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A high-altitude mountain landscape. In the foreground, a large, grey, rocky glacier field with numerous small, shallow meltwater ponds stretches across the valley floor. In the middle ground, a vibrant turquoise lake is nestled within a mountain basin. The background features steep, rugged mountains with patches of green vegetation and snow, partially shrouded in thick, white clouds. The overall scene conveys the effects of climate change on glacial environments.

# CLIMATE CHANGE





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Cover picture: ©Department of Geology and Mines

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## CLIMATE CHANGE

### What is climate change? <sup>1</sup>

Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity .

### Natural variability <sup>2</sup>

Climate change is a normal part of the earth's natural variability, which is related to interactions among the atmosphere, ocean, and land, as well as changes in the amount of solar radiation reaching the earth. The geologic record

includes significant evidence for large-scale climate changes in earth's past.

### Human-induced change <sup>3</sup>

#### Greenhouse Gases

Certain naturally occurring gases, such as carbon dioxide (CO<sub>2</sub>) and water vapor (H<sub>2</sub>O), trap heat in the atmosphere causing a greenhouse effect. Burning of fossil fuels, like oil, coal, and natural gas is adding CO<sub>2</sub> to the atmosphere. The current level is the highest in the past 650,000 years. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change concludes, "that most of the observed increase in



*Fig. 1: Glacial retreat is rapid around the globe*





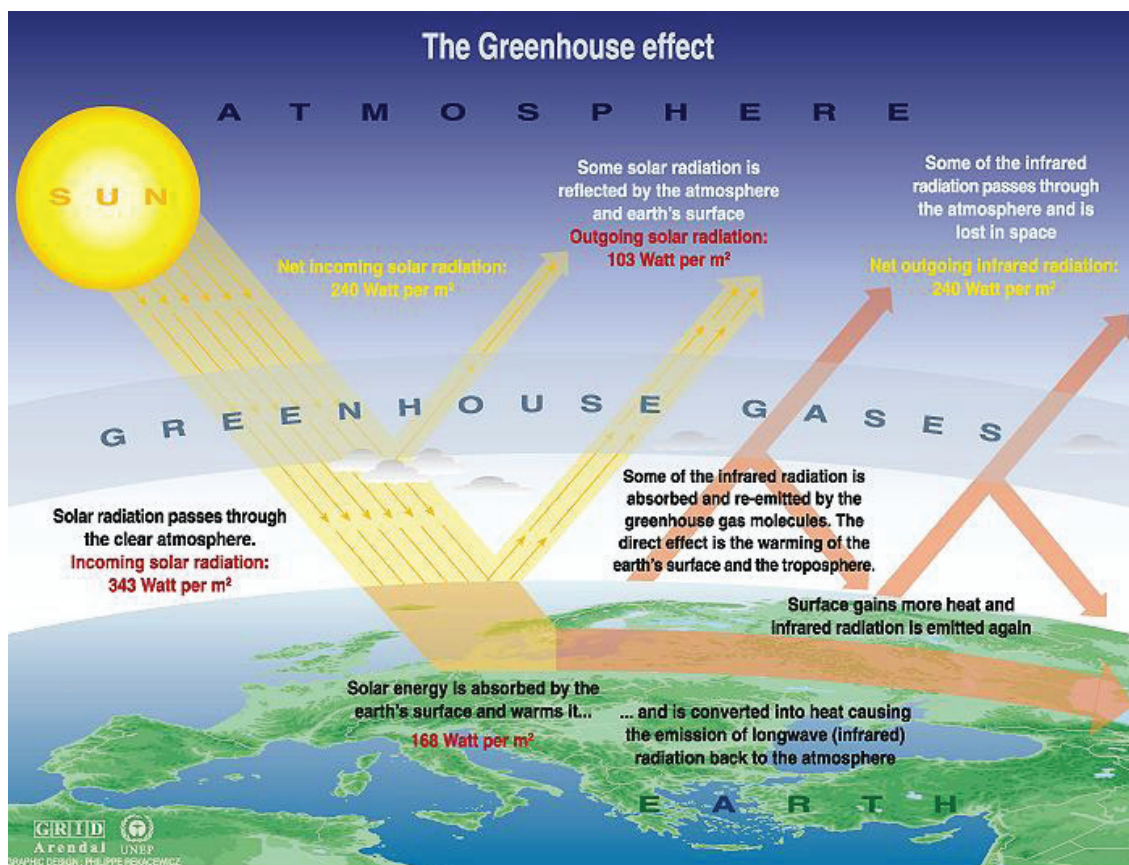


Fig. 2: Diagram showing effect of Green House gases

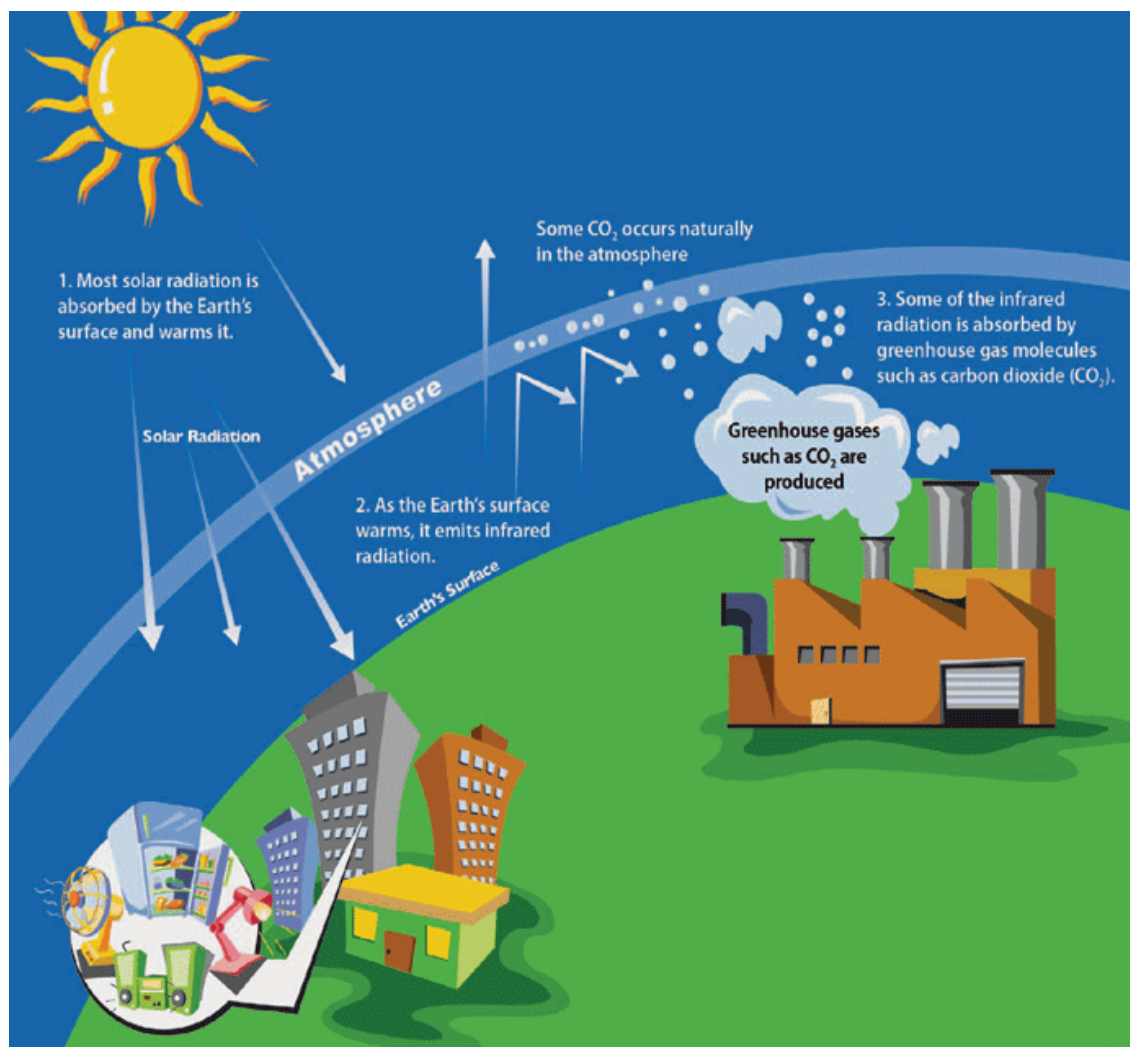
Source: <http://www.solcomhouse.com/globalwarming.htm>

the globally averaged temperature since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."

