



### Six Things to know about **Global Warming** and **Climate Change**

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While the terms 'Global Warming' and 'Climate Change' are widely used in recent times, many questions persist regarding these phenomena. This factsheet helps the readers in enhancing their understanding on these two terms. It informs the reader about the Greenhouse Effect, role of human activities in Global Warming, changes observed in temperature and the climate system, and likely impacts of Climate Change and extreme events. Implications of Climate Change on India and the Mumbai Metropolitan Region (MMR) are also highlighted.



Spread the Word  
Change the World  
Climate Change  
Awareness Drive

1.

## Greenhouse Effect is necessary for Life on Earth

About one-third of solar energy that reaches the top of Earth's atmosphere is reflected back into space (by clouds, and bright surfaces like snow or ice). The remaining two-third of the sun's radiation is absorbed by the earth's surface and the atmosphere. To balance the absorbed incoming energy, the Earth must send the same amount of energy back to space in the form of radiation of longer wavelength. But this **radiation or heat going back from earth is trapped by a blanket of gases in the earth's atmosphere. These gases do not allow the heat to escape into space and warm the earth. This blanketing is known as the natural greenhouse effect and the gases that cause it are called greenhouse gases (GHGs)**

This warming effect is similar to that seen in an ordinary glass greenhouse in a sunny garden. Sunlight passes into the greenhouse and reflects off the plants and surfaces inside. The glass of the greenhouse acts like a one way mirror and prevents the reflected sunlight from passing out of the greenhouse. The trapped heat raises the temperature inside the greenhouse and helps the plants to survive. In a similar way, the natural greenhouse effect keeps the Earth's surface warm and helps maintain life on Earth. Without the natural greenhouse effect the Earth's surface would much colder, with a temperature of around  $-18^{\circ}\text{C}$ <sup>1</sup>.

2.

## Human Actions enhance the Natural Greenhouse Effect and cause Global Warming

**Human activities like burning of fossil fuels such as coal and oil, clearing of forests, use of fertilizers in agriculture, dumping of waste in landfills emit GHGs into the atmosphere.** These additional GHGs like carbon dioxide ( $\text{CO}_2$ ), methane ( $\text{CH}_4$ ), nitrous oxide ( $\text{N}_2\text{O}$ ), sulphur

hexafluoride ( $\text{SF}_6$ ) and the halocarbons (hydro-fluorocarbons (HFCs) and perfluorocarbons (PFCs) accumulate in the atmosphere, and the blanket of GHGs in the atmosphere increases with time. The amount of GHGs like  $\text{CO}_2$  in the atmosphere has increased by a large amount since the industrial era (from the year 1850). (see Figure 1 on next page).

**As the amount of GHGs in the atmosphere increases, they enhance the natural greenhouse effect and trap more heat.** This additional heat causes the temperatures to rise around the world and is called Global Warming.

3.

## Global Temperature has risen and Climate is changing

A definite warming of the Earth's surface is observed in the last century or so and is found to increase over the years. The rate

of warming across the globe over the last 50 years (since 1960) is almost double of that observed over the last 100 years<sup>2</sup>. **The increased warming has resulted in the 12 years from 1995 to 2006 having 11 of the 12 warmest years ever recorded<sup>3</sup>.** Global warming is causing changes in climate parameters like temperature, rainfall, snow, and wind patterns lasting for decades or longer.

The average surface temperatures around the world have increased by about  $0.74^{\circ}\text{C}$  over the past hundred years (i.e. between 1906 and 2005). The trend of rise in temperature is expected to increase even further in the coming years due to increased human activities and  $\text{CO}_2$  emission, unless some action is taken.

Rising temperatures result in warming of the world's oceans and land which in turn causes more moisture to evaporate in the atmosphere due to higher evaporation. This has led to changes in the amount, intensity and frequency of precipitation (snow and rainfall) at many places. Widespread increases in events of heavy



The  
Natural  
Greenhouse  
Effect

(Source :  
IPCC, Climate Change 2007:  
The Physical Science Basis)

Some of the infrared radiation passes through the atmosphere but most of absorbed and re-emitted in all directions by greenhouse gas molecules and clouds.

