to this threat are well known and include the use of a mixture of lime, bleaching powder and alum to water to purify it (Ahmed,2006), or according to the World Health Organization even just bleaching powder.

Health

- Saline contamination of drinking water in coastal and storm surge affected areas is another problem in relation to health.
- Deep tube wells and community or household rainwater harvesting tanks are the best solution. Heat-stress related illness must be tackled by increased awareness especially in the hotter western districts in Khulna and Rajshahi Divisions.
- Monitor the weather and keep people informed on forecasted hot weather by using TV, radio stations and newspapers about the upcoming conditions and also inform how to avoid heat related illnesses.

Health

- Friends, relatives and neighbours are encouraged to visit elderly people during the hot weather and make sure that they have sufficient water and proper ventilation to cope with the situation.
- Set up a telephone “Helpline” to provide information and counselling to the public on avoidance of heat stress.
- Mobile field teams make home visits to vulnerable households.
- Set up shelters for high-risk individuals with ceiling fans or air-conditioned facilities.

- Measures to ensure an adequate supply of water to the communities.

Agricultural Modification

Modifying the threats to crop production seems to be the most practiced adaptation strategy in Bangladesh (Ahmed, 2006). A system of rice farming with its beneficiaries that involves sowing two varieties of rice in the same field, one that needs 8 months to mature but which can survive a relatively long period under water during floods along with a non-flood resistant variety which can produce a yield in only 4 months. Wet bed no-tillage is an adaptation that is used after loss of the transplanted Aman rice crop that has been lost due to tidal surge flooding. The aim of this adaptation is to cultivate relatively quick growing maize before the next winter Boro rice crop.

Agricultural Protection

The adaptation strategy of preventing adverse effects is anticipatory and might require large-scale investments. The building of large-scale embankments or polders to protect valuable agricultural lands from excessive flooding is one such example.

Community Based Adaptation

A process that starts in and with the local community and its adaptive capabilities is vital; especially as climate change adaptation is context. The key characteristic of local and indigenous knowledge is that their methods are locally appropriate, flexible and usually socially or environmentally responsible. Including this knowledge into disaster preparedness, climate change adaptation and the development process can contribute to local empowerment and build sustainability.

National Action Plan on Adaptation, 2005 (updated in 2009) and Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009 have recommended mainstreaming adaptation to climate change into policies and programmes in different sectors. Six Pillars of Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009.

1. Food security, social protection and health to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programmes focus on the needs of this group for food security, safe housing, employment and access to basic services, including health.

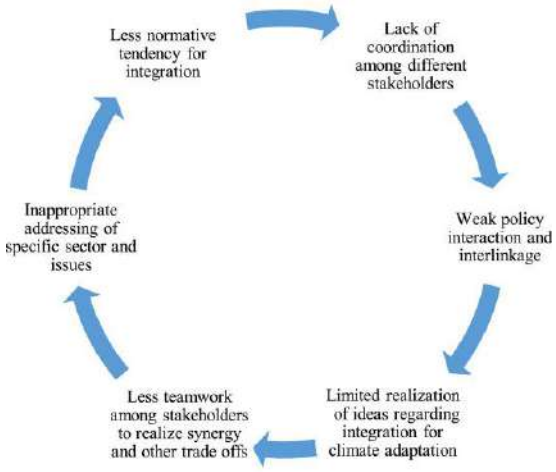
2. Comprehensive disaster management to further strengthen the country's already proven disaster management systems to deal with increasingly frequent and severe natural calamities

3. Infrastructure to ensure that existing assets (e.g., coastal and river embankments) are well-maintained and fit-for-purpose and that urgently needed infrastructure (e.g. cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change.
4. Research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors of the economy and socioeconomic groups; to underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on climate change.

5. Mitigation and low carbon development to evolve low carbon development options and implement these as the country's economy grows over the coming decades.
6. Capacity building and institutional strengthening to enhance the capacity of government ministries and agencies, civil society and the private sector.

Challenges for ensuring proper adaptation

The integration of policies is one of the most significant challenges for ensuring proper adaptation. The lack of institutional processes and weak organizational capabilities hinder the implementation of various adaptation-related projects and programs . There are also challenges in developing fair and robust assessment frameworks for resilience . Lack of awareness - sometimes along with spiritual norms and traditional systems - are barriers to climate change adaptation https://www.sciencedirect.com/science/article/pii/S266727822100105X - bib0091. Furthermore, gendered rules and beliefs of specific regions impact adaptation practices and can impede livelihoods [16]https://www.sciencedirect.com/science/article/pii/S266727822100105X - bib0112.



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What is Mitigation?

Mitigation refers to efforts to reduce greenhouse gas emissions. Mitigation may also refer to efforts to capture greenhouse gases through certain kinds of land use, such as tree plantation. This will reduce global warming, as the greenhouse layer in the atmosphere will not be so thick and its warming, blanket-like effect will be lessened.

What is Mitigation?

Mitigation means to reduce the severity of the human and material damage caused by climate change. Mitigation specifically refers to actions taken that can lessen the severity of a disaster's impact. Investing in measures that limit hazards can greatly reduce the burden of disasters.

Mitigation techniques

Advocacy

As global warming will affect Bangladeshi people seriously, they must get involved in advocacy with the USA and European countries, as well as new big polluters such as India and China on behalf of their children and poorest neighbours who will be most affected. Bangladeshi organizations can work in partnership with International NGOs, overseas leaders, and donors to highlight the effect of global warming and to lobby for action in developed countries to reduce greenhouse gas emissions.

Mitigation techniques

Advocacy

Advocacy in this way is the most important way Bangladesh can contribute to Climate change mitigation. It may do this through - providing stories and photos to partner organizations abroad showing how global warming is effecting the poor; speaking directly on this issue when visiting developed countries, in churches, public meetings, to government representatives; organizing petitions which can be sent by mail/through partners to overseas governments; by writing articles for websites and magazines circulated overseas so that the public there begins to put pressure on their governments and take action themselves on behalf of Bangladesh and other “severely at risk“ countries.

Mitigation techniques

Lifestyle changes

Individuals and organizations in Bangladesh also have a responsibility to reduce greenhouse gases in the atmosphere. A major way to have an impact is in the area of transport which globally accounts for 14% of greenhouse gas emissions. All organizations concerned about climate change should use gas driven vehicles and individuals should seek to use buses, gas-driven taxis or rickshaws that produce less greenhouse gases. Buying recycled or second hand goods, or simply using them for longer, before discarding or recycling them additionally reduces greenhouse gas production.

Mitigation techniques

Energy Use

Energy use is another way to reduce greenhouse gas emission. Natural gas produces 24% of the country’s fuel need and imported coal and mineral oil 19% (Moral, 2002). The latter is produces large quantities of greenhouse gases to produce electricity, while although very much less, gas still produces some carbon dioxide when burnt. Therefore, every organization should try to cut down the use of electricity e.g. using air conditioning on the very hottest days in offices, switching off lights, televisions, fans and computers when leaving rooms or at night. Solar panels can also be installed on roofs to capture energy and have proved effective in Bangladesh. The use of energy saving light bulbs; fluorescent or LED is one simple way to make a huge difference in electricity consumption. Biogas

plants that use dung and vegetable matter to produce gas for cooking also reduce emissions of carbon dioxide as they produce less than wood fuel.