Our climate is changing, largely due to the observed increases in human produced carbon pollution. The changes include increases in global average air and ocean temperature, widespread melting of snow and ice and rising global sea levels. The extra heat in the climate system has other impacts, such as affecting atmospheric and ocean circulation, which influences rainfall and wind patterns.

Another serious impact of increasing carbon pollution is ocean acidification. Around a quarter of human-produced carbon dioxide is absorbed by the oceans. As the carbon dioxide dissolves in sea water it forms a weak carbonic acid, making the ocean more acidic. There are early indications that some marine organisms are already being affected by ocean acidification.

Scientists agree that the worst effects of climate change can largely be avoided if we can reduce pollution to an acceptable level.



*Fig. 3: Diagram showing how carbon dioxide affects the earth's atmosphere*

Source: <http://www.ezsingapore.gov.sg/climate-change-energy-efficiency.html>

### **Why carbon dioxide can bring about changes in the climate of the earth?**

The heat content of the earth surface is mainly from the sun. When sun light shines on the surface of the earth, the earth will heat up.

After receiving the heat, the earth

will radiate the heat back to space. As a matter of fact, the amount of heat received from the sun and the amount of heat the earth radiated out to space is more or less the same in the long run. Nature is in equilibrium.

The carbon dioxide in air can hinder the heat to radiate back to space.

As such, carbon dioxide acts like a blanket, hinders the earth from losing heat.







If the amount of carbon dioxide in air increases, the capability of the earth to shed the excess heat will reduce. In response, the temperature of the earth will rise, resulting to what is known as global warming.

In our daily life, quite a lot of our activities, i.e. using electrical appliances, will have an impact on the air temperature indirectly. We need electricity to drive our electrical appliances. To meet our need, the electrical power companies burn coal, petroleum or natural gas to generate electricity, in doing so, put carbon dioxide into the air. The amount of carbon dioxide in the air increases, so as the air temperatures.

The material for making paper and wooden furniture comes from trees. The use of paper and wooden furniture requires chopping down of a large amount of trees. Reducing the number of trees to absorb carbon dioxide, the temperature of the whole earth will rise.

## What the science tells us

The vast majority of scientists worldwide agree that the many different lines of evidence all point to the same conclusion: human activity has unintentionally

turned up the global thermostat. The release of large quantities of carbon pollution is making our planet warmer.

Climate change has been confirmed consistently by leading scientific organisations from around the world. The current observed global temperature changes are consistent with the climatic warming trend of 0.2 degrees Celsius per decade that was predicted by the Intergovernmental Panel on Climate Change (IPCC).

The World Meteorological Organization has found that 2000-2009 was the world's warmest decade on record, warmer than the 1990s which in turn was warmer than the 1980s.

Carbon dioxide levels, global average surface air temperature and sea level change are all tracking within IPCC projections which were set out in the Fourth Assessment Report. The report, compiled by 1250 expert authors from 130 countries, provides a rigorous assessment of published and peer-reviewed research on climate change. The report is based on a range of scientific evidence for climate change including observed increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.





## HOW DO WE KNOW THAT OUR CLIMATE IS CHANGING? <sup>4</sup>

Many signs around us caution us of a warming earth. Temperatures, precipitation, birds, butterflies, fish, vegetation, glaciers, and sea levels can indicate changes in the climate system. A few example clues to climate change occurring around the world are discussed below.

### ***Glacial retreat (melt):***

Glaciers are large, slow-moving masses of ice, formed from compacted layers of snow. They are considered

among the most sensitive indicators of climate change. Himalayan glaciers are receding faster today than the world average. Sixty-seven percent of Himalayan glaciers are retreating at a startling rate and a major factor has been identified as climate change.<sup>5</sup>

### ***Sea level rise:***

Sea level has risen 6.7 inches (17.01 cm) in the last 100 years. In 2001, over 45 percent of tourist resorts in the Maldives reported Beach Erosion.



©Department of Geology and Mines

*Fig. 4 Major river system sources in Bhutan are glacial lakes*





### ***Timing of Bird Migration:***

Birds have long been used as an indicator of environmental change and are also good indicators of the effect of climate change. In northern Europe, migratory birds such as the swallow arrived earlier and departed later as a direct response to global warming.

#### ***Moths:***

In Denmark, there has been an increase in the number of moth species as a result of warming.

### ***Polar Bears and Sea Ice:***

In the Arctic region, a 0.50 C increase in temperature in the last thirty years has caused shrinking and thinning of summer sea-ice cover by 45%. This has reduced the polar bear's hunting seasons leading to weight loss and a 15% drop in birth rates in polar bears.

### ***Warmest year recorded:***

Twelve of the last thirteen years (1995–2007) rank among the warmest years since 1850. The years 1998, 2005–2007 was the warmest on record.

### ***Annual Mean Temperatures:***

Meteorological data over the last six years show that Bhutan is becoming warmer. In the southern part, the maximum average temperature in Bhur (Sarbhang) has risen from 27.080 C in 2003 to 28.490 C in 2008 while Bumthang in Central Bhutan has seen an increase from 6.28 degree Celsius to 6.61 degree Celsius. In the east, Trashigang recorded an increase of 0.890C of its maximum average temperature over the same period of time.<sup>6</sup>

### ***Trees and forest fires:***

Tree deaths and frequency of large wild fires have increased in Sierra Nevada (USA) due to increase in temperature.<sup>7</sup>

### ***Tree line:***

The tree line is defined as the upper limit or zone beyond which trees cannot grow. In the Eastern Himalayas, the tree line is rising at a rate of five to ten meters per decade.







## GLOBAL WARMING AND CLIMATE CHANGE

The terms '**global warming**' and '**climate change**' are often used interchangeably, but there is a difference:

**Global warming** is the gradual increase of the Earth's average surface temperature, due to greenhouse gases in the atmosphere.

It is an average increase in the temperature of the atmosphere near the earth's surface and in the troposphere, which can contribute to changes in global climate patterns and influence climate change.

**Climate change** is the result of changes in weather patterns due to changes in the earth's average temperature or global warming. Climate change is a broader term. It refers to long-term changes in climate, including average temperature and rainfall.

Global warming will lead to sea level rise. Two reasons could be identified, i.e. (i) thermal expansion of sea water and (ii) melting of ice/snow on land and the water produced flows into the sea.

When water temperature increases, the volume of water will increase due to thermal expansion. Since water cannot move sideways inside the container, the water level will rise. When sea water heats up, the sea level will rise in the same way.

Global warming will cause the glaciers on high mountains and on land in the polar regions to melt. This will make it increasingly difficult for animals like

polar bears, seals, sea lions and penguins to find suitable habitats. As for us, we would find scenic skiing and touring sites disappearing.

When ice melts, it will turn into water. When more ice cubes in the funnel melt, more melted water will flow into the flask and the water level in the flask will rise. With the same principle, when glaciers melt and turn into water, the water will flow into the sea and the sea level will rise.