The effect of this is to warm the Earth's surface and the lower atmosphere

Some solar radiation is reflected by the earth and the atmosphere

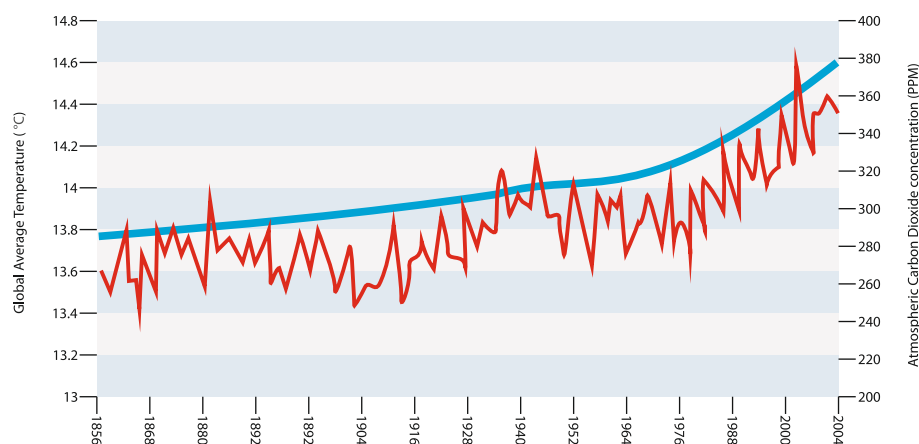
Infrared radiation is emitted from the earth's surface in all directions

About half of the solar radiation is absorbed by the Earth's surface and warms it

<sup>1</sup>. Website of U.K. Government Office of Science. Accessed from : <http://www.bis.gov.uk/go-science/climatescience/greenhouse-effect>, Nov 2012

<sup>2</sup>. U.S. Environmental Protection Agency (EPA.) (2009) : Frequently Asked Questions about Global Warming and Climate Change

<sup>3</sup>. IPCC. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, 2007.



**Figure 1 :**  
**Rise in Global Temperature and CO<sub>2</sub> in Atmosphere**

(Source: Website of Live Smart British Columbia. Accessed from : <http://www.livesmartbc.ca/learn/change.html>, Nov 2012)

— Global Average Temperature ( °C)  
— Atmospheric Carbon Dioxide concentration (PPM)

rainfall have been observed at some places. Snow cover and ice around the world is also seen to shrink. Most mountain glaciers such as the Himalayas and Rockies are getting smaller and snow cover is retreating earlier in the spring. Also, sea ice in the Arctic Ocean is shrinking in all seasons, with the summers of 2007 and 2008 having only half the sea ice cover as compared to 1960s. The melting ice due to higher temperatures has led to a rise in sea level of 3 mm per year since the year 1993<sup>4</sup>.

### Projections of Climate Change for India by 2030s :

- The annual mean surface air temperature may rise from 1.7°C to 2°C by 2030
- Around 10% increase in the Indian monsoon rainfall over central and peninsular India
- Cyclonic disturbances over the Indian Ocean during summer monsoon are likely to be more intense

(Source : INCCA (2010) : Climate Change and India: A 4x4 Assessment- A sectoral and regional analysis for 2030s)

## 4.

### Likely Impacts of Temperature Rise in the Future are significant

Based on how actions are taken around the world to reduce GHG emission and slow down increase in global temperatures, it is estimated that average global temperature can rise from 1.8 - 4°C by the end of the year 2100<sup>5</sup>. Changes in Temperature, precipitation and sea level

rise can have significant impacts on human and natural systems as follows :

○ **Water Resources :** Water supplies to people depending on water from seasonal snow melt would be impacted due to rising temperature and increased precipitation as rainfall instead of snow. Increased melting of snow and ice would cause flooding while decreased rainfall would bring about droughts. Both these changes in climate would impact water availability for humans, agriculture, and energy production<sup>6</sup>.