Mitigation techniques

Agriculture

In South Asia emissions are growing mostly because of the expanding use of nitrogen fertilizers and manure to meet demand for food, resulting from rapid population growth. Firstly organizations should all have family planning on their agenda, as an increasing population will require more intensive agriculture land leading to more emissions from this source, as well as leading to increases from other sources of greenhouse gases such as transport. We can also reduce greenhouse gases emission by reducing the amount of artificial fertilizers, pesticides and other chemicals use during farming. It is also important to apply chemical fertilizers, compost or manure directly into the soil, digging it in, as well as applying only the amount needed. Rice stalks would be better collected and composted or ploughed back into the soil. This management would additionally improve the quality of the soil for agriculture. Agro forestry is the practice of combining forestry and farming on the same piece of land. There is huge potential for tree planting, forest protection and agro forestry in Bangladesh to mitigate climate change.

Adaptation to climate change-related health problems in Bangladesh.

Issues	Health coping strategies
Access to healthcare	Deciding between qualified and unqualified providers
Mental health	Discuss with relatives, friends, and neighbors, avoid self-medication and traditional practices
Extreme weather events	Preparation in advance for food and medications, availability of safe water, assurance of accessible public health service during a post-disaster situation
Vector-borne disease	Netting around beds, avoiding being outdoors at dawn and dusk
Food-borne disease	Maintenance of hygiene during preparation and consumption of foods
Waterborne disease	Precautions regarding health impacts of algal blooms
Disruption of air quality	Regular monitoring and warning during high pollution days
Heatwaves/ Cold waves	Health warning approach in community level, preparedness initiatives during emergency periods

What is adaptation?

Climate change adaptation means altering our behavior, systems, and—in some cases—ways of life to protect our families, our economies, and the environment in which we live from the impacts of climate change.

Adaptation

The word adaptation has evolved from the term adapt, which means, making things/conditions/situations better by changing (Ahmed, 2006). Adapting to changes around us to

have a better way of life is a basic human response and due to the slow action of industrialized countries to implement mitigation measures to reduce their greenhouse gas emissions communities will need to adapt to the already inevitable effects of a changing climate.

Adaptation to climate change is therefore the process through which people reduce the negative effects of climate on their health and well-being and adjust their lifestyles to the new situation around them. In a nutshell adaptation is being better prepared or adapting to climate change, not fighting it, but learning to live with it (Rahman, 2008).

Different Adaptation Strategies

There are a number of basic strategies that can be taken in response to climate change that categorize various ways to adapt to the altered situation. All of these strategies may be the right thing depending on time and place. However, the choice of strategy should ideally be one that allows the community to remain in situ and maintain similar or improved income if at all possible.

Disaster Preparedness measures are activities which increase people’ s ability to predict, prepare for, respond to and recover from the effects of a hazard. Effective early warning systems are a very good adaptation strategy for reducing death and damage due to disasters. Already Bangladesh has an effective early warning system that monitors cyclone formation and their track in the Bay of Bengal using satellite technology. Cyclone warnings issued well ahead of time then allow measures such as evacuation to cyclone shelters and concrete buildings.

Physical measures are also effective and larger scale adaptation measures include-Creation and maintenance of polders/embankments to prevent flooding from surges and high river flow (Jenkins,2006); dredging and re-excavation of blocked rivers, creeks or drainage canals; construction of drainage structures such as ditches, culverts, bridges and regulators/sluices; rehabilitation of roads and other infrastructure (Ahmed, 2006); controlled flooding in combination with compartmentalization, in which certain areas are flooded preventing erosion and flooding elsewhere, as well as allowing nutrients in fresh silt to sediment onto the floodplain; Desalination plants and equipment to provide salt free drinking water; cross dams to enhance the buildup of land through accretion and to reduce erosion (Alam, 2004).

Health

Human health is another area where climate change awareness and various adaptation measures will be needed. The main threat will be an increase in waterborne diseases and heat stress. However, medical workers must monitor diseases such as Kala-azar, spread by the sand fly in dry areas in Rajshahi Division, that may become commoner in drought conditions and dengue fever and malaria that may spread throughout Bangladesh during summer. Regular cleaning-up

of sites where disease vectors like mosquitoes are found such as stagnant or polluted water will also be helpful to improve community.

Bangladesh is already vulnerable to outbreaks of cholera and other waterborne diseases but the effects of climate change will make these more common. Adaptation measures to this threat are well known and include the use of a mixture of lime, bleaching powder and alum to water to purify it (Ahmed,2006), or according to the World Health Organization even just bleaching powder. Awareness on avoiding arsenic containing water, encouraging nutrition or treatment for people who are suffering from arsenic poisoning will also be needed in these areas. Further concern is now also being raised about groundwater irrigation of crops in areas where arsenic contamination is high, as high levels of arsenic have been found in food from these areas; the boro rice crop is particularly affected in this way, so agricultural patterns will also require adaptation to techniques which require less water (Pender, 2005).

- Saline contamination of drinking water in coastal and storm surge affected areas is another problem in relation to health.
- Deep tube wells and community or household rainwater harvesting tanks are the best solution. Heat-stress related illness must be tackled by increased awareness especially in the hotter western districts in Khulna and Rajshahi Divisions.
- Monitor the weather and keep people informed on forecasted hot weather by using TV, radio stations and newspapers about the upcoming conditions and also inform how to avoid heat related illnesses.
- Friends, relatives and neighbours are encouraged to visit elderly people during the hot weather and make sure that they have sufficient water and proper ventilation to cope with the situation.
- Set up a telephone “Helpline” to provide information and counselling to the public on avoidance of heat stress.
- Mobile field teams make home visits to vulnerable households.
- Set up shelters for high-risk individuals with ceiling fans or air-conditioned facilities.
- Measures to ensure an adequate supply of water to the communities.

Agricultural Modification

Modifying the threats to crop production seems to be the most practiced adaptation strategy in Bangladesh (Ahmed, 2006). A system of rice farming with its beneficiaries that involves sowing two varieties of rice in the same field, one that needs 8 months to mature but which can survive a relatively long period under water during floods along with a non-flood resistant variety which can produce a yield in only 4 months. Wet bed no-tillage is an adaptation that is used after loss of the transplanted Aman rice crop that has been lost due to tidal surge flooding. The aim of this adaptation is to cultivate relatively quick growing maize before the next winter Boro rice crop.

Improving livestock rearing productivity has been done in a number of places as a climate change adaptation, such as in Nepal where improved breeds of goats are being promoted. Vermiculture , that is the cultivation of worms to aid composting is supposed to speed up the production of usable compost as well as improve its quality. Vermi compost is cheaper to produce than chemical fertilizers, does not harm the environment as it is natural.

