

# Climate Change

Is it getting any better?



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**Content Development and Review**

Shweta Sinha, Shwetal Shah, Sangeeta Paul Miglani

**Editorial, Design and Production**

Anupama Jauhry, Aman Sachdeva, Santosh Gautam, Vijay  
Nipane, Jessica Mosahari, Shikha Dimri

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# Climate Change

Is it getting any better?





**M J Shah**  
**Joint Secretary**

No. BJT/10/2016/69975/B  
**Government of Gujarat**  
**Climate Change Department**  
**Block 11/1, Sachivalaya,**  
**Gandhinagar 382010**  
**Date: 30/07/2018**

### **Message**

Today climate change is one of the biggest challenges for mankind. India is equally concerned with the consequences of climate change. The intensity and frequency of extreme weather events such as floods, heatwaves, dust storms, droughts, etc. has increased. Occurrence of these unprecedented and alarming climate events pose a grave challenge, as they can have devastating effects on the people and the economy.

Global warming has introduced changes in land and sea habitats, making them inhospitable for some species. Disappearing sea ice, coral bleaching, ocean acidification, and crumbling forests are some of the serious effects of the changing climate on ecosystems. Climate scientists have predicted that the global temperatures will continue to rise for many more decades to come primarily because of the greenhouse gases generated by human activities. In fact, over the next century, the IPCC has projected that the temperature is likely to rise up to anywhere between 2 oC to 8 oC.

Therefore, it is imperative to gear up for immediate action and look for ways to manage and mitigate climate change — it is a major challenge to sustainable development. It is in this spirit that the state of Gujarat has established a Climate Change Department under the leadership of the then Chief Minister and the present Prime Minister Shri Narendra Modi. The state has constantly emphasized on mitigation as well as adaptation efforts. Gujarat's dynamic renewable energy policies and programmes have resulted in reducing the state's dependence on fossil fuels.

However, the responsibility to fight climate change doesn't rest solely on governments. We need to take measures at the individual level, which can be done through energy conservation and reducing our carbon footprint. This book has been designed to help you understand the magnitude of climate change, and it will also help you take small initiatives to make a big difference. It will encourage you to be a climate warrior and to ready 'be the change that you wish to see in the world'.

(M J Shah)  
Joint Secretary  
Climate Change Department



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## **From the Desk of the Chairperson, OTBL**

In December 2017, a shocking video of a sickly polar bear went viral. Struggling to walk, he was scavenging for food (seals) on an iceless Baffin Island, Canada. This footage triggered a wave of sympathy around the world and also gave people a glimpse of how climate change is affecting wildlife. According to some climate scientists, if the earth continues to warm at the same pace, polar bears will completely disappear in the next 100 years. Rising temperatures and the melting sea ice threatens the existence of not just polar bears but the entire polar ecosystems. And this is merely one crisis foretold by the changing climate.

The frequency and intensity of extreme weather events—heat waves, droughts, floods, and so on—has increased. These extreme events not only threaten human lives and property but are also dangerous to habitats and animals. These climate-change realities pose grave challenges for the current generation and for those to follow. The majority of climate scientists believe that global warming is most likely due to human activities that are changing the natural greenhouse, and that is why it is our responsibility to reduce the emission of greenhouse gases (GHGs) that trap more heat in the atmosphere.

However, it was not like this in the beginning. More than a century ago, human activities did not produce GHGs to the extent that they do today. As forests and green patches that act as carbon sinks began to be cleared to build houses and other infrastructure, the greenhouse effect expanded. At the same time, factories and industries mushroomed around the world, due to which our demand for energy shot up dramatically. The overuse of energy is further strengthening the greenhouse effect. In the last 150 years, industrial activities have raised the atmospheric carbon dioxide levels from 280 to 400 parts per million! This has played a crucial role in changing the climate.

This book has been specially created to discuss how climate change is affecting us and how all organisms, including humans, will have to deal with fundamental changes in their environments in order to cope with climate change and survive. Adapting to climate change is not easy, especially for the poor nations that are the most vulnerable. It will take a lot of money and effort. However, making some key modifications to our lifestyle and reducing our carbon footprint can go a long way in helping us deal with climate change and limit its enormity. This book will provide valuable suggestions on how to do that. It is a very useful resource for those who are interested to know how the environment is changing and what we can do to protect it.

(A. K. Dwivedi)

Chairman

ONGC TERI Biotech Limited (OTBL)



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# HOW CLIMATE WORKS

The earth's climate does not remain constant. In fact, the earth has had a history of several warming and cooling cycles since its creation 4.5 billion years ago. Today we are in the middle of yet another warming cycle or an interglacial period. Winters seem to be getting shorter and summers warmer than before. But why is that worrying our scientists such a great deal? Should we be concerned too?



## Climate vs Weather

Weather is the change you see in temperature, rainfall, and wind patterns around you on a day-to-day basis. It may be hot one day and cold or rainy another day. Weather is influenced by the sun's energy combined with the earth's tilt on its axis. Places near the equator receive more sunlight than those farther away, thus creating different weather patterns. Climate scientists study daily weather trends for decades to find out averages in temperature, precipitation, and wind patterns. These averages determine the climate of a region.

## Past and Present: What Is Different Now?

Climate change is a significant variation in the climate system over time. While climate change is nothing new, this time the system is changing both drastically and abruptly. In fact, terrifyingly faster than it ever did! You can almost feel the change yourself. Have you heard your grandparents complain about winters not being as cold as they used to be? Or your parents complain about unseasonal rains? Climate change is affecting every corner of the world — no city, country, or island remains untouched. No one can escape it — human beings, plant life, or animal species. Most importantly, climate change impacts every aspect on earth necessary to sustain life, including air and water.

Earlier, the climate system took millions of years to change. Life on earth had sufficient time to adjust. The same is now happening over just a century. It is challenging to adapt this quick.



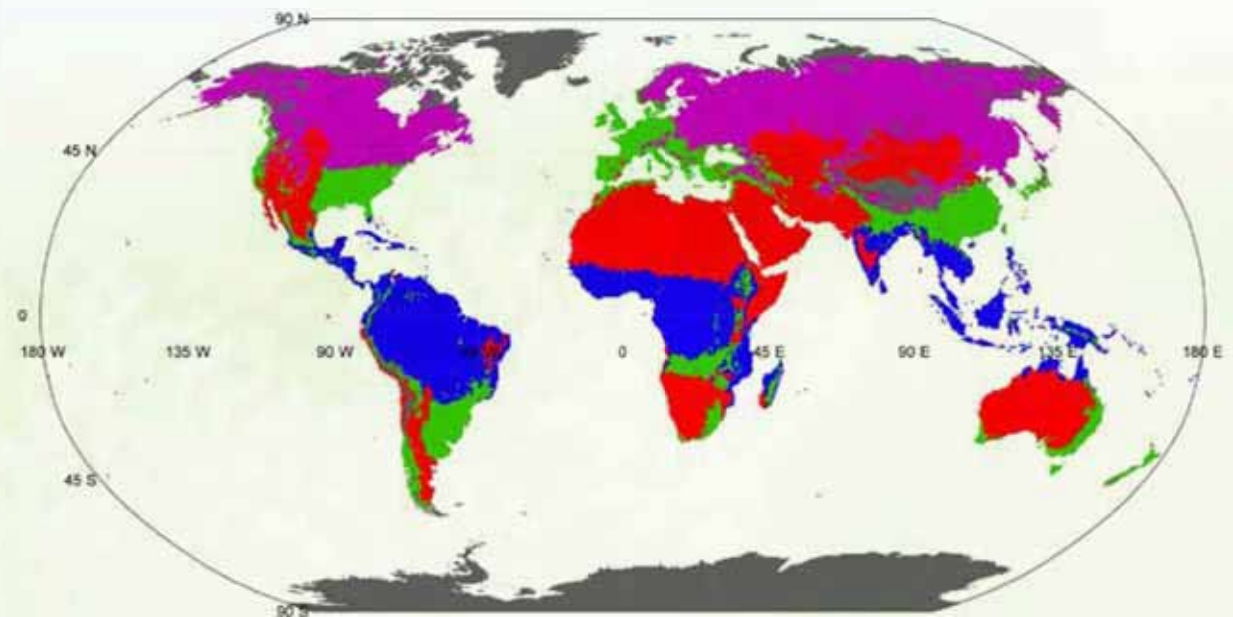
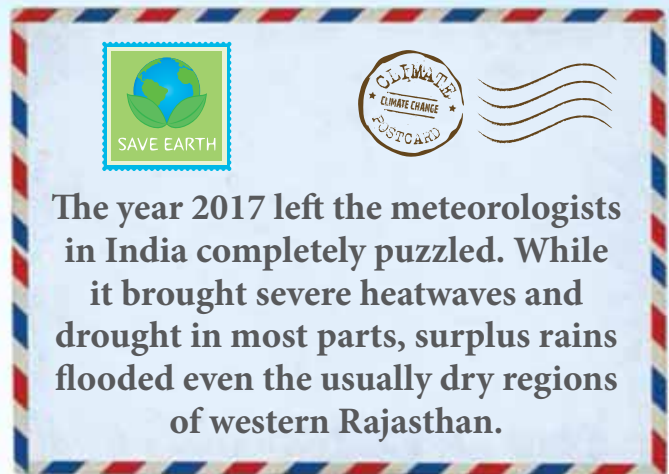
## QUICK FACT

The UN Intergovernmental Panel on Climate Change (IPCC) is an international



## Climate Zones

The Köppen Climate Classification System is used to classify the world's climate zones. Wladimir Köppen (1846–1940) was a German climate scientist. He studied how flora varies with changes in climate, and produced a map of global temperature bands in 1880. The bands ranged from the Equator to the Poles. Later, he refined the map to define five major climate types based on temperature and rainfall variations.