○ **Agriculture and Food Production :** Food production is sensitive to small changes in rainfall and temperature, with quality and yield significantly impacted. The supply and cost of food may change as farmers and the food industry adapt to new climate patterns and impacts such as water availability. Variation in temperature and humidity can strongly impact pathogen and insect populations. Small amount of warming and CO<sub>2</sub> increase may benefit certain crops and plants, though increasingly negative effects would be expected with greater amount of warming<sup>7</sup>.

○ **Human Health :** Increased temperatures and frequent heat waves may cause more heat-related illnesses and fatalities. Air quality in cities would decline as greater heat can worsen air pollution, leading to increased cases of respiratory illnesses and asthma. Outbreaks of insect borne diseases like dengue and malaria may increase as the climate zones supporting the disease life-cycle are altered by Climate Change<sup>8</sup>.

○ **Coastal Areas :** Coastal communities would be impacted by sea level rise and

and increase in storm surges, particularly in low lying areas. Rising sea level may lead to enhanced coastal erosion, coastal flooding, loss of coastal wetlands, and increased risk of property loss from storm surges.

○ **Biodiversity :** Temperature rise and changing rainfall patterns may increase the risk of forest fires. Losses of species may be seen in areas of high biodiversity, as habitat conditions change too quickly for plants and animals to adapt<sup>9</sup>.

### Likely Impacts depending on Degree of Climate Change in the 21st Century

<b>+6°C</b>	Many species face extinction
<b>+5°C</b>	Higher sea levels cause coastal cities such as New York and Mumbai to flood during seasonal storms.
<b>+4°C</b>	Parts of Amazon's rainforest collapse due to cycles of drought and fire.
<b>+3°C</b>	Glacier-fed rivers such as Ganges, a major source of freshwater to India, begin to dry up
<b>+2°C</b>	Forests take root in Canada's melting tundra; Greenland's ice sheet reaches a point of unstoppable melting. <b>Possibly the tipping point that could fundamentally change life on Earth!</b>
<b>+1°C</b>	Many tropical coral reefs and mountain glaciers are lost

(Adapted from National Geographic Society (2008) : Degrees of Change - Conservation in my Community)

<sup>4</sup> Prof. Stefan Rahmstorf (2010) : Climate Change - State of the Science

<sup>5</sup> IPCC. Climate Change 2007 : The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, 2007

<sup>6</sup> Center for Climate and Energy Solutions (2011): Climate Change 101- Science and Impacts

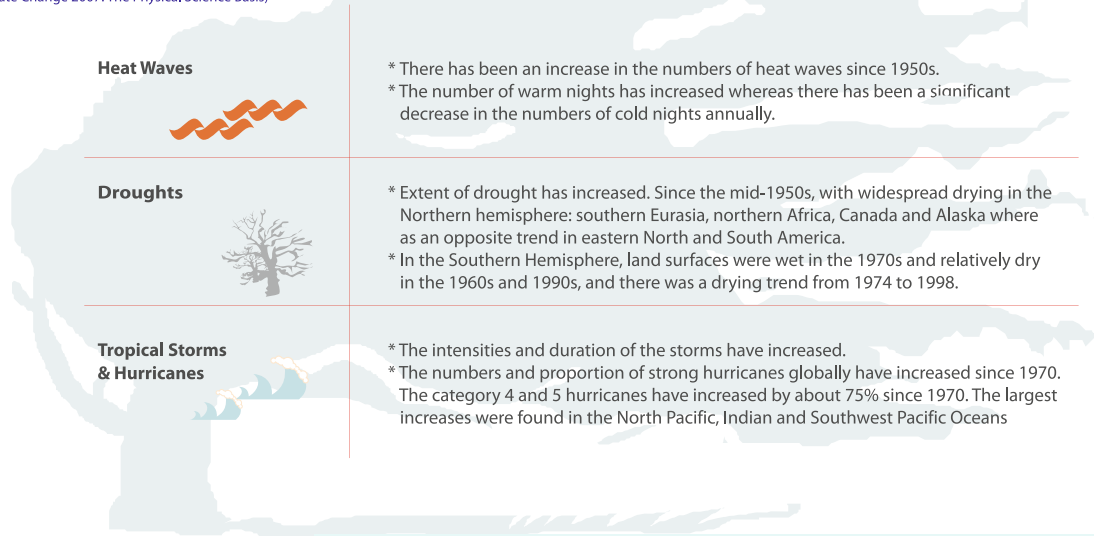
<sup>7</sup> Network of International Development Organizations in Scotland (NIDOS) 2009: India Climate Change Factsheet