Agricultural Protection

The adaptation strategy of preventing adverse effects is anticipatory and might require large-scale investments. The building of large-scale embankments or polders to protect valuable agricultural lands from excessive flooding is one such example.

Community Based Adaptation

A process that starts in and with the local community and its adaptive capabilities is vital; especially as climate change adaptation is context. The key characteristic of local and indigenous knowledge is that their methods are locally appropriate, flexible and usually socially or environmentally responsible. Including this knowledge into disaster preparedness, climate change adaptation and the development process can contribute to local empowerment and build sustainability.

Mainstreaming climate change adaptation into development thinking and practices has been recommended by many as a priority (Ahmed, 2006) and the Government of Bangladesh’ s National Action Plan on Adaptation, 2005 (updated in 2009) and Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009 have recommended mainstreaming adaptation to climate change into policies and programmes in different sectors. Six Pillars of Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009.

7. Food security, social protection and health to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programmes focus on the needs of this group for food security, safe housing, employment and access to basic services, including health.
8. Comprehensive disaster management to further strengthen the country’s already proven disaster management systems to deal with increasingly frequent and severe natural calamities
9. Infrastructure to ensure that existing assets (e.g., coastal and river embankments) are well-maintained and fit-for-purpose and that urgently needed infrastructure (e.g. cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change.
10. Research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors of the economy and socioeconomic groups; to

underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on climate change.

11. Mitigation and low carbon development to evolve low carbon development options and implement these as the country's economy grows over the coming decades.
12. Capacity building and institutional strengthening to enhance the capacity of government ministries and agencies, civil society and the private sector.

What is Mitigation?

Mitigation refers to efforts to reduce greenhouse gas emissions. Mitigation may also refer to efforts to capture greenhouse gases through certain kinds of land use, such as tree plantation. This will reduce global warming, as the greenhouse layer in the atmosphere will not be so thick and its warming, blanket-like effect will be lessened.

Mitigation is the main response that must be made to prevent future impacts of climate change. It consists of measures such as switching from using coal, to petrol/ oil, to natural gas, which are progressively better in terms of greenhouse gas emissions.

Mitigation means to reduce the severity of the human and material damage caused by climate change. Mitigation specifically refers to actions taken that can lessen the severity of a disaster's impact. Investing in measures that limit hazards can greatly reduce the burden of disasters.

Mitigation techniques

Advocacy

As global warming will affect Bangladeshi people seriously they must get involved in advocacy with the USA and European countries, as well as new big polluters such as India and China on behalf of their children and poorest neighbours who will be most affected. Bangladeshi organizations can work in partnership with International NGOs, overseas churches and donors to highlight the effect of global warming and to lobby for action in developed countries to reduce greenhouse gas emissions.

Advocacy in this way is the most important way Bangladesh can contribute to Climate change mitigation. It may do this through - providing stories and photos to partner organizations abroad showing how global warming is effecting the poor; speaking directly on this issue when visiting developed countries, in churches, public meetings, to government representatives; organizing petitions which can be sent by mail/through partners to overseas governments; by writing articles for websites and magazines circulated overseas so that the public there begins to put pressure on their governments and take action themselves on behalf of Bangladesh and other "severely at risk" countries.

Lifestyle changes

Individuals and organizations in Bangladesh also have a responsibility to reduce greenhouse gases in

the atmosphere. A major way to have an impact is in the area of transport which globally accounts for 14% of greenhouse gas emissions. All organizations concerned about climate change should use gas driven vehicles and individuals should seek to use buses, gas-driven taxis or rickshaws that produce less greenhouse gases. Organizations and individuals should also seek to minimize air flights which result in huge emissions and to buy food and luxury items which have been made locally when go out for shopping, as less emissions will have been produced in the transport of locally made items than imported ones. Buying recycled or second hand goods, or simply using them for longer, before discarding or recycling them additionally reduces greenhouse gas production.

Energy Use

Energy use is another way to reduce greenhouse gas emission. Natural gas produces 24% of the country’ s fuel need and imported coal and mineral oil 19% (Moral, 2002). The latter is produces large quantities of greenhouse gases to produce electricity, while although very much less, gas still produces some carbon dioxide when burnt. Therefore, every organization should try to cut down the use of electricity e.g. using air conditioning on the very hottest days in offices, switching off lights, televisions, fans and computers when leaving rooms or at night. Solar panels can also be installed on roofs to capture energy and have proved effective in Bangladesh. The use of energy saving light bulbs; fluorescent or LED is one simple way to make a huge difference in electricity consumption. Biogas plants that use dung and vegetable matter to produce gas for cooking also reduce emissions of carbon dioxide as they produce less than wood fuel.

Agriculture

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combining forestry and farming on the same piece of land. There is huge potential for tree planting, forest protection and agro forestry in Bangladesh to mitigate climate change.

Module: 11 Management and challenges to meet the health outcome

Time: 75 m

Objectives: After completing the module participants will be able:

- To understand the key facts of health outcome
- To understand the climate sensitive health risks
- To understand the vulnerability reduction
- To understand the Mainstreaming climate change into development and national planning
- To understand the climate change policies, planning and institutions

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	key facts of health outcome	5 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, video
2.	climate sensitive health risks	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
3.	Mainstreaming climate change into development and national planning	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
4.	climate change policies, planning and institutions	25 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
5.	Sum up	5 m	Q & A and discussion	Interaction with the participants

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about the key facts of health outcome
- Ask the participants to know their ideas about climate sensitive health risks
- Ask the participants to know their ideas about vulnerability reduction
- Ask the participants to know their ideas about the Mainstreaming climate change into development and national planning
- Ask the participants to know their ideas about climate change policies, planning and institutions
- Ask if any question and give answer
- Summarize and conclude the session.

Note for facilitators

Key facts

- Climate change affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter.
- Between 2030 and 2050, climate change is expected to cause approximately 250 000 additional deaths per year, from malnutrition, malaria, diarrhoea and heat stress.
- The direct damage costs to health (i.e. excluding costs in health-determining sectors such as agriculture and water and sanitation), is estimated to be between USD 2-4 billion/year by 2030.
- Areas with weak health infrastructure – mostly in developing countries – will be the least able to cope without assistance to prepare and respond.
- Reducing emissions of greenhouse gases through better transport, food and energy-use choices can result in improved health, particularly through reduced air pollution.

Climate-sensitive health risks:

Climate change is already impacting health in a myriad of ways, including by leading to death and illness from increasingly frequent extreme weather events, such as heatwaves, storms and floods, the disruption of food systems, increases in zoonoses and food-, water- and vector-borne diseases, and mental health issues. Furthermore, climate change is undermining many of the social determinants for good health, such as livelihoods, equality and access to health care and social support structures. These climate-sensitive health risks are disproportionately felt by the most vulnerable and disadvantaged, including women, children, ethnic minorities, poor communities, migrants or displaced persons, older populations, and those with underlying health conditions.