*World map of Köppen climate classification for 1901–2010*

Type A Tropical	Type B Desert	Type C Sub-tropical	Type D Continental	Type E Tundra and Polar
Hot, rainy, and monsoonal	Arid and dry with low rainfall	Warm temperate climate, mild winters	Severe winters with snow	No true summer, permafrost, extremely cold

# RIISING TEMPERATURES

One major cause for climate change is rising temperatures. The earth has been steadily getting warmer since the last Ice Age ended 11,500 years ago. Global temperatures increased by a mere 4-7 °C in the last 5000 years. Yet it took only a century for the earth to get one whole degree hotter. One degree may sound small, but remember just a degree rise from zero to one can turn ice into water.

## How Do We Know Our Planet Is Getting Warmer?

Ancient evidences of the earth's climate exist in tree rings, layers of ice in glaciers, coral reefs, and rocks. Bubbles trapped in glacial ice have preserved samples of the earth's atmosphere for thousands of years. Researchers gather information from these sources to build a map of past climates. These past climate records, known as paleoclimates, date back to more than 800,000 years ago.

Today we have advanced climate monitoring systems scattered across land and space. They observe and record temperatures, rainfall, snow depth as well as surface and deep-ocean water temperatures. Taken together, these records provide us climate models. Collected over 130 years, these models reveal a steady rise in global temperatures during the past three decades.

## Is This Warming Natural?

The earth is blanketed by a mixture of 61 gases. When the sun's rays hit the earth's atmosphere, 30% of it is reflected back by clouds, tiny particles in the air called aerosols, and by the snow and ice on the surface. The remaining heat is trapped by some of the atmospheric gases, preventing the earth from freezing up.

This is much like how a greenhouse works. A greenhouse is a building made of glass, used to grow plants. It is designed to trap the sun's energy and keep the temperature regulated. The gases that keep the earth warm are known as the greenhouse gases (GHGs).

While GHGs in our atmosphere are absolutely essential, an excess of these gases trap additional heat and make the greenhouse effect too strong.

### QUICK FACT

The average temperature in the Arctic has risen by about -14.7 °C since 1980

Greenhouse gases include water vapour ( $\text{H}_2\text{O}$ ), carbon dioxide ( $\text{CO}_2$ ), methane ( $\text{CH}_4$ ), ozone ( $\text{O}_3$ ), nitrous oxide ( $\text{N}_2\text{O}$ ), and chlorofluorocarbons (CFCs). More GHGs in the air trap more heat. This extra heat releases more  $\text{CO}_2$ , unlocks methane, and causes further evaporation of water, thus raising the GHG levels. It is a vicious cycle.

## Consequences of a Warming World

Global warming has already sneaked upon us and is more than just hotter summers. Here is what happens when excess heat gets trapped in the earth's atmosphere:

- Extra heat evaporates more water from oceans, lakes, and rivers, leading to heavy downpours and monster storms.
- It dries the soil faster, turning droughts worse. India is now twice as likely to face a deadly heatwave than a century ago.
- A warmer weather encourages the growth of pests and the spread of insect-borne diseases such as malaria, zika, and dengue.
- Hotter years are more prone to wildfires.
- Crops fail as they are sensitive to heat, setting off food shortages.

## A Hole in the Sky

The 'Ozone Hole' is a region in the stratosphere (the upper layer of the atmosphere) where CFCs have depleted the ozone layer to a great extent. This region lies above the Antarctic. Ozone depletion results in more UV rays reaching the earth. A disastrous result of increased UV radiation is its effect on the growth of plankton in the oceans. Plankton are at the bottom of the marine food chain, and change in their growth influences the entire food chain.



## Below 2 °C

If we fail to act now, we will see a further 1 °C rise in the current temperatures by 2025. By 2100, temperatures will be 4–6 °C warmer than they were in 1900. Can we halt this march? Yes, we can. 'Below 2 °C' is a movement to ensure the temperature rise is limited to 2 °C. Innovative solutions are needed to adapt to our changing planet and mitigate the risks. Climate change will not go away overnight. We need to persist.





# MELTING GLACIERS, THREATENED SPECIES

What happens if you take an ice cube out of the freezer? It begins to melt because of the higher surrounding temperature. Put it out in the sun and it is gone in no time. The same is happening on a larger scale on earth. Global warming is melting the snow and ice cover. And where does all the melt water go? It floods the land and adds to the ocean volume.

## What Happens When Glaciers Disappear?

Glaciers are the chief source of water for the mountain people. They feed rivers that flow throughout the year, like the Ganges and the Yangtze which provide fresh water to millions. At first, the melting glaciers supplied more water for irrigation, much to the delight of farmers around the world. But as glaciers disappeared, the river water dwindled, affecting agriculture, drinking water sources, and electricity generation. The melt water also flooded high-altitude lakes and created new ones, impacting life on the mountains.

## Threat of Rising Sea Levels

The cryosphere refers to those portions of the earth where water remains frozen. It includes sea ice, glaciers, snow, and so on, which reflect sunlight and keep the earth cool. When the cryosphere melts and flows into oceans and seas, it increases the overall volume and the sea level. Sea levels are also rising due to thermal expansion. When water absorbs heat, it expands and occupies more space. Oceans and seas act as massive heat sinks, absorbing heat from the atmosphere. With global warming, they end up sucking in extra heat, leading to a rapid expansion in sea levels. Rising sea levels threaten to drown coastal cities, wipe out beaches, and damage ecosystems.

## Changing Ecosystems

Every 24 hours, 150 – 200 species of plant or animal life go extinct due to climate change. High temperature coupled with extreme weather is forcing animals and birds to move to cooler regions, provided they find space. Marine life is severely affected as it cannot escape the warming waters. Climate change does not spare even the smallest of soil animals, bacteria, or fungi.

Sea turtles are born on beaches in nesting sites. These sites are in danger of being washed away by rising sea levels. Moreover, the gender of baby turtles depends on the temperature of the nesting site. Colder locations produce males and warmer ones females. Climate change is turning almost all turtles females. This unbalances the male-to-female ratio, affecting reproduction.



*The Sunderbans forest as seen from space*

## Species Going Extinct

Presently, many thousands of species are at risk of disappearing forever from the earth. In the past, extinctions were caused by events like asteroid strikes, volcanic eruptions, and natural climate shifts. On the contrary, the current crisis is almost entirely caused by human activities, primarily due to the loss of habitat, over hunting, diseases, global warming and so on.

We have seen many species going extinct in the recent decades. Most recently, the majestic West African black rhino was declared extinct in 2006. It was one of four subspecies of rhinoceros. The Baiji dolphin, a rare river dolphin native to China, was presumed extinct in 2007. The last documented sighting of the baiji dolphin was noted in 2002.

## Are We Ready To Lose Them?

Plant and animals are vital to maintain the ecological balance, as they play a key role in the food cycle. Extinction of species will ultimately cause a big loss for humans. Some of the species which are most endangered in India are mentioned below.

The **one-horned rhinoceros** is listed as one of the vulnerable species by the International Union for Conservation of Nature (IUCN). In India, they can be seen in Kaziranga National Park, Assam.

**Bengal tigers** are declining due to human interference and poaching. They are found in the tropical evergreen forests, deciduous forests, mangrove swamps, thorn forests, and grass jungles. The mangrove forest of the Indian Sundarbans, which is home to the majestic royal Bengal tigers, is found to be threatened due to the flooding of coastal areas.



# WEATHER GONE WILD

In February 2018, cotton farmers in Maharashtra saw their standing crops destroyed by an unexpected hailstorm. Hailstones, as big as 34 grams, even claimed two lives. Although pre-warned by the Met department, the farmers could do little to save their harvest-ready crops from the unseasonal thunderstorm. The storm lasted only ten minutes, but caused heavy damages to grapes, wheat, and jowar. As the weather gets warmer, extreme climatic events are expected to increase.

## What Is Extreme Weather?

Extreme weather is a weather event that occurs outside of the regular weather patterns of a region. Such events can occur for a day, like a cloudburst, or can extend for longer periods, like a drought. Our planet is not new to extreme climatic events including hot and cold waves, droughts, floods, storms, and so on. However, the warming globe has intensified these climate extremes, increased their duration, and made them more frequent. Over 90% of all disasters in the last two decades have been weather-related.

## New Temperature Highs

Both the minimum and maximum land surface temperatures have increased considerably and are breaking records. Heatwaves, or unusually hot weather, are more common now than a century ago. Such extreme temperatures suck in extra moisture from the land, leading to droughts. "Fire weather" indicates how likely and quickly it is for a wildfire to start. Dry forest vegetation only needs an ignition, like a lightning bolt, to set off a fire. Hot and dry conditions are ideal for forest fires.



## QUICK FACT

In 2001, Kerala received blood-red rainfall. Recent studies have shown that it



## When Rains Won't Go Away

Widespread, consistent warming leads to extreme precipitation and unusual rainfall patterns. Warmer air can hold more moisture. So clouds continue to build instead of falling down as rain, sleet, or snow. The result is heavy rainfall due to additional water vapour that is available to the storm system. Snowstorm extremes work in the same way. India receives the same amount of total precipitation annually, but all that rain now falls within a shorter time frame, creating downpours.