A rise in sea level may submerge some small island states which are established on coral atoll reefs. It will also cause flooding of the low-lying coastal region. Moreover, as illustrated in the figure, if there is a rise in sea level, it will make it easier for the coastal regions to be flooded during typhoon attacks or rainstorm events.

Weather becomes hotter and hotter with global warming. Outdoor activities could become a hardship.

Global warming will make the weather unstable. There will be more rainstorm events. Heavy rain may bring landslides which pose a threat to hiking activities.

Mosquitoes thrive better in a hotter environment. In Hong Kong, more mosquitoes can be found in summer than in winter. With a rise in temperature, the number of mosquitoes will rise too. This will make it easier for mosquito-related infectious diseases such as dengue fever to develop.





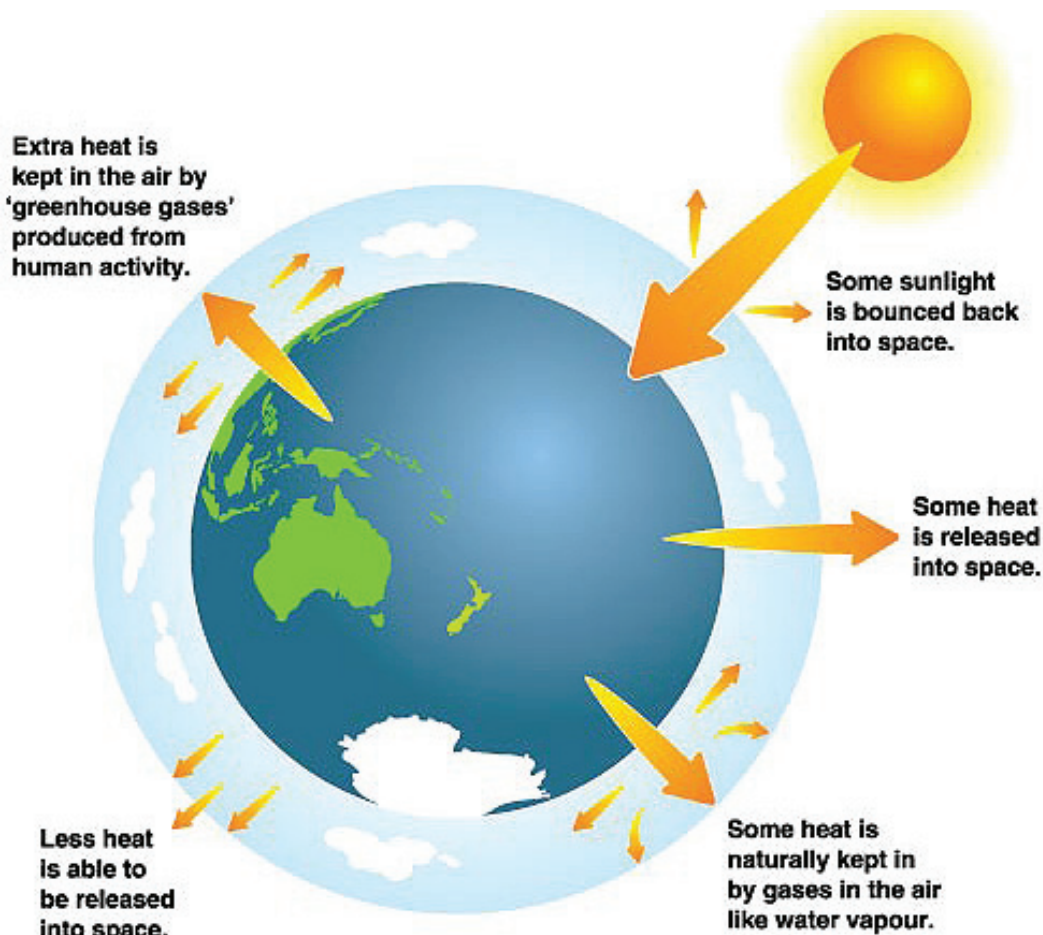
## GREENHOUSE GASES

Greenhouse gases absorb heat from the sun in the atmosphere and reduce the amount of heat escaping into space. This extra heat has been found to be the primary cause of observed changes in the climate system over the 20th century.

Greenhouse gases have always been a natural part of the atmosphere. The chemical properties of greenhouse gases mean that they strongly absorb and re-radiate the sun's warmth in the atmosphere. This process maintains

the earth's temperature at 33°C warmer than it would otherwise be, allowing life on earth to exist.

Water vapour is the most abundant greenhouse gas. Its concentration is highly variable and human activities have little direct impact on its amount in the atmosphere. The main greenhouse gases generated by human activity are carbon dioxide (CO<sub>2</sub>), methane and nitrous oxide. There are also manufactured gases such as chlorofluorocarbons (CFCs), halocarbons and some of their replacements that make a small contribution to global warming.



*Fig. 5: Diagram shows effects of green house gases*

Source: [www.climatechange.govt.nz/science/what-is-climate-change.htm](http://www.climatechange.govt.nz/science/what-is-climate-change.htm)



## Greenhouse gases - and human activity

Greenhouse gases are produced by human activities, including:

- burning fossil fuels, such as coal, oil or gas
- using energy generated by burning

fossil fuels

- some aspects of farming, such as raising cattle and sheep, using fertilisers and growing some crops
- clearing land, including logging
- the breakdown of food and plant wastes and sewerage, and
- some industrial processes, such as making cement and aluminum.