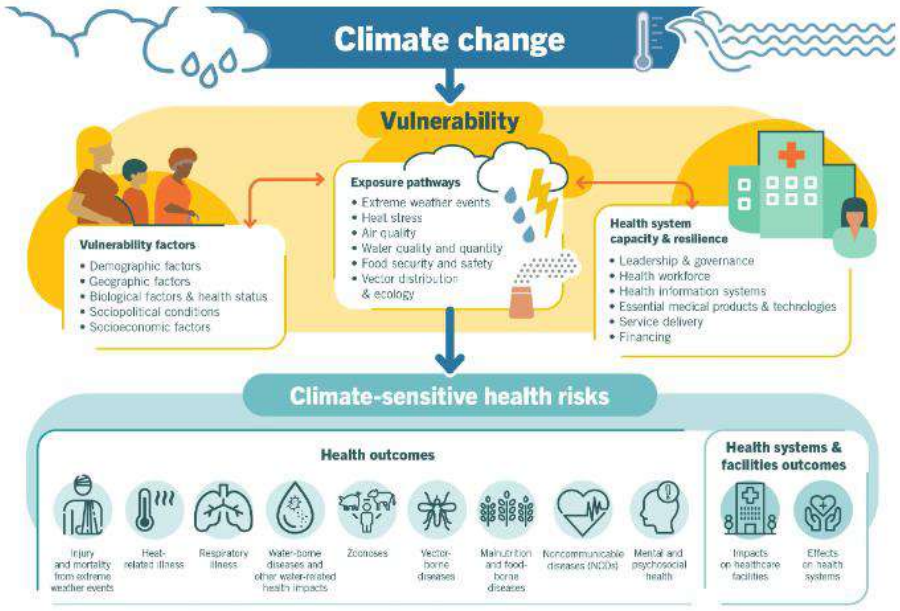

Figure: An overview of climate-sensitive health risks, their exposure pathways and vulnerability factors. Climate change impacts health both directly and indirectly, and is strongly mediated by environmental, social and public health determinants.

Although it is unequivocal that climate change affects human health, it remains challenging to accurately estimate the scale and impact of many climate-sensitive health risks. However, scientific advances progressively allow us to attribute an increase in morbidity and mortality to human-induced warming, and more accurately determine the risks and scale of these health threats.

Vulnerability Reduction

The concept of vulnerability consists of two aspects, susceptibility and resilience; vulnerability reduction aims to reduce susceptibility to hazards and increase community resilience to emergencies. Vulnerability reduction involves vulnerability assessment, hazard prevention and mitigation, and emergency preparedness. Vulnerability reduction aims to decrease community susceptibility and increase community resilience and can focus on emergencies thus preventing many disasters. Vulnerability reduction protects human development, and prepared communities can maintain and improve their level of development. Vulnerability reduction is the responsibility of all, including the health sector, and all sectors at all levels must assist communities to participate in reducing vulnerability. The health sector work in vulnerability reduction requires coordination at all levels within a country.

Mainstreaming climate change into development and national planning

A framework for mainstreaming

The need for developing countries to mainstream adaptation into development planning is reflected in various avenues under the UNFCCC. Article 4.1 of the UNFCCC calls for Parties to take climate change adaptation into account in development planning. Guidance for the development of National Adaptation Programmes of Action (NAPAs) under the UNFCCC states that NAPAs should be 'mainstreamed' into national development planning processes (LEG, 2002). Various guidance exists on 'how to mainstream' adaptation into development, but these are generally targeted 'how-to' guides aimed at development professionals (OECD, 2009; UNDP-UNEP, 2011). Some early guidance was developed for mainstreaming NAPAs into development planning (LEG, 2002), but this was annexed in the overall NAPA development guidelines, and given limited funds for NAPA preparation, many countries did not have the resources or incentives to ensure an integrated approach to NAPA development (Burton & Van Aalst, 2004).

Huq and Ayers (2008) propose a framework for mainstreaming at the national level (see Figure below). As with other guidance developed at this time, the context of the framework assumed the drive for mainstreaming would come largely through international cooperation, given that incentives for climate change adaptation planning at the time were generally externally driven (Ayers & Huq, 2009a). This paper revisits this framework in the context of Bangladesh in the light of experiences around mainstreaming since 2008.

Figure . To building national capacity on climate change adaptation for mainstreaming.

Climate change policies, planning and institutions

Bangladesh has approached adaptation mainstreaming both from a climate change perspective, through development of climate change specific plans, programmes and institutions that address developmental aspects of vulnerability, and also from a development perspective, integrating climate risk into development programmes and policies to help build broader cross-sectoral resilience.

Climate change policies, planning and institutions

In terms of climate-specific planning, Bangladesh was one of the first countries to develop its NAPA, in 2005. The NAPA proposed 15 projects that would contribute towards meeting Bangladesh's 'urgent and immediate' adaptation needs (MOEF, 2005). To date, one NAPA project has gone forward for implementation with funding from the Least Developed Countries (LDCs) Fund: 'Coastal Community-Based Adaptation to Climate Change through Coastal Afforestation in Bangladesh' (MOEF, 2008). The NAPA was updated in 2009, presenting nine short-term projects and nine medium-term projects. Although the NAPA is generally well regarded, it has faced criticism for adopting a relatively 'stand-alone' approach to adaptation through targeted climate change adaptation projects. Further, the process was developed in response to international policy and financial incentives under the UNFCCC, rather than being a product of national political will (COWI/IIED, 2009).

Climate change policies, planning and institutions

The National Capacity Self-Assessment (NCSA) for implementing the provisions of multilateral agreements, including the UNFCCC, was launched in 2007, and capacity-building for climate change received high priority. The Capacity Development Action Plan of NCSA identified a package of 15 actions for climate change, including capacity-building of relevant ministries and agencies for adaptation and mitigation.

Climate change policies, planning and institutions

Following the NAPA, the Government of Bangladesh, with support from development partners including the UK DFID, instigated the Bangladesh Climate Change Strategy and Action Plan (BCCSAP). Updated in 2009, the BCCSAP is now the main national planning document for climate change action in Bangladesh. The BCCSAP is widely regarded as having built on progress made under the NAPA, taking forward the research and recommendations into a more integrated and strategic planning framework.

Climate change policies, planning and institutions

The BCCSAP is a ‘pro-poor' climate change management strategy which prioritizes adaptation and disaster risk reduction, and also addresses low carbon development, mitigation, technology transfer and mobilization of international finance. The BCCSAP (MOEF, 2009) has six pillars:

- Food security, social protection and health,
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Climate change policies, planning and institutions

There are 44 programmes under the BCCSAP. A 2.5 million USD Technical Assistance programme is being implemented by ADB to support BCCSAP implementation, including capacity-building of the Ministry of Environment and Forests (MOEFs) as well as other ministries involved in implementation.