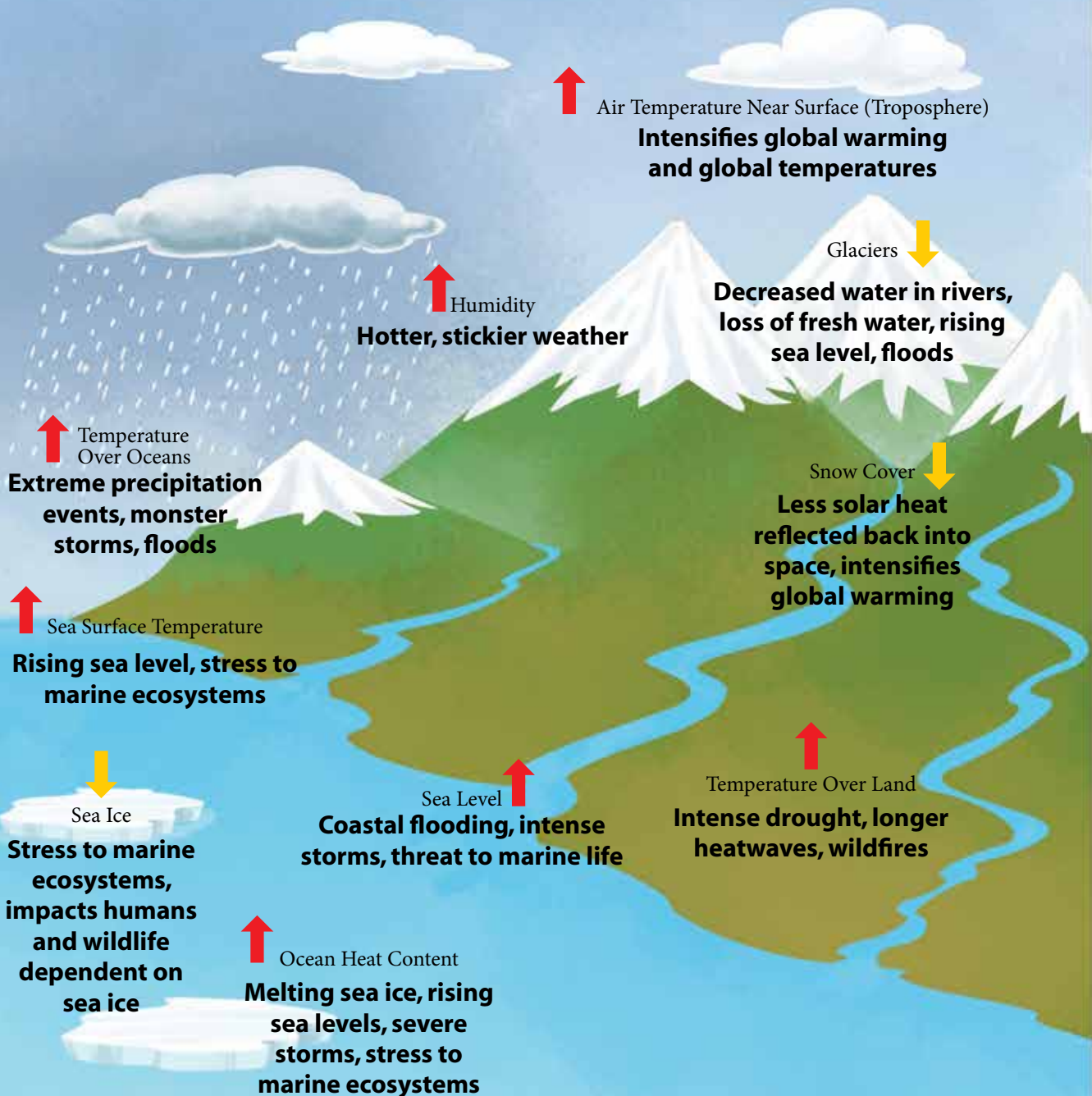
It doesn't end there. The parched soil is unable to absorb the heavy rainfall in such a short span of time. Hence, much of the rainwater runs off into lakes and rivers, resulting in the soil remaining dry underneath the surface. The excess water ends up eroding the land and causing severe floods as well.



was caused by an alga trying to disperse its spores.

## Ten Indicators of Climate Change

Ten major shifts in our climate system tell us that the changes we are experiencing are permanent.



### QUICK FACT

The golden toad of Central America was the first species to go extinct due to



## Measure Rain with Your Own Rain Gauge

How much rain falls on your head in a day? In a month? In a year? One way we can find out and connect to our natural weather patterns is with a rain gauge. Making one at home is easy, and nearly free! With your rain gauge you can discover how much rain you received.

### You Will Need

- 1 litre bottle
- Pebbles or marbles
- Scissors
- Ruler
- Pen or marker
- Paper and Pencil (for recording rainfall)

### Get Started

1. Take a 1 litre plastic disposable water bottle. With a knife/scissors, cut its neck on the cylindrical part.
2. Invert the top to make a funnel. This funnel will prevent evaporation of water.
3. An empty plastic bottle, being light, will fall down in the slightest breeze. Put pebbles/marbles in the bottom of the bottle. This will hold the bottle in place.
4. Using your ruler and marker, place a mark after every 1/2 inch on the bottle. These will allow you to measure how much rain you received.
5. Set the bottle on a level surface and pour some water in until it reaches the bottom mark. Your rain gauge is now ready to go!
6. After it rains, check your gauge!
7. Record your results — make a note of the date and the amount of rain.
8. Repeat steps 6–7 for several rainy days.

With this information, you will know how much rain you could potentially harvest if you install a rain barrel. Whether it's 5 inches or 50 inches, every drop counts when saving precious water from becoming polluted runoff!



# Survival at RISK

Clean air, safe drinking water, sufficient food, and a secure shelter are all required for a healthy life. In recent years, climate change has been adversely impacting all of these factors. Climate plays a key role in spreading diseases, either directly or indirectly through interaction with ecological systems. As the temperatures continue to rise and the weather worsens further, hunger, deaths, and infectious diseases are bound to increase.

## Direct and Indirect Impact

The direct impact of climate change on health can be in the form of heat strokes. The depleting ozone layer exposes us to greater UV radiations, causing skin cancers and cataract in the eyes. On the other hand, indirect impacts include diarrheal risk from water contamination via flooding, deterioration in nutritional health due to crop failure owing to droughts and high temperatures resulting in reduced cereal yields, and vector-borne diseases.

Vector-borne diseases are spread by insect bites and warm weather supports the survival and distribution of pests like mosquitoes, ticks, and rodents that carry diseases. Malaria and dengue, spread by mosquitoes, now prevail in over 100 countries in the tropical and semi-tropical regions. According to a report in the *Times of India*, Gujarat, recorded 37,028 cases of malaria till November 2017.

Air pollution, a major factor for climate change, also causes heart and respiratory diseases.

## All at Risk

Habitats, species, and livelihoods are all at risk! Climate change has largely affected land animals, birdlife, and plants, and have left some on the verge of extinction. Changing rainfall patterns, climate variability, and rise in sea levels, have all impacted their distribution and behaviour.

The changing weather pattern affects human behaviour and threatens the health of the population. People who face increased risk include young children, old people, people with disabilities or medical conditions, and the poor. The threats climate changes and extreme weather pose to human health are unhealthy air, malnutrition, the spread of infectious diseases, and food poisoning.

As we get increasingly exposed to climate change, the urgency to act, prepare, and adapt to these changes becomes vital for protecting our own health and the environment.

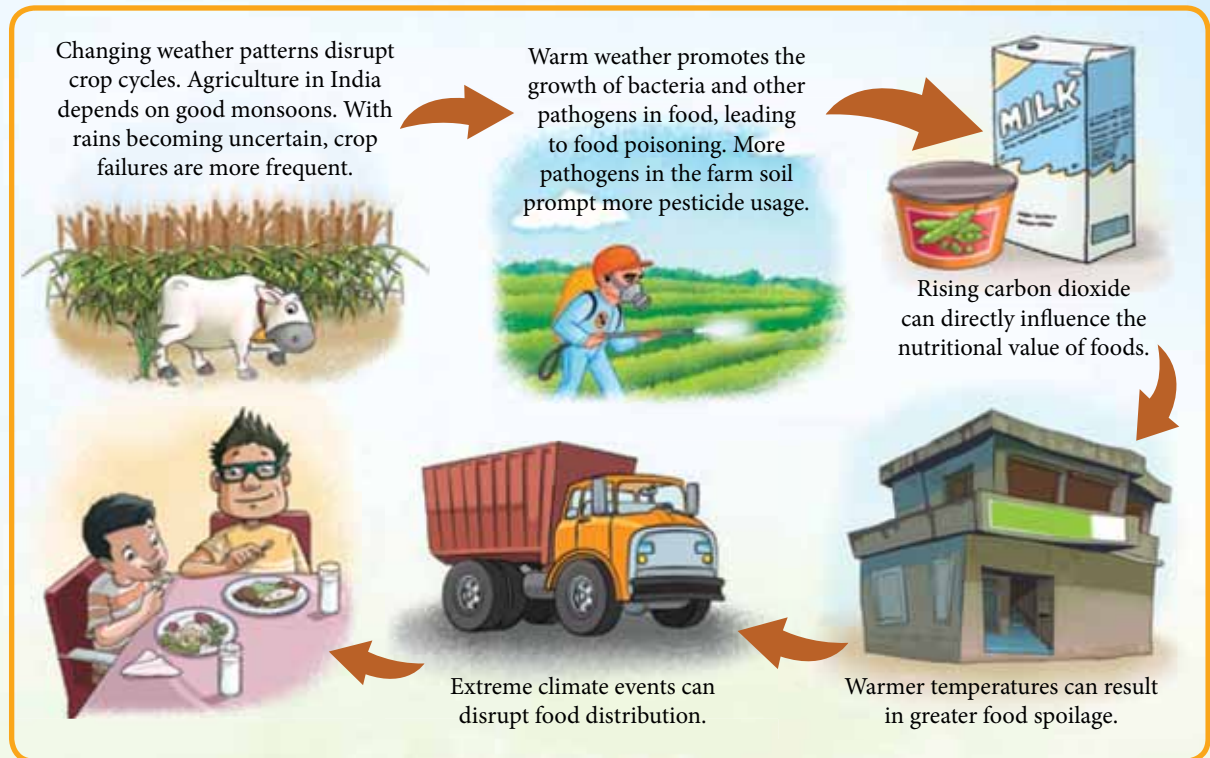
## QUICK FACT

According to the IPCC, the yield of rain-fed crops will fall by 50% in some



## Threat to Food Safety

Climate change directly impacts the production of food, its distribution, and the nutritional value of the food that reaches our tables.