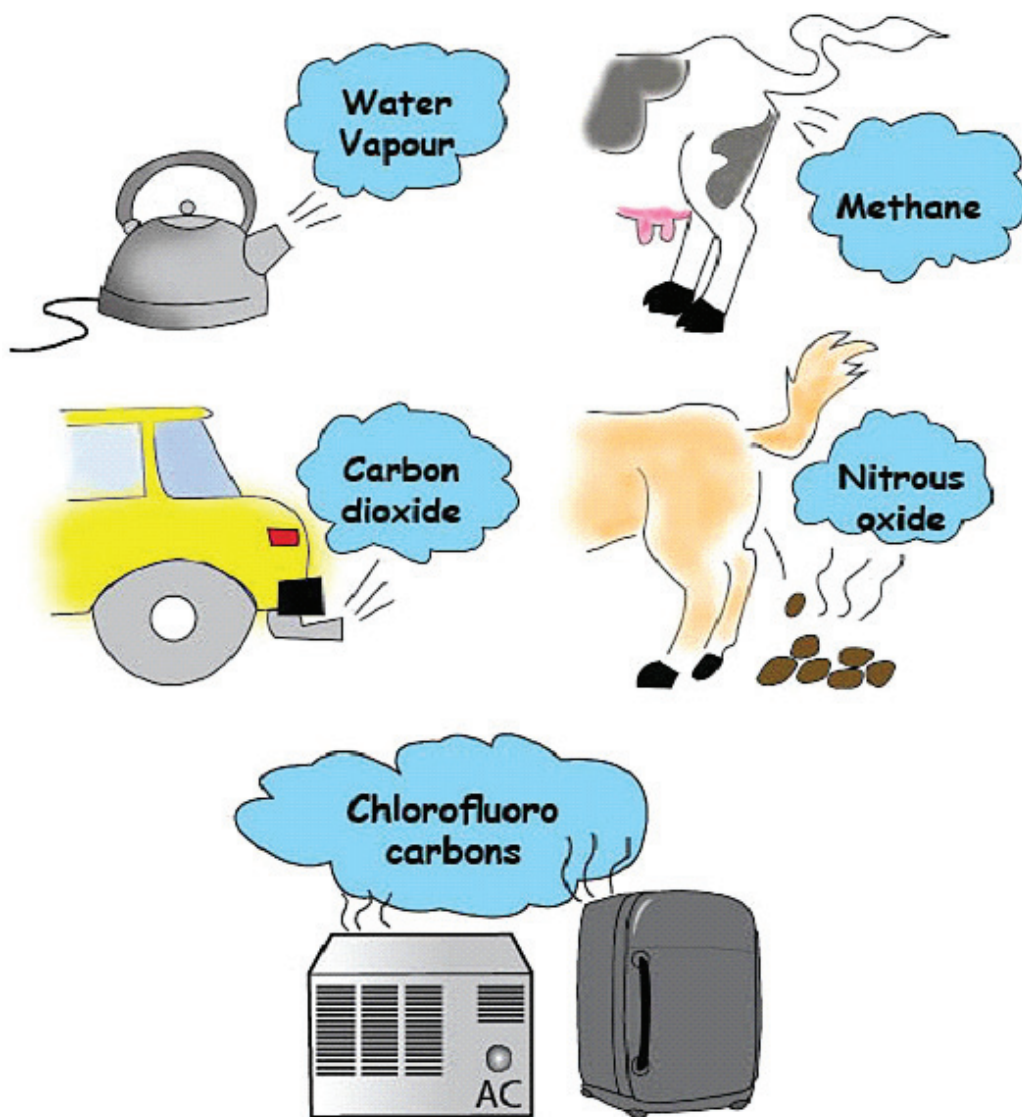


Fig. 6: Diagram showing sources of green house gases







## LIVING WITH CLIMATE CHANGE - WAITING AND ADAPTING VERSUS ACTING NOW

The level of greenhouse gases already in the atmosphere means that some impacts cannot be avoided and scientists believe that further climate change is inevitable, regardless of future efforts to reduce emissions. Without actions to reduce greenhouse gas emissions, the earth's surface temperature is likely to rise by 1.1 to 6.4°C by the year 2100 with more heat waves, fewer frosts, less snow, more storms, stronger tropical cyclones and an 18 to 59cm or greater rise in sea level. Therefore, strategies enabling adaptation to changes in climate will play an important part in reducing the damages and increasing the opportunities associated with the impacts.

Damages can also be reduced by slowing global warming and sea level rise through the stabilisation of greenhouse gas concentrations. The level at which greenhouse gas concentrations might be stabilised will depend on the actions the world takes to reduce emissions and how quickly this might happen. A reduction in emissions does not translate to an immediate reduction in concentrations because carbon dioxide has an atmospheric lifetime of 50-200 years. Once concentrations eventually stabilise, global temperature and sea levels will continue to rise for centuries because of the heat holding capacity of the ocean.

At a two degree temperature rise, we will certainly need to adapt. If temperatures rise by five degrees at the end

of the century, the results would be catastrophic. Food production from farms would decline, and we would experience more bushfires and severe weather events that threaten the livelihoods of our communities. Human health would be at risk from the spread of disease, and the Great Barrier Reef would suffer more coral bleaching as the ocean acidifies more through increasing sea temperatures.

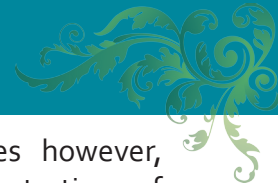
### ***Coping with climate change and a warmer world will mean changing the way we live.***

For example, urban planning in coastal areas will need to consider beach erosion and flooding caused by rising sea levels. In some regions, buildings will need to be designed to cope with more intense tropical cyclones and storm surges. Areas prone to flooding may need to increase their drainage capacity, while drier areas will need to use water more efficiently.

Some farmers may need to adjust their cropping calendar, fertiliser application or varieties of crops to cope with climatic changes. Climate change may affect market prices for some commodities.

Putting in place strategies to adapt to climate change has the potential to reduce the adverse impacts as well as to capture possible benefits. Adapting to climate change will, however, incur





costs and will not prevent all damage. The ability of different sectors, communities and countries to cope with climate change will vary widely.

Many natural systems will have difficulty coping with climate change, particularly those systems that are already vulnerable. For example, coral reefs may experience more frequent bleaching as ocean temperatures rise.

## People and Climate Change: How Humans Affect the Climate System <sup>8</sup>

Changes in the climate have been part of the earth's 4.6 billion year history. From the ice age to longer periods of warmth, natural factors such as volcanic eruptions and the amount of energy released from the sun has affected the earth's climate.

The past two centuries however, have seen changes in concentrations of greenhouse gases in the atmosphere at an unprecedented rate as a result of human activities. Most come from the combustion of fossil fuels in cars, factories and electricity production. As the human population grew, demands for land resources also increased. Land-use change for agriculture and forest products contributed much of the nitrous oxide and methane.

The combined effect of these events altered the earth's energy balance and enhanced the greenhouse effect seriously. Listed below are examples of how human activities have contributed to global warming and climate change

### ***Burning of Fossil Fuel***

Since the Industrial Revolution began, there has been excessive burning of fossil fuels such as coal, oil, and natural gas to run factories, cars and produce elec-



*Fig. 7: Emissions from industries*

<http://www.greenlivingearth.net/tag/sources-of-industrial-pollution/>





*Fig. 8: Vehicular emission is a growing concern*

Source: <http://www.thestar.com>

tricity

Globally, industries contribute to about 6.3 billion tonnes of carbon dioxide into the atmosphere every year. The Industrial Revolution therefore, marked the beginning of the period during which man began to alter the composition and concentration of the atmosphere.

In Bhutan, in 2008, total carbon emission from the industrial sector including mineral products (cement, limestone, and dolomite), chemical products (calcium carbide) and metal production (ferro alloys) was 451.94Gg.<sup>9</sup>

### **Vehicular Emissions**

Worldwide, about 33 percent of the carbon emissions come from the burning of gasoline in internal-combustion engines of cars and trucks. On an average, for each litre of petroleum a vehicle consumes, 2.3 kilograms of carbon dioxide are emitted into the air.

In 2008, carbon emissions from the transport sector was calculated at 201.19Gg. Vehicular emission in Bhutan accounted for nearly 45.3% of the total carbon emission.<sup>10</sup>





## Farming and Agriculture

Carbon dioxide, nitrous oxide and methane are three primary gases from farming agriculture that contribute to global warming. Carbon dioxide is produced through several agricultural processes like tillage and from the use of energy and fuel. High levels of soil nitrogen due to fertilization can lead to increased levels of  $\text{N}_2\text{O}$  production. Beside, altering the earth's land cover and land use, processes such as deforestation and desertification can also change the earth's ability to absorb or reflect heat and light. Livestock production accounts for a significant amount of the world's methane emissions. Animals like cows, sheep and goats digest their food, and they belch methane. With millions of animals on the planet, about 80 million tons of methane a year enters the atmosphere.

Bhutan measured 26.93Gg of methane from the agricultural sector in 2008.<sup>11</sup>

## Waste

The materials in solid waste represent what is left over after a long series of steps: (i) extraction and processing of raw materials; (ii) manufacture of products; (iii) transportation of materials and products to markets; (iv) use by consumers; and (v) decomposition at the landfill. Every step along the way involves the release of greenhouse gases into the atmosphere.