Climate change policies, planning and institutions

There are two main trust funds to support implementation of the BCCSAP. One is funded by the Government of Bangladesh – the Bangladesh Climate Change Trust Fund (BCCTF), at a size of 100 million USD. More than 100 projects have been approved under the BCCTF (Pervin, 2013). The second is funded by several donors, the Bangladesh Climate Change Resilience Fund (BCCRF), with over 170 million USD to date. This dual approach is a resolution resulting from tensions over fund management control between the Government of Bangladesh and international agencies concerning fiduciary risk (Hedger, 2011). Projects submitted to either fund must conform to the needs and priorities identified in the BCCSAP.

Climate change policies, planning and institutions

Figure presents the institutional arrangements supporting climate change in Bangladesh. The 2010 Climate Change Trust Fund Act provides guidance on how BCCTF funds can be disbursed and the supporting national institutional arrangements. The Climate Change Act established:

A Technical Committee, chaired by the Secretary of MOEF with multi-stakeholder membership including from civil society. The Technical Committee reviews and evaluates project proposals to the National Trust Fund. There are subcommittees with key experts related to each pillar of the BCCSAP.

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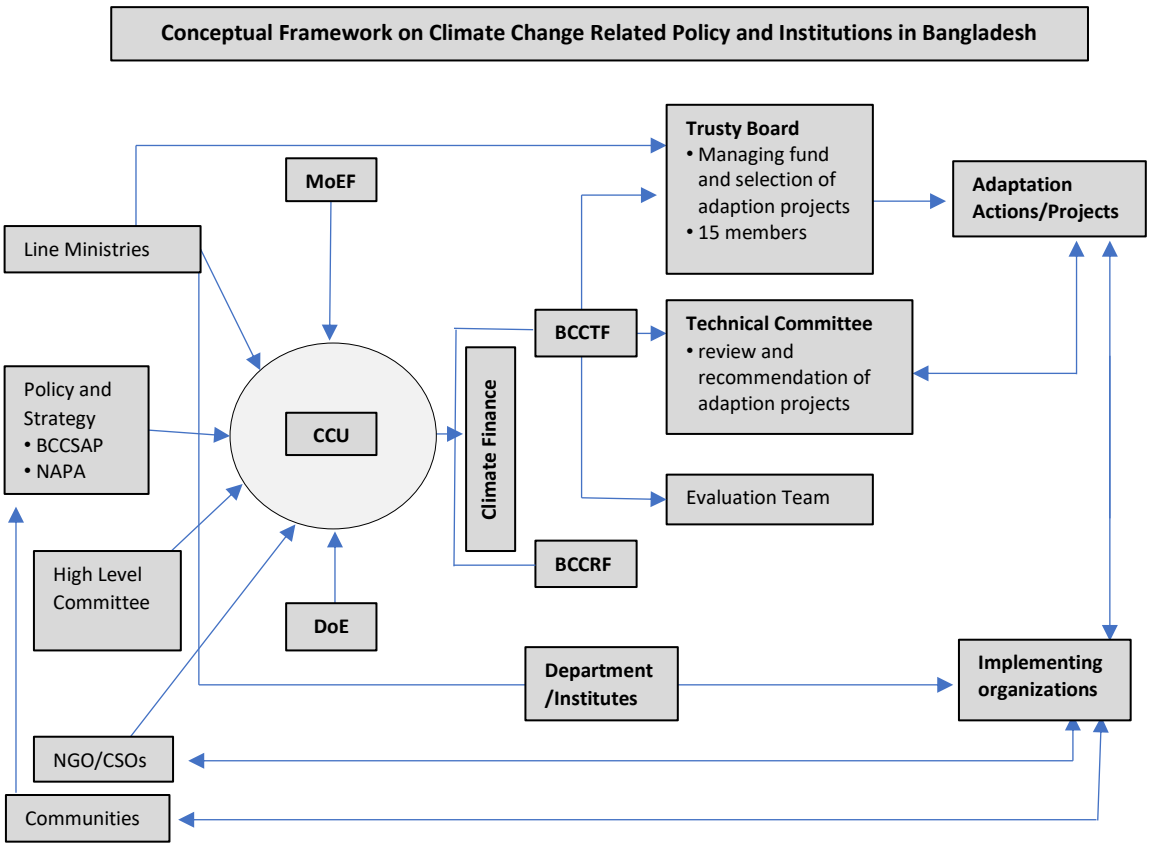
The Trust board, which has the ultimate decision on applications to the BCCTF. Membership comprises 10 ministries and 17 members. The Technical Committee makes recommendations to the Trust Board, which often then requests further information before making a decision.

Figure . Conceptual framework on climate change-related policy and institutions in Bangladesh.



Acronyms:

- BCCSAP- Bangladesh Climate Change Strategy and Action Plan
- BCCRF- Bangladesh Climate Change Resilience Fund
- CCU- Climate Change Unit
- BCCTF- Climate Trust Fund
- MoEF- Ministry of Environment and Forests
- NAPA- National Adaptation Programme of Action
- NGO/CSOs- Non-Governmental/Civil Society Organizations

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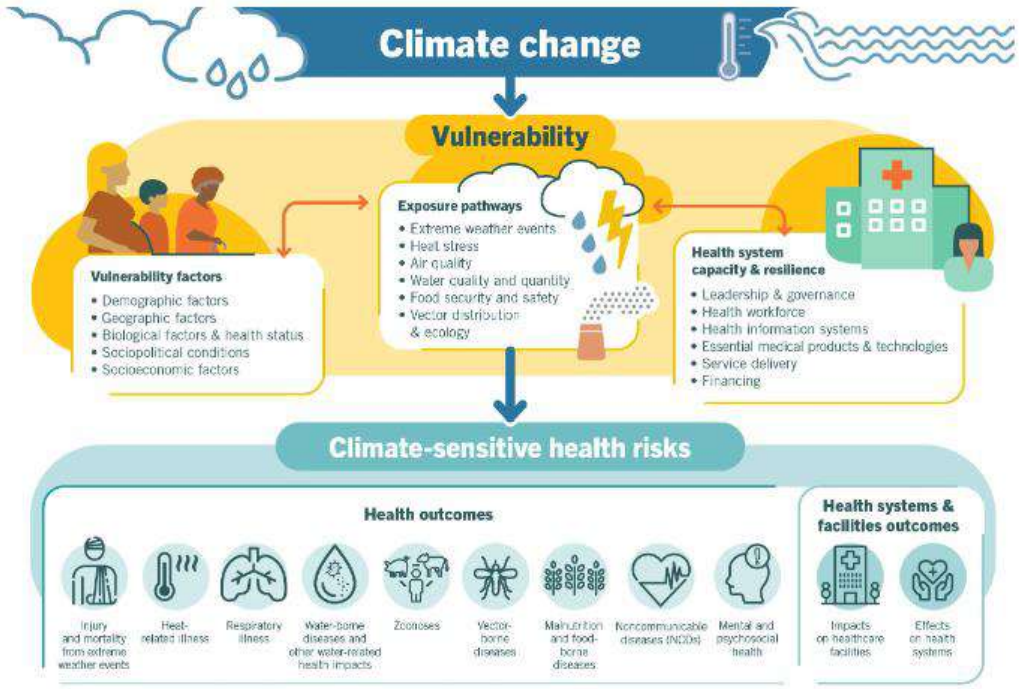

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Mainstreaming climate change into development and national planning

A framework for mainstreaming

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Figure . Four steps to building national capacity on climate change adaptation for mainstreaming.