<sup>8</sup> U.S. E.P.A. (2009) : Frequently Asked Questions about Global Warming and Climate Change

<sup>9</sup> Website of U.K. Met Office. Accessed from <http://www.metoffice.gov.uk/climate-change/guide/what-is-it>, Nov 2012

## Changes Observed in Extreme Events

(Adapted from IPCC, Climate Change 2007: The Physical Science Basis)



# 5.

## Climate Change is expected to increase the Frequency of Extreme Events

As the earth warms in response to increasing GHG emission, changes in climate extremes are expected. The type, frequency and intensity of extreme events such as floods, droughts, heat waves, and storms are expected to change even with relatively small changes in climate. Changes in few types of extreme events have already been observed, such as increase in the frequency and intensity of heat waves and heavy precipitation events.

# 6.

## India is vulnerable to the Impacts of Climate Change

Climate Change such as temperature patterns, precipitation and sea level rise can impact the distribution and the quality of natural resources in India. With natural resource based sectors such as agriculture, water and forestry driving the Indian economy and affecting livelihoods, the impacts of Climate Change can be considerable. The Indian population is vulnerable to Climate Change impacts and extreme events, particularly people residing along the long coastline of India. Moreover, impacts of Climate Change on food production and water resources would amplify existing issues related to food and water scarcity.

## Key Climate Change Impacts on India and MMR

### Key impacts of Climate Change in India are as follows :

- Water availability would be affected significantly due to decline in run-off of the river basins such as Sabarmati and Luni while salt water intrusion near the coastal regions by would affect water quality in freshwater sources
- Significant variability in agricultural yield can reduce production of important crops like wheat by 4-5 million tonnes with every 10°C temperature rise
- About 40 million hectares of land in India is extremely vulnerable to floods, affecting about 30 million people each year

(Source : NIDOS (2009) : India Climate Change Factsheet)

### Key impacts of Climate Change within the MMR are as follows :

- Sea-level rises, cyclones and storm surges could have a devastating impact, particularly in high risk zones of Mumbai, parts of Thane, and Alibaug falling into a low elevation coastal zone
- Production of major agricultural produce like rice can reduce by up to 20% till 2030, affecting major rice cultivating areas like Thane district
- Decrease in number of rainy days in the Western ghats can lead to high intensity rainfall in short span leading to flash floods
- Climate Change can lead to the onset of waterborne diseases like diarrhoea and cholera and vector-borne diseases like dengue and malaria (which has already doubled in Mumbai)

(Source : INCCA (2010) : Climate Change and India: A 4x4 Assessment- A sectoral and regional analysis for 2030s)

### For further information, refer to :

- National Geographic : Degrees of Change-Conservation in My Community Available at : <http://www.nationalgeographic.com/expeditions/lessons/14/g68/SixDegrees.pdf>
- IPCC, 2007: Climate Change 2007: Frequently Asked Questions. Available at : <http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-faqs.pdf>
- U.K. Met Office: Guide to Climate Science. Available at : <http://www.defra.gov.uk/publications/2011/03/26/ghg-guidance-pb13309/>
- INCCA (2010): Climate Change and India: A 4x4 Assessment - A sectoral and regional analysis for 2030s. Available at: <http://moef.nic.in/modules/others/?f=event>