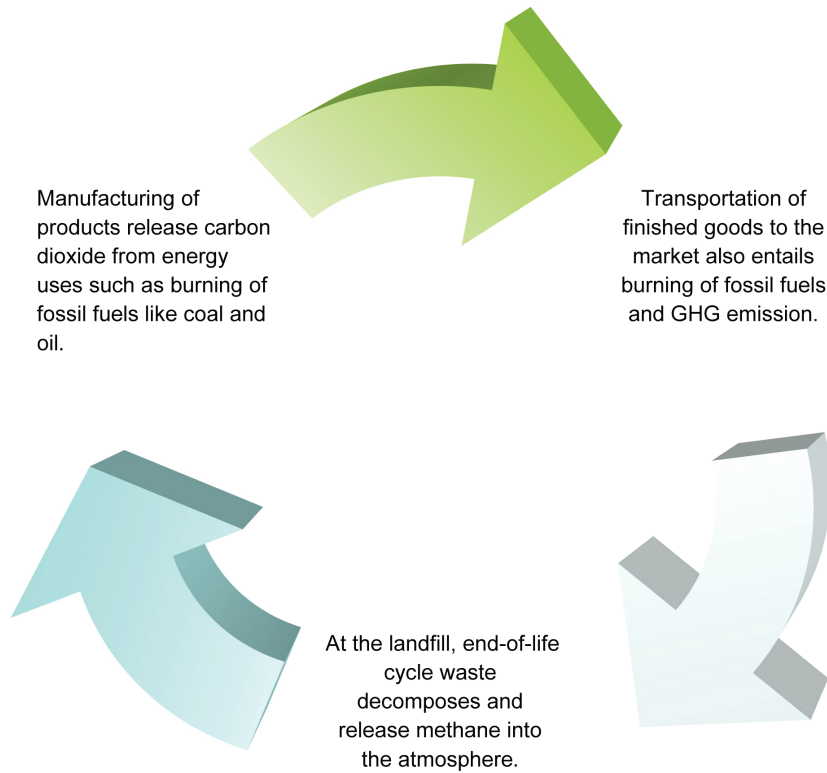
Let us look at the lifecycle of a plastic bag. The process of extracting raw materials, manufacturing, transporting it to the market and landfill sites all consume

A few interesting facts about wastes:

- Up to 60% of the rubbish that ends up in the dustbin could be recycled.
- 70% less energy is required to recycle paper compared with making it from raw materials.
- The unreleased energy contained in the average dustbin each year could power a Television for 5,000 hours.
- As much as 50% of waste in the average dustbin could be composted.
- Glass is 100% recyclable and can be used again and again.
- Glass that is thrown away and ends up in landfills will never decompose.
- Recycled paper produces 73% less air pollution than if it was made from raw materials.
- It takes 24 trees to make 1 ton of newspaper.
- Plastic can take up to 500 years to decompose.

energy which is mainly combustion of fossil fuels that add greenhouse gases to the atmosphere. At the landfill site, the anaerobic decomposition of waste produces methane while incineration of waste produces carbon dioxide as a by-product.





*Fig. 9: Cycle of waste*





## Deforestation

Trees absorb carbon dioxide from the atmosphere and store (sequester) it. Large numbers of tree, therefore, act as carbon sinks or reservoirs that accumulate carbon and help to regulate the natural greenhouse effect.

Trees also trap the sun's energy for photosynthesis and only 12 to 15 percent are reflected back into the atmosphere. Deforestation or clearing of large tracts of forests reduces the potential of forests to absorb both heat and carbon dioxide. On the other hand, trees are 50 percent carbon, so when they are felled or burned, the carbon dioxide they store escapes back into the air. Between 25 and 30 percent of the greenhouse gases released into the atmosphere each year is caused by deforestation. That is equivalent to 1.6 billion tonnes of greenhouse gases that enter the atmosphere.

**Deforestation** is clearing of Earth's forests on a massive scale.

**Carbon sinks** are reservoirs that absorb and sequester (store) CO<sub>2</sub> from the atmosphere. Other natural carbon sinks include soils, peat in wetlands, permafrost (permanently frozen ground), or ocean water

- Worldwide, some 13 million hectares of forests are lost every year, almost entirely in the tropics.
- In Bhutan, a significant emission of carbon was emitted in 1994, but forest and forest management activities have resulted in a net removal of 3,321.05Gg.



©Pema Gyamtsho

*Fig. 10: Clearing of forest cover for cultivation*







## CLIMATE CHANGE: HOW IT ALL RELATES TO ME <sup>12</sup>



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*Fig. 11: Figure depicting drought as one of the impacts of climate change*

Climate change threatens the basic elements of life for people throughout the world. The most vulnerable ecological and socio-economic systems are those with the greatest sensitivity to climate change and the least ability to adapt. Sensitivity is the degree to which a system will respond to a given change in climate. Adaptability is the degree to which systems can adjust to, or in anticipation of, changed conditions. Vulnerability defines the extent to which climate change may damage or harm a system; this depends both on a system's sensitivity as well as its ability to adapt.

### Impact on Agriculture Productivity and Food Security

The frequency of heat stress, droughts and floods will negatively affect crop yields. Two major climate factors, (i) temperature and (ii) rainfall, can adversely affect agricultural productivity and reduce food security for individuals and families. There is also the risks of fires, pest and pathogen outbreak.

**An increase in the average temperature** can adversely affect crops in regions where summer heat already limits production; increase in soil evaporation rates; and increase the chances of severe droughts.

**Change in rainfall** amount and patterns can affect soil erosion rates and soil moisture, both of which are important for crop yields. The IPCC predicts



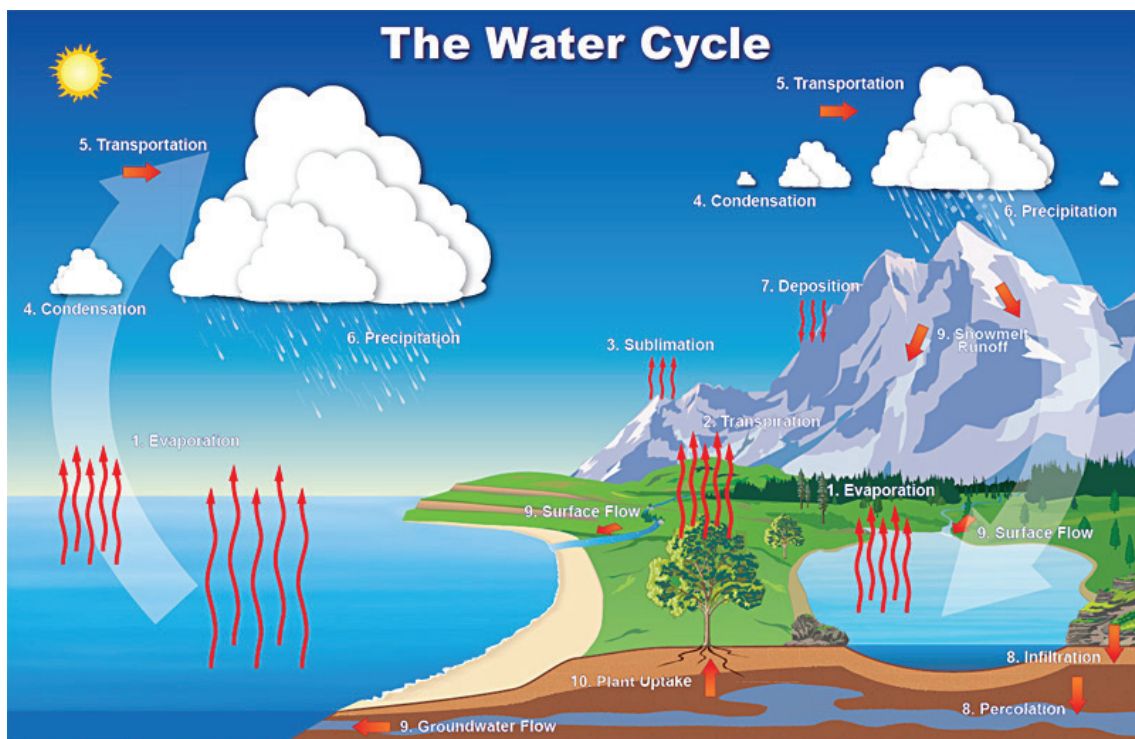
that precipitation will increase in high latitudes, and decrease in most subtropical land regions.