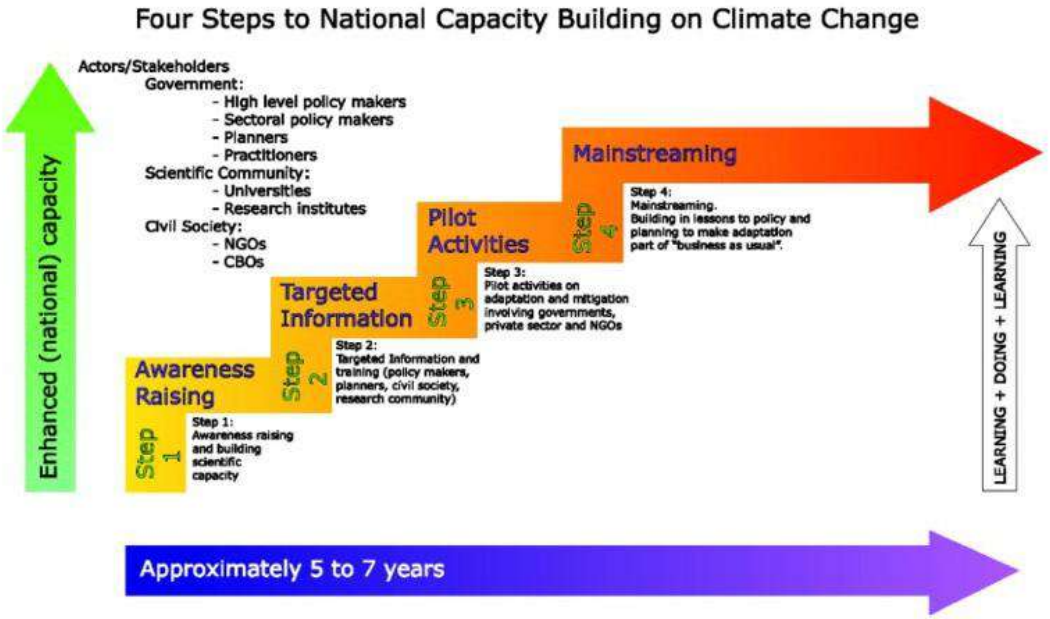

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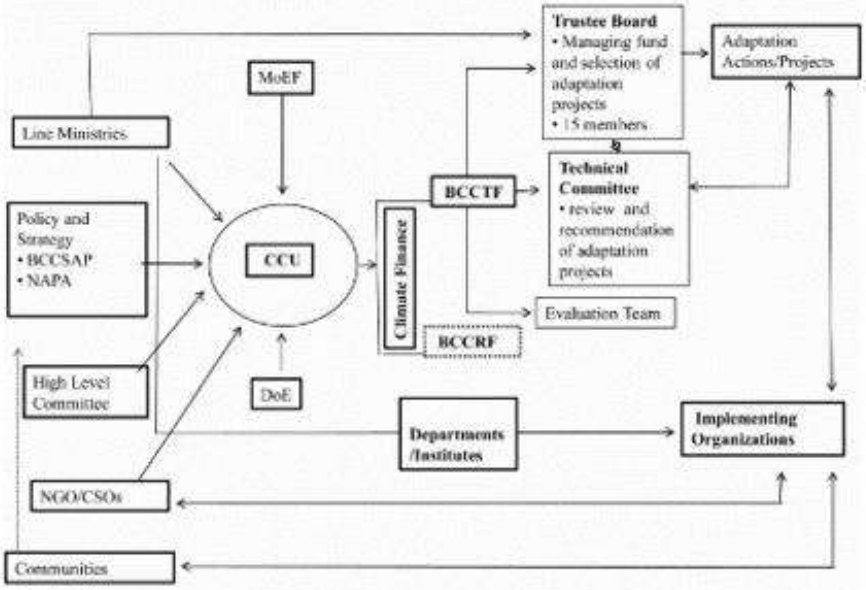
Figure 2. Conceptual framework on climate change-related policy and institutions in Bangladesh.

Conceptual Framework on Climate Change Related Policy and Institutions in Bangladesh



Acronyms:

- BCCSAP: Bangladesh Climate Change Strategy and Action Plan
- BCCRF: Bangladesh Climate Change Resilience Fund
- CCU: Climate Change Unit
- BCCTF: Climate Trust Fund
- MOEF: Ministry of Environment and Forests
- NAPA: National Adaptation Programme of Action
- NGO/CSOs: Non-Governmental/Civil Society Organisations

Module: 12 Community engagement and community-based adaptation

Time: 75 m

Objectives: After completing the module participants will be able:

- To understand the key facts of health outcome
- To understand the climate sensitive health risks
- To understand the vulnerability reduction
- To understand the Mainstreaming climate change into development and national planning
- To understand the climate change policies, planning and institutions

Steps, Contents, Time, Methods and Materials:

Steps	contents	Time	Methods/techniques	Materials
1.	key facts of health outcome	5 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, video
2.	climate sensitive health risks	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio

3.	Mainstreaming climate change into development and national planning	20 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
4.	climate change policies, planning and institutions	25 m	Brain storming, discussion and visualized presentation	Flip sheets, marker, VIPP board, multimedia, vedio
5.	Sum up	5 m	Q & A and discussion	Interaction with the participants

Process:

- Welcome the participants and start the session and establish a link between the last and the current session.
- Ask the participants to know their ideas about the key facts of health outcome
- Ask the participants to know their ideas about climate sensitive health risks
- Ask the participants to know their ideas about vulnerability reduction
- Ask the participants to know their ideas about the Mainstreaming climate change into development and national planning
- Ask the participants to know their ideas about climate change policies, planning and institutions
- Ask if any question and give answer
- Summarize and conclude the session.

Note for facilitators

Community engagement:

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Steps of Community engagement:

- Community Building
- Community Education
- Community Organizing

- Deliberative Dialogue
- Direct Service
- Economic Development
- Engaged Research

Community-based adaptation

Community-based adaptation (CBA) is an approach to strengthening the adaptive capacity of local communities vulnerable to climate change. The CBA approach increasingly features in discussions among policy makers, planners, advocates, and researchers, and has been endorsed and adopted by numerous governmental and non-governmental organizations.

Community-based adaptation

Community-Based Adaptation (CBA) begins by identifying the communities in the developing world that are most vulnerable to climate change. They are generally very poor, depend on natural resources and occupy areas already prone to shocks such as floods or droughts (Huq, 2007). CBA is based on the premise that local communities have the skills, experience, local knowledge and networks to undertake locally appropriate activities that increase resilience and reduce vulnerability to climate change (Dodman & Mitlin).

Community-based adaptation

The people of the coast in particular and the country in general have developed through a process of innovation and practices, a variety of coping strategies and community-based adaptation measures that are well-suited to the local environment, economy and socio-cultural system. The paper argues that because of practicing of age-old indigenous knowledge and practices, people of the coast could lessen damages to lives and property to a great extent in the face of natural disaster.