## Effect of Extreme Weather

Climate change causes extreme weather patterns or disasters such as flooding, drought, and storms, which threaten the health and survival of people. Disasters affect human health by water and food contamination, damage to habitats, disrupting food

production, and increase in illness. Heavy rainfall or floods increase the risk of contaminating waterbodies and sources of drinking water. Various waterborne and vector-borne diseases spread across as a result of the rising temperature and precipitation. We need to take practical actions to manage the risks and threats arising from climate change and natural disasters. It is important to avoid unsafe food and water consumption in the event of a disaster.





# WHO CAUSED THIS MESS?

**Are humans causing the current climate change? This debate has long been over. Thousands of scientists around the world have collected heaps of evidence that prove one point: Humans are indeed the main culprit. Since the Industrial Revolution, we've been burning fuel like there's no tomorrow. We cut down forests to build megacities.**

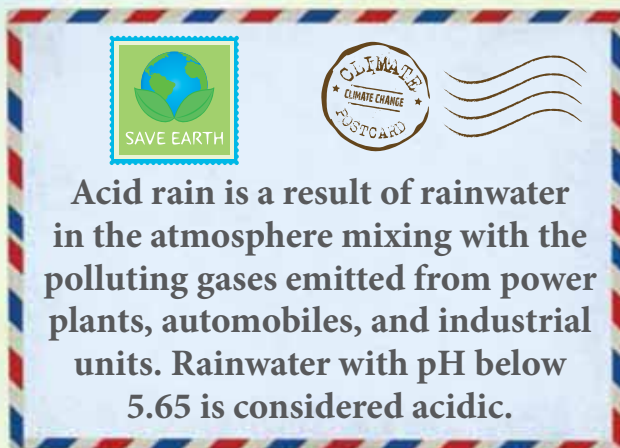


Human activities on earth have increased the concentration of atmospheric CO<sub>2</sub>. Burning of fossil fuels and decrease in the green cover has led to the increase in the greenhouse effect.

With the growing population, use of fossil fuels has been increasing in industries, factories, vehicles, agriculture, and electricity generation. All this has led to an increase in the greenhouse effect, which in turn affects rainfall, release of air pollutants, and depletion of the ozone layer. Deforestation has also increased CO<sub>2</sub> concentrations in the atmosphere, reducing rainfall and increasing the likelihood of droughts and floods.

The consequences of climate change patterns due to the changing natural atmospheric GHGs are seen to impact the environment. The earth has become warmer and warmer conditions have led to more evaporation and precipitation, resulting in some regions

becoming wetter and others dryer. Rise in temperatures has led to melting of glaciers and ice covers, which increases the sea level. Ocean water will also expand due to rise in temperatures, contributing further to the sea level rise. Higher temperatures and shifting climate patterns have changed the areas where crops grow best and affect the food production and security.

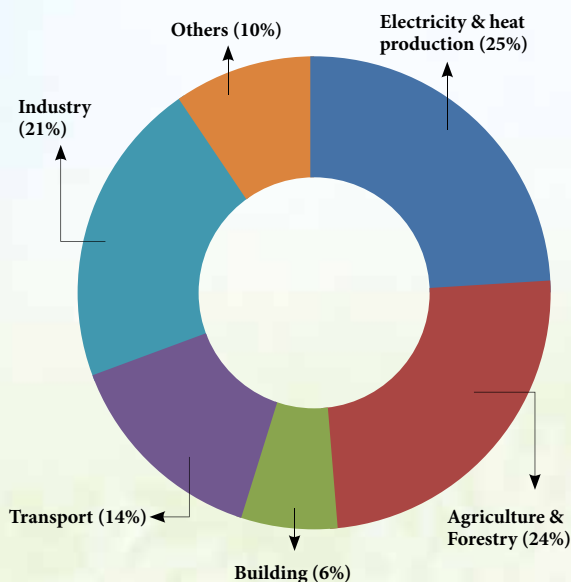


## GHGs Emissions

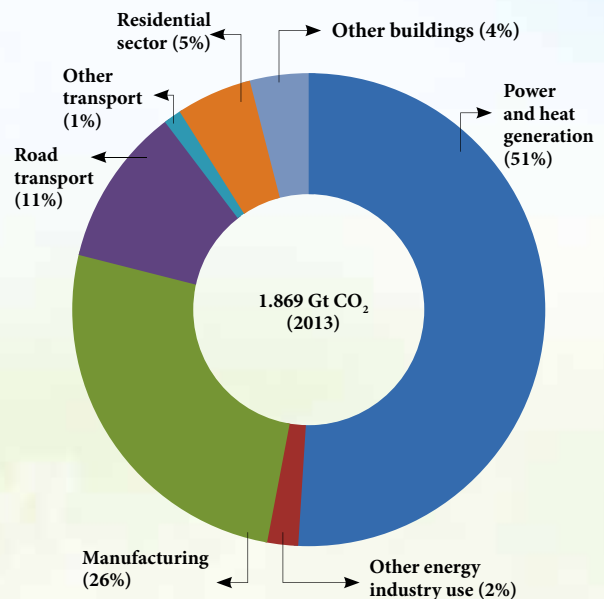
The total global GHG emissions continue to increase by about 0.5%, reaching 49.3 gigatonnes of CO<sub>2</sub> equivalent in 2016. Most of the emissions (about 72%) consist of CO<sub>2</sub>, but methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and fluorinated gases make up substantial shares (19%, 6%, and 3%, respectively).

India is the world's fourth-largest emitter of CO<sub>2</sub>. India's CO<sub>2</sub> emission is mainly from coal combustion, which has a share of 72% in the total fossil fuel combustion emissions, with 25% from oil products.

## Global GHG Emission by Sector      Sector-wise CO<sub>2</sub> Emissions in India from Fossil Fuel combustion



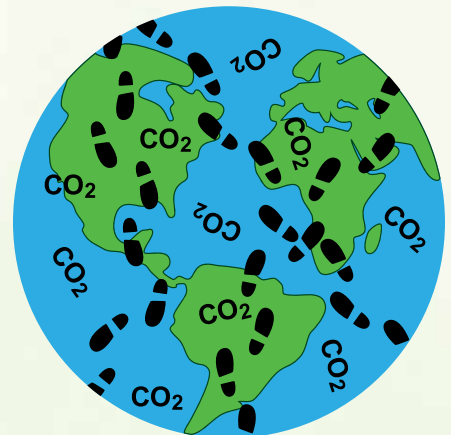
Source: IPCC, 2014



Source: IEA, 2015

## Carbon Footprint

All your activities and needs add CO<sub>2</sub> to the environment directly or indirectly. CO<sub>2</sub> emissions are created during travel, cooking, heating, and even during manufacturing goods. It's like leaving your stamp on the atmosphere, much like leaving footprints when you walk on sand. The amount of CO<sub>2</sub> released due to your activities is your carbon footprint. For instance, buying a bottle of packaged water instead of filling a reusable bottle at home, increases your footprint size. The bottle had travelled a great distance to reach you, releasing pollutants on the way.