As temperatures increase and rainfall patterns change, crop yields are expected to drop significantly in Africa, the Middle East and India (IPCC)<sup>13</sup>. In Central and South Asia, increasing temperature and water stress are expected to lead to a 30 percent decrease on crop yields by mid 21st Century. Add the high rate of population growth to this and the result will be grave food insecurity.

## Impact on Water resources

Climate is a fundamental driver of

the water (hydrologic) cycle. It determines how much water is available in the short and long term. Changes in the climate will bring about changes in water quality and quantity. Rising global temperatures will disturb the hydrological cycle resulting in drier dry seasons or wetter rainy seasons. This can lead to extreme and frequent droughts and floods which will have large impacts on the availability of freshwater. Climate change is already diminishing fresh water resources, with changes in precipitation patterns and the melting of glaciers. Water quality will decrease with increase in the air temperature which in turn causes water temperatures to increase as well. As water temperatures increase, water pollution problems will arise from the following:



*Fig. 12: Figure showing water cycle*

Source: [http://www.srh.noaa.gov/jetstream/atmos/hydro\\_cycle.htm](http://www.srh.noaa.gov/jetstream/atmos/hydro_cycle.htm)







*Fig. 13: Floods cause major damage to human lives and environment*

- Lower dissolved oxygen levels which in turn affect aquatic life.
- Increase in pathogens, nutrients and invasive species.
- Increase in concentrations of some pollutants such as ammonia
- Increase in algal blooms

Sometimes, run-off from heavy precipitation can result in erosion and sedimentation and contaminate a water body.

**Droughts** are likely to be more frequent from decrease in annual maximum daily stream-flow due to temperature rise and increased evaporation with less or no change in precipitation. Over three billion people could suffer from increased water shortages by 2080. (Insert images/illustrations)

**Flood** catastrophes are likely to increase with increase in frequency of heavy rainfall related to climate change. Globally, river floods, flash floods, urban floods, sewer floods, glacial lake outburst floods and coastal floods have damaged properties and affected lives of over 140 million people.

The Himalayas which stretches over 2400km has more glaciers than any other place on the earth. These water towers provide freshwater to over a billion people living in the region. But the mountains and its glaciers and icecaps are most sensitive to rising temperature and changing climates. Satellite images already indicate that nearly 67% of the Himalayan glaciers have retreated.

For Bhutan and the rest of the Himalayan population, the melting of glaciers means increase in flood risks during the





monsoons, and reduced water supply in the dry seasons. A glacial melt caused by climate change can form or expand glacial lakes and weaken the natural dams or moraines that hold the water in these lakes. A collapse of these dams will discharge large volumes of water and debris known as glacial lake outburst floods (GLOF). This can cause catastrophic flooding downstream with major damages to lives and properties.

Bhutan has 562 glaciers and 2,674 glacial lakes, of which 25 are categorized as potentially dangerous. The 1994 Punaakha flood was caused by GLOF pouring an unprecedented 18 million cubic meters of water into the Mochu basin. The flood claimed 22 lives and damaged 1700 acres of fertile agricultural land and several infrastructure facilities.

Glacial lake outburst floods are among the most serious natural hazards for countries in the Himalayan region. But the effect of global warming and climate change could trigger more frequent and intense bursts and associated damages downstream as the glacier melt faster along with change in precipitation.

**Sea level rise** is the biggest threat that from global warming. With increas-

- Freshwater ecosystems are aquatic systems which contain drinkable water or water of almost no salt content.
- Only 3 percent of the world's water is fresh, and 99 percent of this is either frozen in glaciers and pack ice or is buried in aquifers. The remainder is found in lakes, ponds, rivers, and

ing average global temperature, the water in the oceans expands in volume, and additional water enters them which had previously been locked up on land in glaciers and ice sheets. Thermal expansion has already raised the oceans levels by four to eight inches (10 to 20 centimetres). Sea level rise would threaten the coral reefs and other ecosystems. The consequences will be catastrophic among millions of human population living on islands and coastal zones.





## IMPACTS OF CLIMATE CHANGE

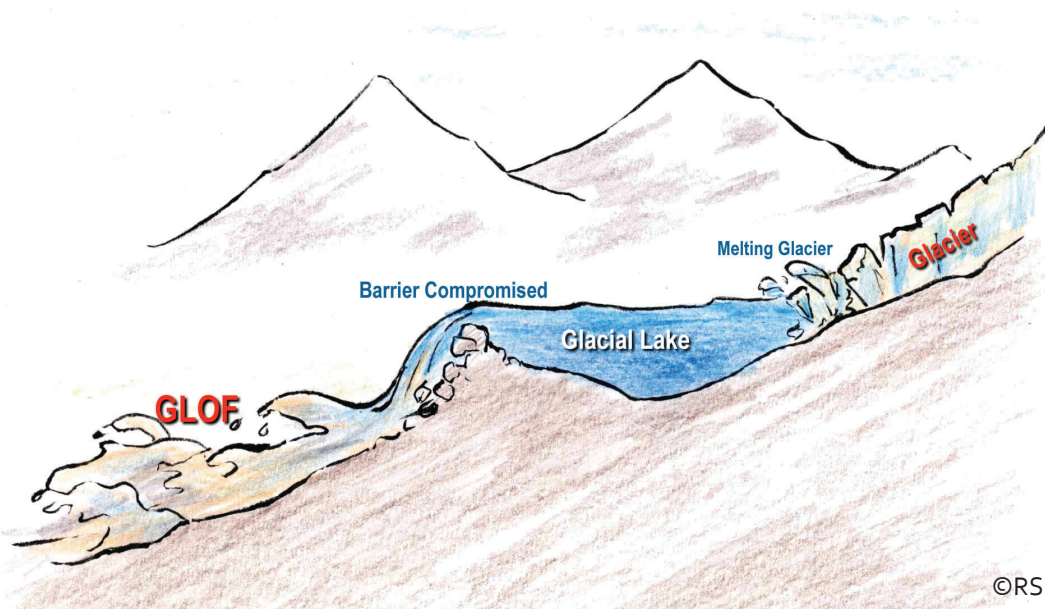
### Impact on Ecosystem and Biodiversity

"An ecosystem is an interdependent, functioning system of plants, animals and micro organisms. Without the support of the other organisms within their own ecosystem, life forms would not survive. Such support requires that predators and prey, fire and water, food and shelter, clean air and open space remain in balance with each other and with the environment around them".<sup>14</sup>

Climate is an important part of an ecosystem and therefore, any change in the climate has the potential to alter the organisms, resources, and services they provide to each other and to society. Human societies depend on ecosystems for the natural, cultural, spiritual, rec-

reational and aesthetic resources they provide. Increasing global temperature could change terrestrial ecosystems altogether; while some species will be forced out of their habitats (possibly to extinction) because of changing conditions, others will flourish. Many of the species at risk are the Arctic and Antarctic mammals such as the polar bears and Emperor Penguins.

In the Himalayas, Snow Leopards typically inhabit the area between the tree line and the permanent snow line. Temperature changes have caused the permanent snow line to recede, which causes the Snow Leopards to move further up mountain slopes. At these high elevations, herbivorous animals, primary food of these leopards are diminishing.



©RSPN

Fig. 14: Figure showing how GLOF is caused



## Climate Change Impacts on My Health <sup>15</sup>

Throughout the world, the prevalence of some diseases and other threats to human health depend largely on local climate. Extreme temperatures can lead directly to loss of life, while climate-related disturbances in ecological systems, such as changes in the range of parasites, can indirectly cause serious infectious diseases. In addition, warm temperatures can increase air and water pollution, which in turn harm human health.<sup>16</sup>

According to the World Health Organization Report 2002, climate change

was responsible for approximately 2.4% of worldwide diarrhoea, and 6% of malaria in some countries.