Community-based adaptation

The paper further argues that the fierce people of the coast have been maintaining a co-existence with natural disaster by applying their indigenous knowledge and practices acquired from their forefathers over the years. Although, Bangladesh is a low greenhouse gas emitting country, it is one of the most vulnerable countries of the world concerning climate change. Due to its vulnerability, local community over the generations has developed many rural adaptation techniques, based on their localized knowledge and practices.

Community-based adaptation Measures

Being one of the most vulnerable countries of the world to climate change, Bangladesh has to go for adaptation measures. The adaptation processes in flood and waterlogged area are hydroponics, duck rearing, ring-based vegetable cultivation. In saline prone area, adaptation processes are mat weaving by reed, reed cultivation, crab cultivation, sheep rearing and kewra cultivation. In drought-prone area, such an adaptation to climate change measures are sheep rearing etc. Considering vulnerability of the coastal people to climate related stresses, following 8 sector-specific CBA measures are looked into:

a) Agriculture;

b) Fisheries;

c) Forestry;

d) Health and Sanitation;

e) Water;

f) Livelihood and Habitat; and

g) Cyclones and Tidal surges.

Community-based adaptation Measures

Agriculture

Anticipated higher temperatures and changing rainfall patterns, coupled with increased flooding and rising salinity in the coastal belt are likely to reduce crop yields and crop production, taking their toll on food security. IPCC estimated in a projection that by 2050, rice production could decline by 8% and wheat production by 32% throughout the country (4th IPCC, 2007).

Best adaptation is replantation, if time permits. If not, fast-growing vegetables could be another alternatives. Other high-value Rabi crops, like maize, potato, peanuts are tried in cyclone-hit areas. Crop damages due to seasonal floods (July-Sept) could be lessened by “double transplantation” of Aman rice; more seedlings; flood-tolerant vegetables; early plantation of crops like potato, maize, and relay crops; floating seedlings etc. Conservation of rainwater in ponds and in borrow pits for irrigation during dry season is practiced, when salinity increases.

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5 th IPCC 2014 said many terrestrial, freshwater, and marine species have shifted their geographic ranges, seasonal activities, migration patterns, abundance in response to ongoing climate change. Fisheries are affected due to increased salinity and drying up of rivers; and tidal surges. In many places, “Cage Aquaculture” for rearing of Telapia fishes (Anik, 2012) and other saline-tolerant 11 variety of fishes (Vetki, Bata, Tengra), Crabs and shrimps are promoted as an answer to increased salinity. Raising banks of Chingri Gher and other water bodies in case of rise in water level and tidal surges is practiced. When salinity decreases in monsoon, other sweet water fishes like Ruhi fishes are inter-cropped with

shrimps. High temp (32 degree C) could increase mortality rate in shrimp hatcheries and there could be outbreak of virus diseases (Shrimp hatcheries in Cox's Bazar were seriously affected by Thai virus some few years back). In some water-logged areas, low-water surviving fishes like Shing, Magur, Koi are cultivated. Intercropping of shrimp (Bagda) with rice has been in practice in many parts of the coastal areas. Climatic change may affect propagation and migration pattern of Hilsa and shrimp. Impacts of temp increase on corals; shrimp, crabs and sharks have not been studied so far.

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Forestry

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Community-based adaptation Measures

Health and Sanitation

Climate change is expected to worsen health principally through increased vulnerability to diseases due to reduced food security, water scarcity and waterborne diseases associated with poor water quality due to floods and droughts (Sen et al., 2009). They take precautionary measures in case of outbreak of cholera, diarrhea, malaria and dengue in flood-prone and tidal surge-prone zones. Some indigenous healing system like use of medicinal plants is adopted to heal common sickness like cold and cough.

Community-based adaptation Measures

Water Resources

In the coastal areas of southern Bangladesh, one further threat of climate change is increasing salinity. Saltwater makes it difficult to grow crops irrigated by freshwater. Near the mangrove forests of the Sunderbans, villagers are responding to the threats of salinity by building houses on raised platforms and installing sealed containers of freshwater. Small containers- called mokti are often made of pottery and partly buried into the clay soil surrounding houses to provide reservoirs of freshwater for every house (Ayers, 2009). Larger water tanks of plastic or even concrete are also installed near schools or in villager centers to provide a more communal and robust reservoir. The freshwater usually comes from rain that is channeled off roofs into containers. Some wealthier farmers are also converting old rice fields to fishponds and using these to fatten crabs for local restaurants. Rainwater harvest in salinity and arsenic contaminated areas has been in practice for ages. In some areas, people excavated canals and created 13 community ponds for ensuring availability of sweet water and rainwater in the face of continued aggression of salinity intrusion.

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Community-based adaptation Measures

Livelihood and Habitant

Coastal zone vulnerability would be acute due to the combined effects of climate change, sea level rise, subsidence, changes in upstream river discharge, and cyclone and coastal embankments (Huq et al, 2003). One community-based adaptation project involves raising and reinforcing homesteads to make them more resilient against flooding and cyclonic activity, reducing the need for people to flee their homes during extreme weather events and reducing 14 losses (Ayers, 2009). These include raising foundations, reinforcing house structures, and creating raised platforms within homes where people can

take shelter during floods. In wetland areas, some NGOs are found running schools in floating boats with the help of solar power (e.g., Shidhulai Swanirvar Sangstha, Natore).

Community-based adaptation Measures

Cyclones and Tidal Surges

In some islands like Sandweep, people go for plantation of Hurma trees which are very strong and can withstand tidal surges (Haque, 2000). In newly-accreted coastal Charlands, plantation of climate-change resistant mangrove forests is promoted. Many people's lives were saved in cyclones and tidal surges with the help of mangrove trees, like Keora and Sundari. In another study, it was observed that the coastal people identified five major symptoms in anticipating and predicting velocity and impacts of a progressing cyclone, they are: a) wind direction; b) temperature and salinity of sea water; c) colour and shape of the cloud; d) appearance of rainbow; and e) behaviour of certain bird species (Hassan, 2000).

Community-based adaptation Measures

Cyclones and Tidal Surges

In a study conducted on the people of the coastal islands, it was revealed that the islanders have developed certain short term survival strategies of their own. Simple tactics like holding onto and binding themselves to trees; looking for comparatively more dependable places like embankments and polders; using floating items such as timber, banana trees, thatched roof, straw piles and bunches of coconuts represent spontaneous survival strategies (Hassan, 2000). For example, during the April 1991 cyclone, people held on these trees or even tied themselves to the tree trunks for survival.

Community-based adaptation Measures

Cyclones and Tidal Surges

Another interesting phenomenon was that during tidal surges, people tied rafts to coconut trees so that they could rise and fall with the water level (Haque, 2000; Haque, 2013). People of the locality have also devised appropriate methods for food preservation during cyclones and tidal surges. Generally, outside help and relief goods appear 2/3 days after the disaster. What do they do during this intervening period? People eat stems and roots of edible plants. For drinking purposes, they drink rain water, as cyclones are always followed by rain for several hours. In absence of rainwater, they share coconut water. Due to non-availability of medicines, generally, the victims depend on herbs and other local substances for treating minor injuries, fever and diarrheal diseases.