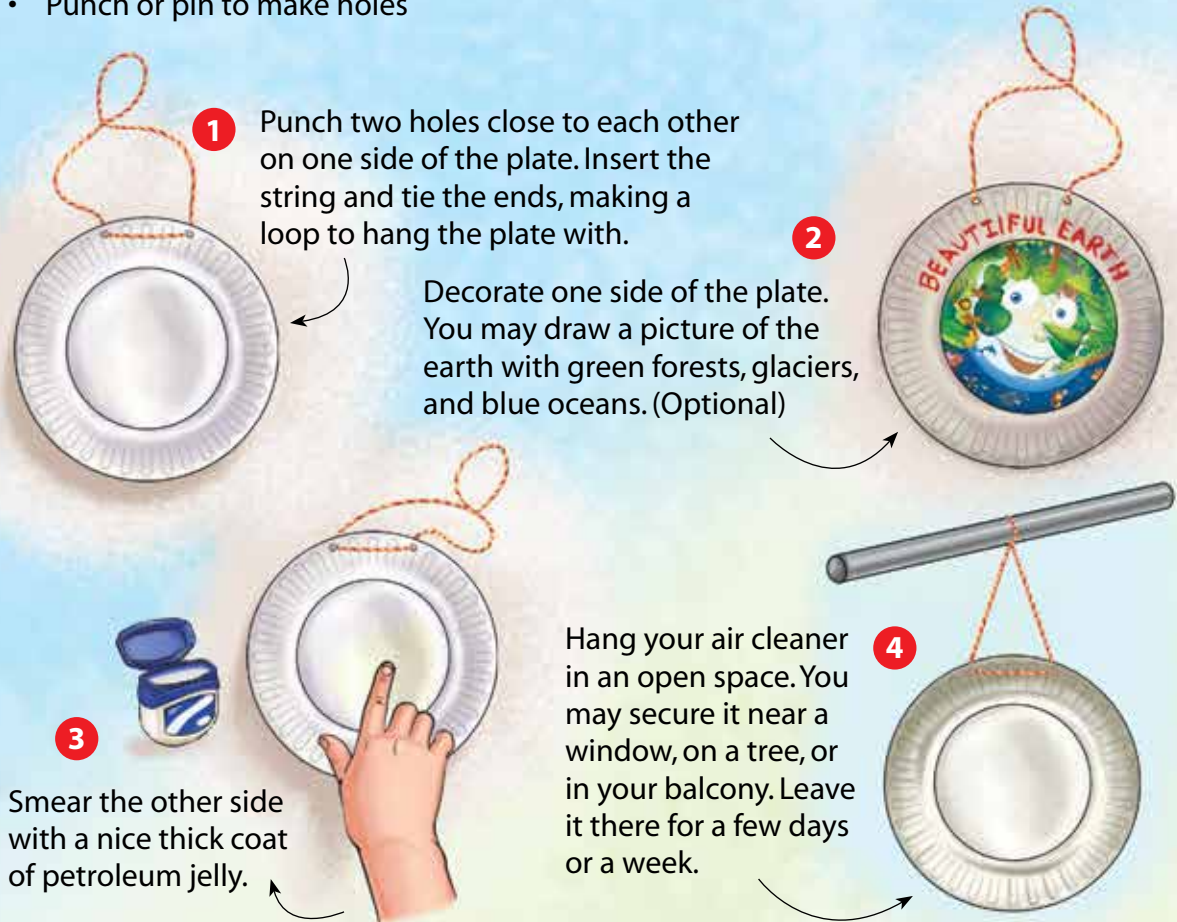
# Activity

## Let's Clean the Air for a Change

Aerosols are minute particles floating in the air. Some are produced by nature, like the sand from sandstorms, salt particles from the oceans, ice crystals, and ash particles from volcanoes. A lot are man-made too, like dust, smoke, and other industry emissions. While aerosols help form clouds, increasing amounts cause asthma and acid rains. Aerosols add to the air pollution, create dense smog, and are a major contributor to global warming. Wouldn't it be awesome if we helped clean the air?

### You Will Need

- One large, sturdy paper plate
- String
- Scissors
- Punch or pin to make holes
- Petroleum jelly
- Decoration materials (optional)
- A place to hang the air cleaner



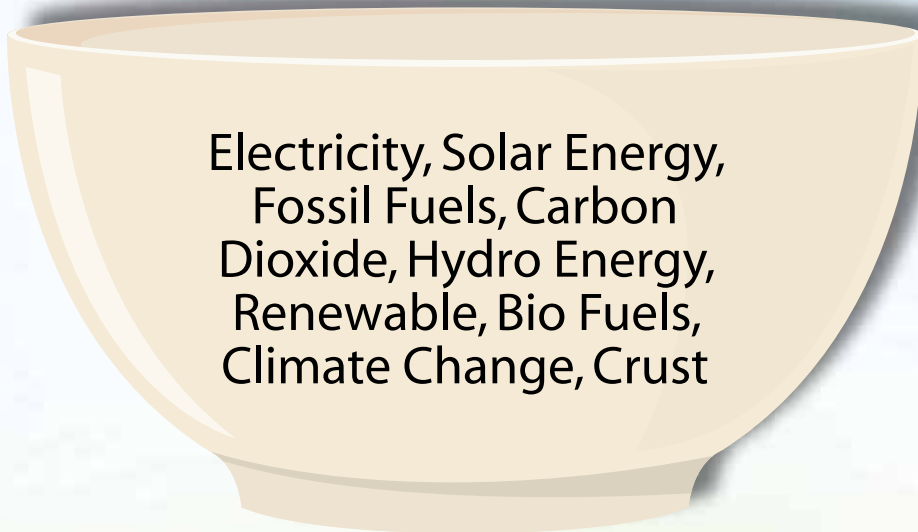
Observe the plate. How do the two sides look? The side with the petroleum jelly is now black. You helped catch a good amount of dust and soot from the air that would've otherwise entered our lungs.

### QUICK FACT

Past civilizations, like the Maya and the Indus Valley, collapsed when they

## Get, Set, Go

1. Choose the right words from the bowl to complete the paragraph.



Poor nations or developing countries depend on coal-based energy which leads to a high discharge of \_\_\_\_\_ into the atmosphere. Therefore, we need to switch to clean energy, also known as \_\_\_\_\_ energy. It is one of the most effective tools to fight \_\_\_\_\_. The kinetic energy of the wind can be used to generate \_\_\_\_\_.

\_\_\_\_\_ can be used for a variety of purposes known as heating, cooling, lighting, and electricity generation. The energy of moving water in rivers and tidal waves is known as \_\_\_\_\_. Geothermal energy is stored in the earth's \_\_\_\_\_ within rocks and underground streams. The energy produced from plants and animal waste is used to generate \_\_\_\_\_. Compared to \_\_\_\_\_, the use of renewable energy emits less carbon dioxide.

# ROLE OF CLEAN ENERGY

The core of the climate change crisis lies in our economy's dependence on fossil fuels. Over 80% of the energy consumed today comes from them. While all energy sources impact the environment in some way, fossil fuels cause far greater damage than others. Even the process of electricity generation dumps millions of tons of CO<sub>2</sub> into the atmosphere through the combustion of fossil fuels. This trend has to stop.

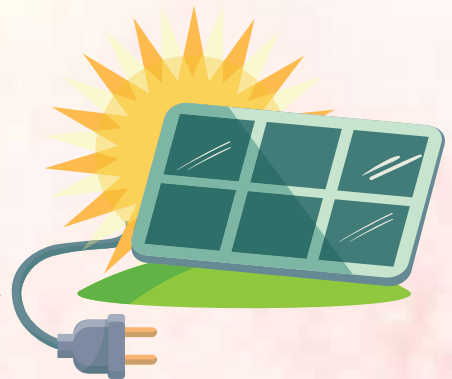
## Consumption of Energy

As countries develop, so do the energy consumption and its supply. Electricity has a particularly large hand in the progress of our society. Developed countries, like the US, have already used up a great deal of their carbon budget share and need to implement drastic cuts in their emission levels. Developing and poor nations depend on coal-based energy sources that result in high CO<sub>2</sub> discharge. Climate mitigation demands that they invest in clean, renewable energy that does not damage the atmosphere further.

## Clean Energy

Renewable energy is one of the most effective tools we have to fight climate change. With new improvements, costs of renewable energy sources are declining rapidly. Unlike fossil fuels, these sources are limitless, or they can be regrown and refilled.

1. **Solar Energy:** The sun's energy is the most abundant form of energy in most parts of the world. It can be used for a variety of purposes including heating, cooling, lighting and electricity generation.

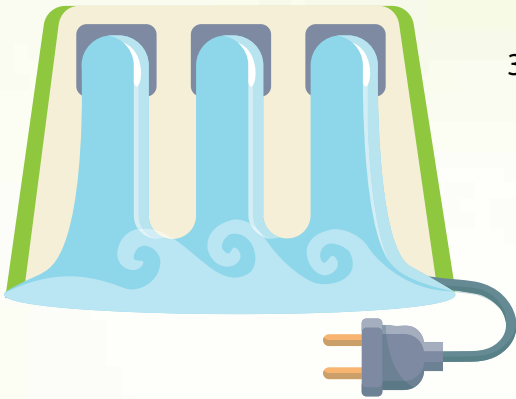


2. **Wind Energy:** The kinetic energy of the wind can be used to generate electricity. Like solar, it has zero GHG emissions and is cost-wise competitive with fossil fuels.

## QUICK FACT

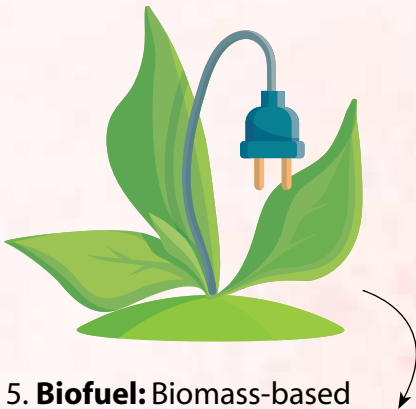
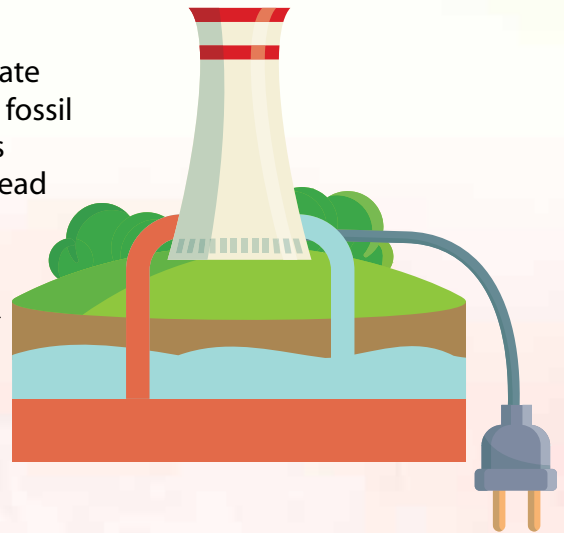
In 2015, Germany set a new national record by meeting 78% of a day's



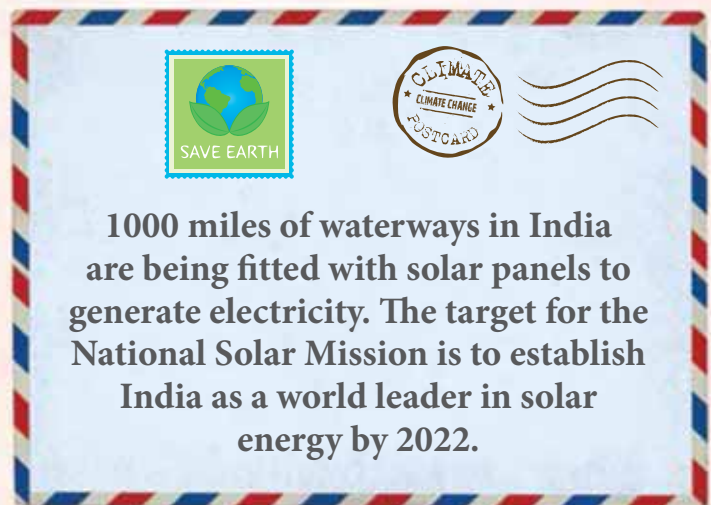


3. **Hydro energy:** The energy of moving water in rivers and tidal waves can be harnessed for multiple purposes, including electricity generation. The oceans are a huge reservoir of energy that is more than sufficient to fulfil the current as well as future energy needs of people.