In the Himalayan region, the impacts of climate change on health conditions are both direct and indirect:

- (i). Direct health impacts are related to weather conditions such as drought, heat waves, and flash floods,
- (ii). Indirect health impacts can arise from crop failures, conflicts, hunger, malnutrition and spread of infectious diseases due to changing environmental conditions

### Heat stroke


Rising average temperatures are



Fig. 15: Climate change has greater impacts on human health







predicted to increase the incidence of hot extremes across the world. Higher temperatures can increase the occurrence of heat-related illnesses such as heat exhaustion and heat stroke. This in turn can worsen the existing conditions related to circulatory, respiratory and nervous-system problems. Heat waves can cause deaths among certain sub-groups of the population such as the elderly (over 75), the young (under 4) or those who are already ill.

Although Bhutan has not experienced heat waves, the potential of a sudden rise in temperature especially in the southern belt can cause mortality in the elderly and disadvantaged groups.

### **Vector-borne Diseases**

Climate change may increase the risk

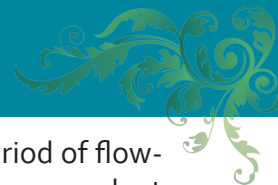
of some infectious diseases, particularly those that appear in warm areas and are spread by mosquitoes, other insects, and rodents. These “vector-borne” diseases include malaria, dengue fever, yellow fever, and encephalitis.

Rising temperatures, humidity, and changes in precipitation are creating favourable conditions for disease carrying vectors to breed (eg. female anopheles mosquitoes which transmit malaria from person to person).

Higher temperatures in combination with favourable rainfall patterns are likely to lengthen the transmission seasons of these vector-borne diseases, and to alter their geographic range, potentially bringing them to regions which lack either population immunity or a strong public health infrastructure.

In Bhutan, three major areas of climate-induced health concerns include water related diseases, expansion of vector-borne diseases, and morbidity from extreme weather and climate events. Water related diseases such as diarrhoea is already causing high mortality among the Bhutanese communities. In addition, water contamination from precipitation changes and floods will potentially increase the burden of diseases. Meanwhile, changes in vegetation, precipitation, water availability, and temperature could become conducive to vectors, thereby increasing their range and distribution, while increasing the risks of vector-borne diseases. Apart from direct impacts of climate change like heat waves, indirect health hazards and morbidity could increase from glacial lake outburst floods, riverine floods, flash floods and breached landslide dam floods. Dengue, Japanese encephalitis, malaria, respiratory disorders are all climate sensitive diseases.

Source: Source: RSPN. 2010. *Manual on Climate Change and Health*



## **Water-borne diseases**

Global climate change would cause warming temperatures and a change in frequency of extremes of the hydrologic cycle (including more floods and droughts). Heavy precipitation events often result in substantial societal impacts, including an increased risk of waterborne disease outbreaks. Waterborne diseases are defined as those infectious diseases transmitted through drinking water. Changes in temperatures and rainfall will raise the risk of flooding and hinder the supply of fresh water for domestic consumption and thereby increase risks of water related diseases such as diarrhoea. At the same time, effects of temperature and run-off on microbiological contamination of surface waters and direct effect of temperature rise on diarrhoeal diseases are some health concerns.

## **Respiratory diseases**

There has been a sharp rise in the number of respiratory diseases. Key air pollutants, such as nitrogen dioxide and sulphur dioxide worsens existing cardiovascular and lung diseases. The continued emissions of GHG will exacerbate air pollution levels.

In Bhutan, anecdotal data from medical doctors indicate increased number of asthmatic cases every year. It is suspected that rapid urbanization and climatic changes are relevant factors. Warming is likely to further cause an ear-

lier onset and extend the period of flowering and pollen season for some plant species. This may aggravate allergic rhinitis, asthma and other atopic disease.

## **Malnutrition**

Climate change represents an additional pressure on the food supply system as climate and annual weather patterns are key factors in agricultural productivity. A change in climate would change temperature, rainfall patterns, soil moisture and soil fertility. Crop pests could find ideal conditions to thrive. Food production, especially cereals, would be severely affected increasing food security. This can lead to widespread malnutrition which impacts child growth and development. Malnutrition and hunger would also affect the health of adults as well.

## **Psychosocial Stress**

Natural disasters not only lead to destructions and loss of lives, but also displacements. Survivors of such disasters have to cope with physical injuries, psychological stress of losing family members, homes and livelihood. This can have temporary and permanent impact on their mental health.

Climate change may also contribute to social disruption, economic decline and displacement of population in certain regions, due to effect on agriculture and extreme weather events.





## THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

The UNFCCC is the primary mechanism for coordinating a global response to climate change. In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted as the basis for a global response to the problem. The Convention entered into force on 21 March 1994. With 194 Parties, the Convention enjoys near-universal membership. The ultimate objective of the Convention is to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system. As a framework convention, the UNFCCC defines general rules, principles and commitments. It recognizes that the climate system is a shared resource, whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases.



*Fig. 16: Logo of United Nations Framework Convention Climate Change (UNFCCC)*

### ***Objective of the Convention***

According to the Article 2 of the Convention, its objective is “to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [originating in human activity] interference with the climate system”. This objective is qualified in that it “should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner”

### ***Commitments under the Convention***

The convention defines two interrelated policy responses to climate change and associated commitments for parties. The first is mitigation of climate change and the second is adaptation to impacts of climate change. In addition to commitments applying to all Parties, the Convention sets different types of commitments for developed and developing country Parties, which can be classified as follows:

1. Commitments applicable to all Parties (Article 4.1)
2. Annex I Party commitments (Article





- 4.2)  
3. Annex II Party commitments (Article 4.3, 4.4., 4.5)

Under the Convention, all Parties are required to gather and share information on greenhouse gas emissions, national policies and best practices. The Convention requires Parties to develop national emissions inventories, formulate and implement national programs containing measures to mitigate climate change and facilitate adaptation and communicate to the COP information related to implementation.

The Convention set more stringent mitigation commitments for developed country Parties listed in Annex I. They are required to adopt policies and measures to limit their emissions and enhance sinks. It also established a not legally binding target for these Parties to return their GHG emissions to 1990 levels by 2000.

Developed country Parties included in Annex II are required to provide financial resources to developing countries to help them comply with their commitments and in adaptation, and to take steps for transfer of technologies.

## The Kyoto Protocol

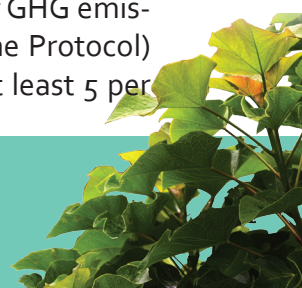
The Kyoto Protocol entered into force generally on 16 February 2005. The object and purpose of the Kyoto Protocol


The Kyoto Protocol to the 1992 UNFCCC, serves to give effect to the UNFCCC's objective of reducing human-induced greenhouse gases (GHGs) in an effort to address climate change,

guided by the UNFCCC's key principles of PRECAUTION, INTERGENERATIONAL EQUITY, sustainable development, and COMMON BUT DIFFERENTIATED RESPONSIBILITIES and RESPECTIVE CAPABILITIES. As a logical extension of this last principle, Parties to the Kyoto Protocol are placed into one of two categories:

- developed countries, referred to as Annex I countries who are subject to binding GHG emissions reductions targets and reporting requirements involving an annual greenhouse gas inventory and supplementary information to demonstrate compliance with the Protocol, including minimising adverse impacts on developing countries, and
- developing countries, referred to as Non-Annex I countries, which are not subject to GHG emissions reduction commitments, though they may take part in the Clean Development Mechanism.