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Lessons and challenges in community-based adaptation

Although CBA is a very recent development, a number of lessons and challenges are already emerging, around the availability and credibility of climate change information and data, the quality of participatory processes in CBA, scaling up, and monitoring and evaluation.

- **Issues around knowledge**
  - Good information on which to base climate change adaptation is vital, but it is not always available, accessible, or credible.
- **Scientific data**
  - Christian Aid (this issue) highlight the difficulties communities often experience in accessing climate change data that they can use in planning.

Lessons and challenges in community-based adaptation

- **Local knowledge**
  - Whilst communities often have little confidence in the reliability of information from scientists, scientists are often equally reluctant to trust local knowledge, which they regard as subjective and lacking in rigour (Gaillard and Maceda, this issue). However, in the absence of weather records and climate change data, CBA may be largely dependent on local knowledge of past climate trends for forecasting future trends.
- **Issues around participation**
  - CBA activities demonstrate a variety of types and degrees of participation
- **Difficulties with the concept of 'community'**

- Whilst CBA focuses on 'the community', it is very important to be aware of differences in priorities, needs, vulnerability, and capacities within communities. Tanner et al., for example, show that there are marked differences in perceptions of the importance of different hazards by age and gender in the Philippines.

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Lessons and challenges in community-based adaptation

- **Monitoring and evaluation**
- Monitoring and evaluation (M&E) of CBA activities will also be a challenge. Good CBA should be truly participatory and devolve much of the decision-making down to the community level, but this makes any centralised reporting or evaluation activities more difficult to coordinate. This is an important issue, because it is the responsibility of industrialised nations to help poor countries adapt to climate change, so some means of evaluating the effectiveness of funded CBA programmes is required.
- **Policies and institutions for CBA**
- Whilst CBA is focused on the community level, it cannot be carried out in isolation from events and activities occurring at other levels, for example: • CBA is affected by the services and support available (or more often not available) at district and national levels, for example, long-range weather forecasts, downscaled climate scenarios, satellite images, information on weather

forecasting, and agricultural and other extension services, and the ability of support organisations to integrate their activities.

Community engagement

'Community engagement' is therefore a strategic process with the specific purpose of working with identified groups of people, whether they are connected by geographic location, special interest, or affiliation to identify and address issues affecting their well-being.

Steps of Community engagement:

Community Building

Projects that intentionally bring people together to simply get to know one another.

Community Education

Projects that provide instructional services or curricula or serve to educate the public about a social issue (in a non-partisan way).

Community Organizing

Projects that bring people together with the goal of solving a community issue. Please note that OCE cannot work on partisan issues, but can contribute to creating solutions for non-partisan, local issues. An example is assistance in establishing the Latino Parent Advisory Board for the local school.

Deliberative Dialogue

Projects that intentionally bring people together to build understanding across differences.

Direct Service

Projects that provide a service or product to an individual, group, or the community as a whole. Examples include filling a volunteer shift at a local organization, creating social media tools for an organization, or creating a community mural.

Economic Development

Projects that work on developing the regional economy in a sustainable way. Note that OCE does not partner with for-profit entities except when doing so would benefit the community as a whole and not the for-profit only organization. Examples include feasibility studies for new businesses and projects that attract people to small town business disricts.

Engaged Research

Research that directly benefits the community by clarifying the causes of a community challenge, mapping a community's assets, or contributing to solutions to current challenges and

also fits a faculty member's research agenda. In the best-case scenario, faculty with research expertise work alongside community members and students on such projects. An example would be the MIEI community needing assessment.

Institutional Engagement

University resources intentionally offered without undue barriers to the community. OCE can play a role in envisioning institutional engagement efforts. Examples include making Briggs library cards available for community members, making campus events accessible, and choosing to use local and sustainable businesses to supply services or goods.

Community-based adaptation

Community-based adaptation (CBA) is an approach to strengthening the adaptive capacity of local communities vulnerable to climate change. The CBA approach increasingly features in discussions among policy makers, planners, advocates, and researchers, and has been endorsed and adopted by numerous governmental and non-governmental organizations.

Community-based adaptation (CBA) to climate change is an approach to adaptation that aims to include vulnerable people in the design and implementation of adaptation measures. The most obvious forms of CBA include simple, but accessible, technologies such as storing freshwater during flooding or raising the level of houses near the sea. It can also include more complex forms of social and economic resilience such as increasing access to a wider range of livelihoods or reducing the vulnerability of social groups that are especially exposed to climate risks.

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to its vulnerability, local community over the generations has developed many rural adaptation techniques, based on their localized knowledge and practices.

Founder of Taoism, Lao Tzu has outlined the philosophy of participatory development and narrated the idea of community based development long back in his poem, "Go to the people/ Live with them/ Learn from them/ Love them/ Start with what they know/ Build with what they have/ …when the work is done/ the task accomplished/ the people will say/ we have done this ourselves (Rashid & Khan, 2013). The seven principles are found to represent important assumptions of the community-based approach, they are:

a) community focus;

b) community members' participation;

c) inter-sectoral collaboration;

d) substantial resource requirements;

e) long term programme view;

f) multifaceted interventions; and

g) population outcome (Nilson, 2006).

Adaptation Measures

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Community-Based Adaptation to Climate Change

Adaptation to climate change risks will need to take place at the individual, family, community, and government levels. Top-down interventions include programs and activities implemented by local, state, or national public health and environmental agencies. Stakeholder engagement in the design, implementation, and monitoring of these interventions is needed because the potential health impacts of climate change, and therefore the actions to reduce these impacts, are intimately interwoven with

Framework for Community-Based Adaptation to Climate Change

Because the effects of and responses to climate change will depend on the local context, including geographic, demographic, social, economic, infrastructural, and other factors, many adaptation options will be more effective if designed, implemented, and monitored with strong community engagement. Although some adaptations will require a more top-down approach (e.g., standards to ensure safe air and drinking water), putting the community at the center of other adaptation activities will

An Urban Intervention

A community-based strategy to expand social capital was developed by a nonprofit organization (The City Repair Project) in Portland OR, field-tested in several settings, and evaluated.29, 30 The intervention was not designed to address climate change, but was a primary prevention effort to retrofit the urban environment to reduce urban heat islands. Metropolitan areas tend to be at higher risk during heatwaves because urban climates are often warmer than the unbuilt surroundings.31, 32

Conclusion

Although public health programs designed to reduce the current burdens of climate-sensitive health outcomes are largely successful, recent events highlight an adaptation deficit to current climate variability, suggesting that climate change is likely to challenge the ability of programs and activities to control climate-sensitive health determinants and outcomes in some regions and populations.43, 44 One solution may be to incorporate the risks of climate change into all hazards approaches. The