4. **Geothermal energy:** This includes the energy stored in the earth's crust within rocks and underground streams. It is harnessed to generate electricity using steam-powered cycles. Unlike fossil fuels, which are also trapped within the earth's crust, geothermal sources are more widely spread and produce near-zero pollution.



5. **Biofuel:** Biomass-based energy sources are a traditional source of fuel in rural areas, produced from plants and animal waste. Soon research will bring us biofuel cars zooming down our highways. Although biofuels emit CO<sub>2</sub>, they still have a higher mitigation potential as compared to fossil fuels.

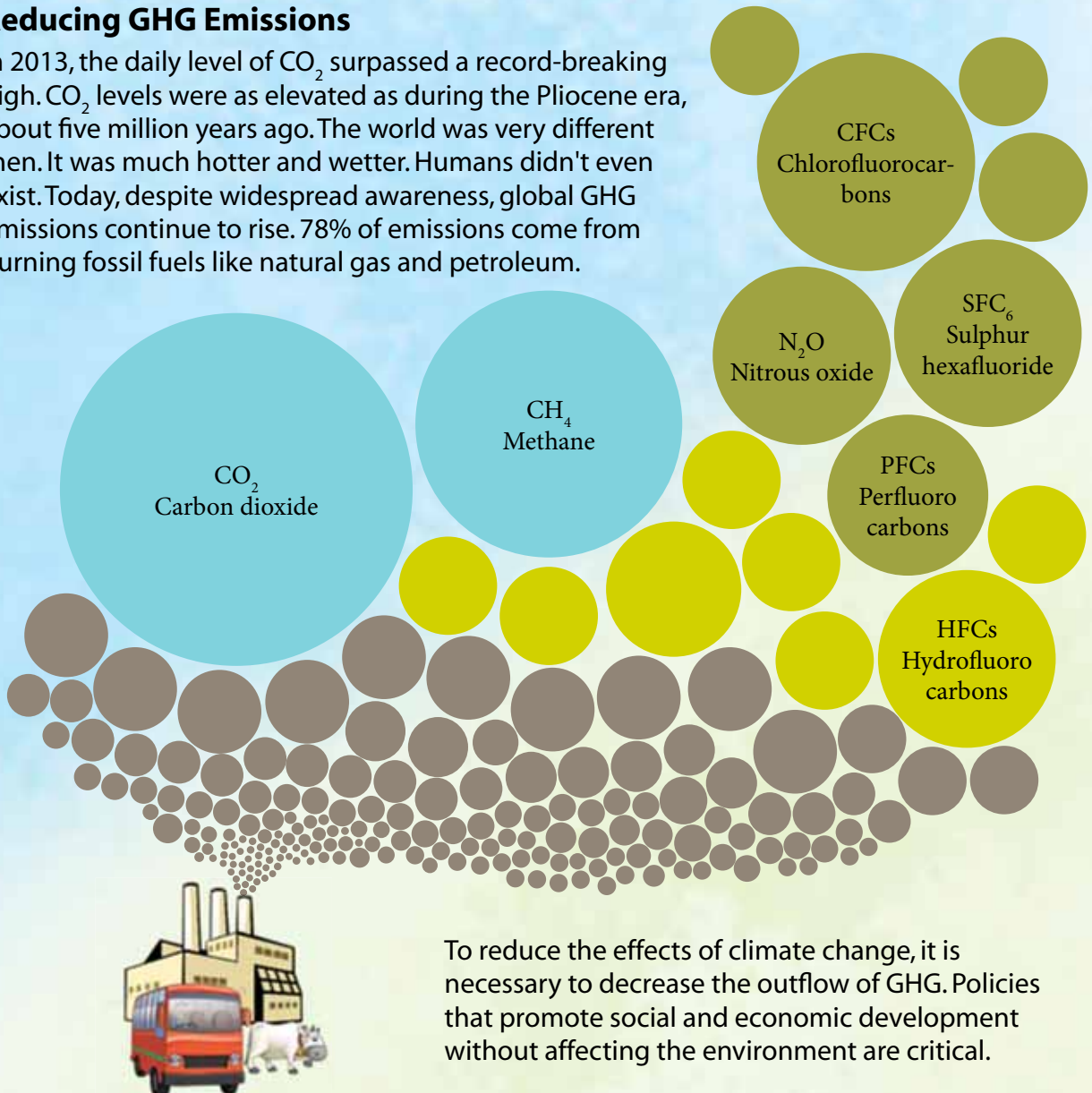


# LIMITING THE CONSEQUENCES

Is it even possible to reverse the trend of climate change? While it may not be likely to go back to the pre-industrial state, we can definitely take actions to limit the consequences of climate change. There are two steps to mitigating climate risks — reduce GHG emissions and increase the forests areas which will decrease the GHG levels in our atmosphere.

## Reducing GHG Emissions

In 2013, the daily level of CO<sub>2</sub> surpassed a record-breaking high. CO<sub>2</sub> levels were as elevated as during the Pliocene era, about five million years ago. The world was very different then. It was much hotter and wetter. Humans didn't even exist. Today, despite widespread awareness, global GHG emissions continue to rise. 78% of emissions come from burning fossil fuels like natural gas and petroleum.



To reduce the effects of climate change, it is necessary to decrease the outflow of GHG. Policies that promote social and economic development without affecting the environment are critical.

## QUICK FACT

The UNFCCC aims to achieve stable GHG concentrations within a time frame

## Gujarat's Action Plan on Climate Change

Gujarat is the first state in India, the first in Asia, and the fourth in the world to form an independent Department for Climate Change. The Gujarat government's Department for Climate Change was set up on 17 September 2009 as a bridge between the government and society to address climate change. Gujarat has initiated a range of policies and programmes that have the potential to counter the challenges of climate change while ensuring the achievement of the sustainable development objectives.

### Renewable Energy Put to Use

The Gujarat government acknowledges its rich solar energy resource and has introduced a solar power policy to facilitate and promote large-scale addition of solar power generation. The country's first MW scale canal-top solar plant was set up at Chandrasan in Mehsana District of Gujarat.

Gujarat's geographical location also holds huge prospective for harnessing wind energy, due to its long coastline and good wind speeds. The recently launched wind-solar hybrid power policy will allow setting up of wind as well as solar power projects at one location.

Gujarat has rivers, streams, and large canal networks which could be used for generation of clean and renewable power through hydroelectricity projects. The Gujarat government has introduced programmes to support and facilitate small hydel projects in the state and to reduce the dependency on the depleting fossil fuel reserves for energy security and sustainability.



### Power of Waste

Municipal solid waste (MSW) is growing and its disposal is a challenge everywhere. It is estimated that the MSW of Gujarat can support a waste-to-energy plant of approximately 100 MW. Therefore, the government has introduced a waste-to-energy policy to facilitate and promote the utilization of MSW for the generation of electricity at an affordable cost in a sustainable manner and also help in a more environment-friendly disposal of MSW.

# Activity

## Cook Using Solar Oven

In one hour, more sunlight falls on earth than what is used by the entire population of the earth in one year. You can harness the sun's energy and make a tasty treat. Making a solar cooker is easy, clean, safe, and free!

### You Will Need

- Cardboard box
- Plastic wrap
- Aluminium foil
- Glue and tape
- Scissors
- Black paper
- Ruler/stick

### Get Started

1. Draw a 1 inch border on all four sides of the top of the cardboard box. Cut along three sides of the lid. Fold this flap back along the fourth side.

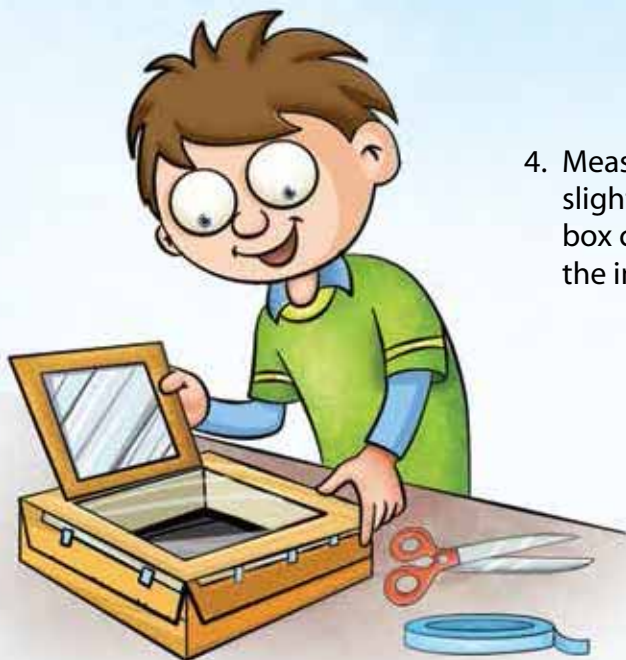


2. Cut the aluminium foil the size of the flap. Glue it on the inside of the flap.
3. Measure and cut the aluminium foil to line the bottom of the box, and then tape/ glue it tightly. Similarly, measure and cut black paper the size of the bottom of the box, and then tape/glue it tightly on top of the foil.