The Protocol's objective is sought to be achieved through the imposition on developed countries (included in Annex I) of individually assigned and legally binding GHG emissions targets (prescribed in Annex B of the Protocol), with the attendant commitment to the development and adoption of other relevant enabling policies and measures. Notwithstanding the variation in Annex I countries' emission targets, the goal is to bring about a reduction of GHG emissions (listed in Annex A of the Protocol) by, a collective average of at least 5 per





cent below the 1990 emissions levels for the commitment period 2008–2012. More specifically, 1990 is used as a base year for CARBON DIOXIDE, METHANE and NITROUS OXIDE, whereas 1995 is the base year adopted for industrial trace gases (HYDROFLUOROCARBONS (HFCs), PERFLUOROCARBONS (PFCs) and sulphur hexafluoride (SF6)).

## Bhutan and the UNFCCC

Bhutan ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 25th August 1995. Bhutan also became a party to the Kyoto Protocol in 2002. The National Environment Commission is designated as the National Climate Change Committee.

As party to the convention, Bhutan has its obligations to respond to the provisions of the convention. Bhutan's key obligations are to submit periodical national communication highlighting GHG inventory, climate change vulnerabilities and prioritized adaptation measures.

### **Initial National Communication (INC)**

As part of its obligations under the UNFCCC, Bhutan submitted its Initial National Communication at the Sixth Session of the Conference of Parties in November 2000. Bhutan also completed its First National Inventory on Greenhouse Gas Emissions and carried out basic training on developing a greenhouse gas inventory.

### **Second National Communication (SNC)**

To review the assessments carried out under the Initial National Communication and also addresses the gaps and constraints identified during the Initial National Communication process, Bhutan will complete the SNC later this year. Under the project, Bhutan's Second Greenhouse Gas Inventory has also been completed. The SNC will also strengthen the vulnerability and adaptation assessment which was assessed to be weak in the INC.

### **National Adaptation Program of Action (NAPA)**

Bhutan was one of the first LDCs to submit its NAPA in 2006. The NAPA is a countrywide program that encompasses the immediate and urgent adaptation activities to address the impacts of climate change. Financial assistance of US\$3.45 million has been received to fund three of the nine projects listed in Bhutan's NAPA.

The NEC is currently in the process of updating Bhutan's NAPA. The exercise will be completed later this year.

**Declaration to remain Carbon Neutral**  
At the Fifteenth Conference of Parties (COP 15) in Copenhagen, the Royal Government declared that as a commitment to our future generations, Bhutan shall remain carbon neutral for all time to come.

The declaration made by the Royal Government of Bhutan pledged that:

- For all times to come, Bhutan will re-



main carbon neutral.

- Bhutan will continue to follow and be guided by a strong sense of conservation ethics.
- Bhutan will not produce GHG in excess of what the country can sequester but will also serve as a carbon sequestration tank for the world in general.

The Declaration further strengthened Bhutan's position as a committed, dedicated nation when it comes to ecological conservation and concerns about GHG emissions and climate change.

## How Can I make a difference? <sup>17</sup>

We have looked at various aspects of climate change; what causes it, how it influences our forests, animals, agriculture, water, and more importantly its impact on human health. We now know that people are responsible for releasing those greenhouse gases into the atmosphere. As we cook, heat our homes, drive, and throw away garbage, we contribute to global warming and climate change.

There are two ways to deal with climate related health problems;

- Reduce the causes of climate change and its consequences on human health— known as “mitigation”.
- The first priority is to reduce emissions of greenhouse gases. Changes in lifestyle and behaviour patterns will be needed to contribute to cli-

mate change mitigation across all sectors.

- Improve the capacity to cope with climate change hazards and health risks by being better prepared— known as “adaptation”.

## *Here are a few simple steps to mitigate climate change.*

- Act now to fight global warming and climate change. Because we owe it to ourselves, our children, and our children's children.
- Buy energy efficient appliances at home and at the office. From washing machines, refrigerators, dishwashers to ovens and light bulbs, buy the most energy-efficient model you can afford. They may cost higher but they pay for themselves through lower energy bills. Encourage your office to buy energy efficient computers, photocopiers and printers.
- Consider alternatives to chemical



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use in your garden. Birds, frogs and reptiles can become sick or die if they feed on insects sprayed with pesticides. Useful insects, like ladybirds and praying mantis, help control pests and are killed by pesticides.

- Drive less and drive smart. Less driving means fewer emissions. Use the mass transportation system or car-pool whenever you can. Besides, you can walk and bike. These are great forms of exercise for a healthy life.
- Encourage your friends, families, and neighbours to reduce emissions. Share information, spread the word, and take actions together.
- Heat your home and office smartly. Insulate well, use thick curtains and double glaze windows. It will help save energy, save money, and reduce emissions from your bhukharis and kerosene heaters.
- Join a local climate action network



and help spread the message or kick start an environmental campaign in your neighbourhood

- Know about your health risks related to climate change. Assess your community's climate vulnerability. Ask your local environmental and disaster management agencies for support.
- Learn about climate change and Lead by example. Learning is fun and exciting. There are many books and resources out there about climate change and its impacts on ecosystems, people, and health. Expand your knowledge on what you can do to reduce emissions and Just Do It!
- Minimize your meat intake. Remember cows produce methane from both ends.
- Offset your carbon footprint. There are many cost-effective energy saving and carbon reducing steps anyone can take. See more at: <http://www.carbonfund.org/>
- Plant trees! Trees absorb carbon dioxide. It is a great way to prevent erosions because trees stabilize soil and water resources.
- Quit plastic bags and carry your own cloth bags when you go shopping.
- Reduce, Recycle, and Reuse your household and garden wastes. Do your part to reduce waste by choosing reusable products instead of disposables. Buy products with minimal

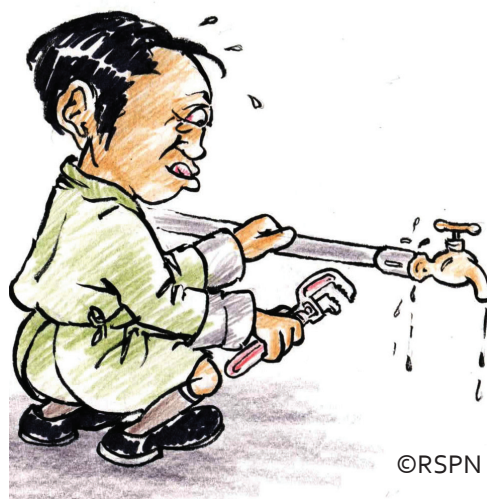


to help to reduce waste. And whenever you can, recycle paper, plastic, newspaper, glass and aluminium cans. When you recycle, you send less trash to the landfill and you help save natural resources like trees and petroleum.

- Save Water! Take short showers and close the tap while brushing. Repair leaky faucets.
- Turn off televisions, videos, stereos and computers when they are not in use—they can consume between 10 and 60% of the power when in "stand-by" mode. Turn off computer screens and photocopiers when you take a break. Also turn off lights when you don't need them,—it saves energy after a minute or two. Unplug electronic items when you're not using them.
- Use recycled paper. It saves trees and reduces 2.3 kilograms of carbon dioxide per ream of paper
- Value locally grown, organic food. Locally grown fruits and vegetables means there has been very less or no emissions in transporting it to your market. Organic food is excellent for health and does not pollute air, water, and soil. Organic soils can also capture and store carbon dioxide at much higher levels.
- Write letters about the health impacts of climate change to the local newspapers. This is a great way to keep the issue in the public mind. It also sparks a debate and allows us all

to understand what the real issues are.

- Express your concerns on environmental health issues and solutions and stay informed. Read widely and understand what we are dealing with.



- You can be a Youth Climate Ambassador. Get your friends, colleagues, families, community members, and leaders work towards reducing climate change.

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