### QUICK FACT

Hunger and malnutrition currently causes 3.1 million deaths around the world





4. Measure and cut a piece of plastic slightly larger than the opening of the box cover. Then tape/glue it tightly to the inside of the box cover.



5. Use a ruler or stick to support the flap. This will redirect all the sunbeams to the food inside.
6. Your solar oven is now ready for use. (Important: Use gloves or cloth when you check the food in the solar cooker)

## Make Sabudana Khichri

### Ingredients:

- Sabudana — 70g (soaked in water for 3 hours)
- Crushed peanuts — 2 tablespoons
- Salt to taste
- Green chilly or red chilly powder — as per taste
- Coriander leaves and lemon juice for garnishing

### Procedure:

Drain the extra water from the soaked sabudana and mix all other ingredients in a utensil. Mix properly, close the lid, and place it in the solar cooker. Cook it for 40 to 60 minutes. Let it cool before serving.



# PREPARING FOR CLIMATE CHANGE

Adapting to climate change will not be easy. It will cost crores of rupees annually, for several decades; not all countries have that kind of money, especially the poor nations. More research is needed for developing cheaper adaptation technologies. Yet, based on what we know, there certainly are best practices we can implement.

## Food and Water Security

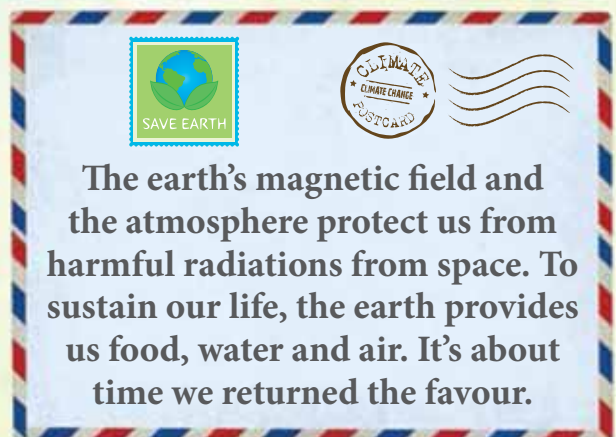
Over-extraction is depleting our groundwater supplies. Cape Town in South Africa is the first major modern-era city expected to run out of drinking water soon. There is an urgent need to reuse and recycle our resources, implement better land management practices and reduce water wastage. Farmers require policies that boost their income. Promote climate-smart agricultural practices, which merge traditional methods with new research. Adopt a proactive approach, instead of merely reacting to changes.

## Coping with Severe Weather

- Build strong houses to withstand storms.
- Set up shelters in case evacuation is needed.
- Preserve natural barriers, like sand dunes, to help protect against storms.

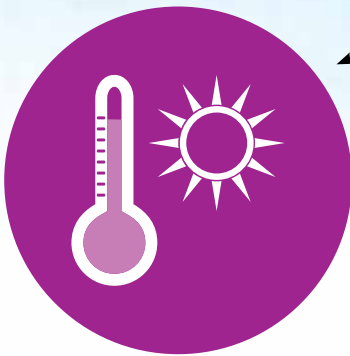


- Avoid building homes on floodplains.
- Preserve wetlands that can store floodwater.



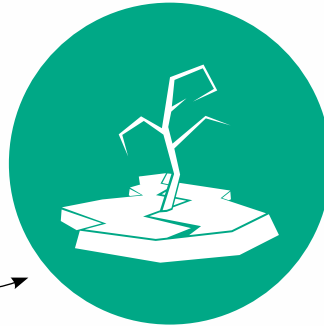
## QUICK FACT

Earth Overshoot Day is the date when humanity's consumptions of the year



- Stay inside, drink fluids, and wear loose-fitting clothes.
- Set up warning systems for heat emergencies.
- Create green zones to keep cities cooler.

- Conserve water.
- Plant drought-resistant crops.
- Use water-efficient fixtures at home.



## Staying Safe from Rising Seas

Areas prone to coastal flooding need barriers like sea walls or sandbags to block the water. Preserve wetlands and floodplains that can store the floodwater. Protect beaches and reduce erosion. Improve the drainage system and keep it free of blockages. Build settlements away from the shoreline. Have an evacuation plan ready.

Heavy monsoon rains in South Asia this year triggered the worst floods in a decade in India, Nepal, and Bangladesh, killing hundreds and affecting millions of people. India has the most exposure to damage from river flooding, according to the World Resources Institute.

While monsoon rains trigger floods in northern and eastern India every year, Gujarat, which is in a semi-arid region, has also experienced floods more frequently in recent years as warming temperatures bring heavier rains. We need to have a vigorous forecasting mechanisms, pre-emptive safety measures and effective post-flood management to evade damage to human civilization.





# Activity

## Make Your own Wind Vane

Knowing the direction of the wind is an important part of predicting weather because wind brings us our weather. A wind vane is a tool for measuring wind direction and was probably one of the first weather instruments ever used. To determine wind direction, a wind vane spins and points in the direction from which the wind is coming and generally has two parts, or ends: one that is usually shaped like an arrow and turns into the wind and the other that is wider so that it catches the breeze. The arrow will point to the direction the wind is blowing from. So if it is pointing to the east, it means the wind is coming from the east. To use a wind vane, you must know the four directions: north, south, east, and west.

### You Will Need

- Tag board or old cards
- Straight pin
- Scissors
- Clear tape
- Pencil with a new eraser
- Plastic drinking straw
- Sand
- 1 litre plastic bottle
- Marker pen



### Get Started

1. Cut out an arrow point 5 cm long.
2. Cut out an arrow tail 7 cm long.
3. Make 1 cm cuts at the ends of each straw.
4. Slide the arrow point and the arrow tail into the cuts in the straw. Secure each of the ends with a small piece of clear tape.
5. Push a straight pin through the middle of the straw and into the eraser end of the pencil.
6. To create the weathervane base, fill the cut bottom of the plastic bottle with some sand, and firmly stick the pencil weathervane into the centre of the sand.
7. Mark the directions (north, south, east, and west) on the side of the plastic bottle.
8. Test out your wind vane: Blow on the vane and make sure that the arrow can spin freely.



### QUICK FACT

Rooftop gardens in cities not only grow organic food but also insulate



### News Report

Imagine you are a reporter and you visit a disaster-affected area with your cameraperson. Write a report about the tragic incident touching upon how it occurred, what precautions should have been taken and what steps are being taken to help the victims.



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# WHAT CAN I DO THAT MATTERS?

Climate change is the most complex issue facing the world today. It encompasses multiple dimensions, from science to economics to society and politics. It is as much the government's job to devise policies and exercise control on emissions as it is our responsibility to change our habits and behaviour. You don't need to be big to make an impact.

## 10 Ways to Make a Difference



### Grow your own food

Growing your own food reduces your carbon footprint, plus it's delicious and saves money.

1

### Save energy

Use less energy by turning off appliances when not in use; switch to energy-saving bulbs and appliances.



2

### Conserve water

Use water efficiently, turn off taps when not in use, take short baths, and avoid unnecessary water consumption.

3



4



### Reduce, reuse, recycle, & compost

Practice reuse and recycling of old products, and composting of waste. If you recycle half of your household waste, you can save 1088 kg of CO<sub>2</sub> each year.

## QUICK FACT

Fighting climate change and building resilience to its impacts should be high



### Plant trees

Restore damaged ecosystems by planting trees around your home, school, and parks.

6

### Buy local & seasonal

Support local farmers; enjoy the freshness and variety of seasonal food.



5



7

### Travel green

Opt to walk, cycle, or use more public transport. 25% of the world's gas emissions are caused by vehicles.



8

### Use renewable energy

Use solar powered products such as solar cookers, solar lanterns, and so on. In one second, the sun produces enough energy to meet the current needs of the entire earth for 500,000 years.



9

### Avoid packaged food & use reuseable bags

Avoid unnecessary buying; buy products with minimal packaging. A single plastic bag can take up 500 years or longer to degrade.



### Spread the word

Tell your friends, family, and neighbours about the benefits of sustainable practices. Motivate them to adopt these practices.

10

# Activity

## Let's Make Seed Paper!

Recycling is better than using the original! Here is a way to not only recycle your old paper but also turn it into a beautiful card with seeds in it. You can paint a design or write a message on it and gift it to someone to plant it in a pot or in the ground.

### You Will Need

• Used paper, cut into tiny pieces. Use 1–1/2 cups for each card. • Large bowl of warm water  
• Screening cloth material • Small embroidery hoop • Food colouring (optional) • Mixie/Blender • Tray • Flower seeds • Bath towels • Waxed paper • Coloured markers

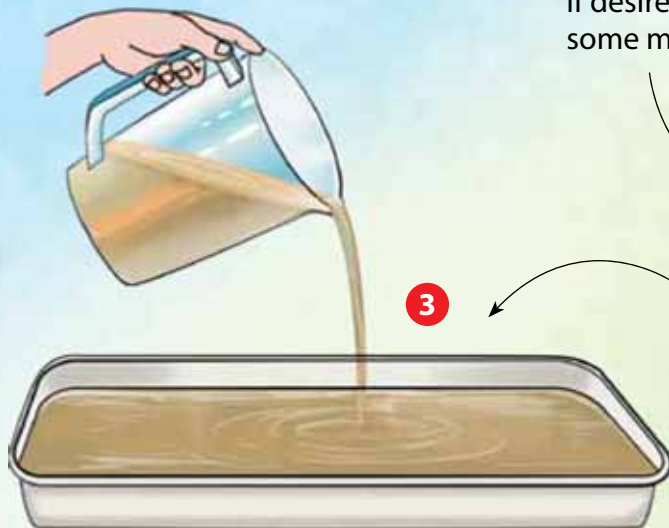
### Get Started



1. Soak the paper pieces in the bowl of warm water overnight. Put the soaked paper into the blender, then fill the blender halfway with fresh water.



2. Blend until the mixture is soupy.
3. Add food colouring, if desired, and blend some more.



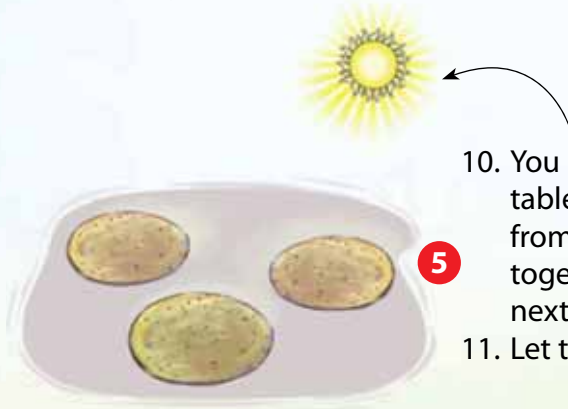
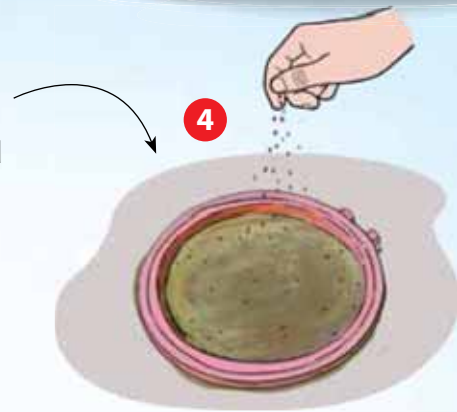
4. Pour the blended paper mixture or pulp in a tray.
5. Slip in the embroidery hoop with screening cloth from the side so that it slides beneath the pulp. If necessary, spoon some of the pulp over the screen.

### QUICK FACT

Without the greenhouse effect, the earth would be a frozen planet, incapable



6. Lift the screen gently, catching the pulp mixture evenly on top and letting the water drain off.
7. Lay the screen on a bath towel to drain.
8. Sprinkle some seeds on top of the wet pulp, and gently pat them into the surface of the pulp.
9. When the bath towel or felt has soaked up as much water as it can, pick up the hoop and turn it over onto a sheet of waxed paper or plastic sheet to dry. (Seeds will be on the bottom.)



10. You may have to gently hit the hoop on the table or counter surface to loosen the pulp from the screen. If the pulp does not stick together, try putting more pulp on the screen next time.

11. Let the paper dry for at least 24 hours.

12. If the paper does not lie flat, place a heavy object (like a book) on it for a few hours to flatten it.



13. Decorate it with markers on the un-seeded side.

## To Plant the Paper

When you plant the paper, lay it on the surface of the soil and sprinkle about one-quarter-inch thick layer of soil on top. Water the soil lightly and keep the seeds wet until they sprout and have a few days to grow roots.

# GLOSSARY

cryosphere	those portions of the earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground (permafrost)
decade	a duration of 10 years
deforestation	the permanent removal of standing forests
equator	an imaginary line on the earth's surface, equidistant from the North and South Poles, dividing the earth into the Northern and Southern Hemispheres
extinct	something that has ended or has died out
flora	the plants of a particular region or period
GHG	Greenhouse gases in our atmosphere that trap sun's heat and keep our planet warm
glacier	a mass of ice formed from snow accumulating over the years and moving very slowly
habitat	the natural environment of an organism
maritime air	the air originating over tropical oceans
meteorologist	a scientist who studies climates or climatic conditions
NASA	an independent US agency, responsible for the civilian space programme, as well as aeronautics and aerospace research
pathogen	any disease-producing agent, especially a virus, bacterium, or other microorganism
permafrost	soil, rock, or sediment that is frozen for more than two consecutive years
precipitation	any product of the condensation of atmospheric water vapour that falls under gravity, including rain, snow, sleet, and hail
thermal expansion	the tendency of matter to change in shape, area, and volume in response to a change in temperature



# EVALUATION

## Choose the right answer.

1. This gas in our atmosphere has been increasing in concentrations over the past 100 years. Name it.
  - i. oxygen
  - ii. carbon monoxide
  - iii. carbon dioxide
  - iv. hydrogen
2. Which type of radiation is absorbed by the ozone layer?
  - i. ultra violet (UV)
  - ii. gamma-ray
  - iii. x-ray
  - iv. yellow
3. What is climate change?
  - i. a sudden change in conditions including temperature and precipitation
  - ii. an extreme weather event such as a hurricane or drought
  - iii. a change in global temperatures and weather patterns over many years
4. An unexpected thunderstorm is an example of:
  - i. weather
  - ii. climate
  - iii. storm
  - iv. climate change
5. What does the atmosphere contain that keeps the earth's surface warm?
  - i. nitrous oxide
  - ii. carbon dioxide
  - iii. water vapour
  - iv. all of the above
6. What is the main cause of extinction of animals?
  - i. Poaching and hunting
  - ii. Deforestation and agriculture
  - iii. Human overpopulation
  - iv. Pollution
  - v. All of the above
7. Which of the following is not a waterborne disease?
  - i. Cholera
  - ii. Malaria
  - iii. Typhoid



8. Which of the following is not a carrier of vector-borne diseases?

i. Ticks

ii. Bugs

iii. Dirty water

9. What is the advantage of "clean" energy sources ?

i. they produce less GHG

ii. they can be replenished

iii. they are cheaper

iv. both i) and ii)

v. both ii) and iii)

10. What is the best way to reduce the effects of climate change?

i. cut down on fossil-fuel use

ii. save paper

iii. plant trees

iv. use clean sources of energy

v. combine efforts like these all across the world

**State whether true or false.**

1. Fires release the carbon stored in plants. (True/False)

2. Oceans and forests are major sinks of carbon dioxide. (True/False)

3. Compared to other greenhouse gases, water vapour is the most effective in trapping heat near the earth's surface. (True/False)

4. Tropical islands are safe places to escape climate change. (True/False)

5. Melting sea ice can raise sea levels by several metres. (True/False)

**Fill in the blanks.**

1. Each ozone molecule contains three \_\_\_\_\_ atoms.

2. \_\_\_\_\_ was the first species to go extinct due to climate change.

3. World Environment Day is celebrated on \_\_\_\_\_ every year.

4. Geothermal energy is a form of \_\_\_\_\_ energy source.

5. Your \_\_\_\_\_ is the amount of carbon dioxide released by your activities and needs.

Name: \_\_\_\_\_

Class: \_\_\_\_\_ Sec: \_\_\_\_\_

School: \_\_\_\_\_

Place: \_\_\_\_\_







# HOW BIG IS YOUR CARBON FOOTPRINT?

**Calculate the CO<sub>2</sub> and other GHG emissions that you are responsible for, as an individual.**

1. How would you best describe your diet?
  - a) Vegetarian.
  - b) Meat very rarely/just fish.
  - c) Meat in most meals.
2. How much food do you waste and throw away?
  - a) None
  - b) 0%–20%
  - c) More than 20%
3. How often do you buy locally produced food?
  - a) A lot of the food I buy is locally sourced
  - b) Some of the food I buy is locally sourced
  - c) Local sourcing isn't a top priority for me
4. How do you travel to school?
  - a) Walk or cycle
  - b) School bus / car pool / public transport
  - b) Car
5. Do you regularly turn off your lights and appliances (instead of leaving them on standby)?
  - a) Yes
  - b) Sometimes
  - c) No
6. What kind of bulbs is used at home/school?
  - a) LED
  - b) Fluorescent
  - c) Incandescent
7. What kind of fuel is used for cooking food?
  - a) LPG cylinders
  - b) Kerosene
  - c) Wood



8. How do you take lunch?
  - a) On reusable plates at school or home
  - b) Disposable plates
  - c) Packaged food
9. What type of grocery bags do you use?
  - a) Reusable cloth or jute bags
  - b) Paper or microfiber bags
  - c) Plastic bags
10. What do you do with your waste?
  - a) Try to Reuse
  - b) Recycle and/or compost
  - c) Throw away

**Check Your Footprint Size:**

1. No of a's = \_\_\_\_\_ (You're doing good)
2. No of b's = \_\_\_\_\_ (Good, but you can do better. Try to reuse and recycle more in your daily routine.)
3. No of c's = \_\_\_\_\_ (Your carbon footprint is above global averages. Be more aware of your actions and make improvements to reduce your footprint size.)

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Name: \_\_\_\_\_

Class: \_\_\_\_\_ Sec: \_\_\_\_\_

School: \_\_\_\_\_

Place: \_\_\_\_\_





Climate change is happening right here, right now. It is influencing human lives directly through impacts on health and the risk of extreme weather events on lives, livelihoods and human settlements. Indirectly, it impacts food security and the viability of natural resource-based economic activity.

This book enables children to understand what climate change is, how we know it is happening, and what this might mean for the future. It also highlights the importance of behavioural changes which are required at individual level to decrease their carbon footprint and counter their impacts into our future. Further, the book encourages children using fun activities to research, investigate how and why things happen, and make their own decisions about environmental issues.

So, Get Set Explore!

