

CLIMATE SCIENCE LITERACY CURRICULUM

South Asia

2023

Contents

MODULE 1: THE CLIMATE SYSTEM

Lesson 1.1. Earth's Energy System

Lesson 1.2. Earth's Spheres & Their Roles in the Climate System

Lesson 1.3. GHGs & Their Role in Climate Change

MODULE 2: THE CARBON CYCLE

Lesson 2.1. Earth's Carbon Cycle

Lesson 2.2. The Slow & Fast Carbon Cycles (*Advanced*)

Lesson 2.3. Human Induced Alterations to the Climate Cycle

MODULE 3: CLIMATE INDICATORS & MEASUREMENTS

Lesson 3.1. Climate Indicators and Measurements

Lesson 3.2. Planetary Boundaries & Tipping Points (*Advanced*)

Lesson 3.3. The 1.5°C Threshold

MODULE 4: HUMAN IMPACTS ON THE CLIMATE

Lesson 4.1. Deforestation

Lesson 4.2. Burning of Fossil Fuels

Lesson 4.3. Pollution

Lesson 4.4. Over Population

Lesson 4.5. Habitat Destruction

MODULE 5: CLIMATE CHANGE IMPACTS ON HUMANS

Lesson 5.1. Extreme Temperatures

Lesson 5.2. Increased Droughts

Lesson 5.3. Warming Oceans & Rising Waters

Lesson 5.4. Food Scarcity

Lesson 5.5. Climate Change and Health Risks

Lesson 5.6. Climate-led Poverty and Displacement

MODULE 6: MITIGATING CLIMATE CHANGE

Lesson 6.1. An Introduction to Climate Mitigation

Lesson 6.2. Climate Mitigation Measures

Lesson 6.3. Mitigation Policies and Programs

Lesson 6.4. Private Sector Initiatives and Sustainable Business Practices

Lesson 6.5. Climate Mitigation in Action

MODULE 7: LIVING WITH CLIMATE CHANGE

Lesson 7.1. Introduction to Climate Resilience

Lesson 7.2. Climate Resilience Strategies

Lesson 7.3. Climate Resilience in Action

Lesson 7.4. Climate Justice and Equity (*Advanced*)

Lesson 7.5. Climate Action Opportunities

Lesson 7.6. Tracking the Effectiveness of Climate Action (*Advanced*)

Introduction

Addressing youth rights to long and healthy lives and decent livelihoods is especially important in South Asia (India, Nepal and Pakistan); the region is home to one of the largest global population of young people. However, this will be challenging to realise in an era of ecological stress. Climate change is a defining threat in South Asia today, exacerbating biodiversity loss, food and water insecurity, poverty, pollution and social inequalities. The COVID-19 pandemic, various socio-political challenges, and exclusion from policy and decision-making, is preventing South Asian youth from becoming effective solution providers for climate rights and resilience.

In order to better enable South Asian youth to lead and deliver climate action and policy, this curriculum will provide a science-based understanding of climate change, and strengthen the ability to integrate that knowledge into human society. Decisions that involve Earth's climate must be made with an understanding of the complex inter-connections among the physical and biological components of the Earth system as well as the consequences of such decisions on social, economic, and cultural systems.

Actions take by individuals, communities, states, and countries all influence climate. Practices and policies followed in homes, schools, businesses, and government can affect climate. Climate-related decisions made by one generation can provide opportunities, as well as limit the range of possibilities open to the next generation. Steps to reduce the impacts of climate change may provide other benefits such as improved public health infrastructure and sustainably built environments.

Curriculum Components

Module:	The modules are the overarching topics and are divided into specific lessons to make the content more digestible.
Subject:	The subjects provide an indicator to the educators, of the main-stream areas of knowledge that the modules will cover.
Module Teaching Time:	The module teaching time is the anticipated amount of time it would take to deliver the module as a whole.
Average Lesson Time:	The average lesson time is the anticipated amount of time it would take to deliver a single lesson with a specific module.
Skills Developed:	This refers to the anticipated skills that will be developed through teaching a specific module.
Learning Objectives:	The learning objectives refer to the knowledge that will hopefully be gained by learners through delivery of the module.
Lesson:	All modules are divided into lessons, which follow a logical flow, and make the content more digestible. Each lesson has a Background section through which educators can familiarise themselves with the content; an Educators Cues section which Educators can use to start conversations around the lesson; a Further Resources section for more information around the lesson; and an Activities section to reinforce the learnings.
Level:	Each lesson is divided into Basic, i.e., the knowledge which all learners should have, and Advanced, i.e., the knowledge which is important but not everyone need know.

MODULE 1

THE CLIMATE SYSTEM

Subjects Covered	Module Teaching Time	Skills Developed	
<ul style="list-style-type: none">• Earth Sciences• Data Science• Physical Sciences• Climatology	2 hours 25 minutes	<ul style="list-style-type: none">• Research• Critical Thinking• Data Processing	
	Average Lesson Time		
	45 mins		

Learning Objectives

The objective of this module is for learners to understand Earth's climate system, the complex interactions between the various components of Earth's spheres, that regulate it, and the role that gases in the atmosphere (both natural and introduced) play in changing the Earth's climate. In this module learners will gain knowledge of:

1. Earths' energy system
2. Earths' spheres (atmosphere, biosphere, hydrosphere and lithosphere), their complex interactions and their roles in climate regulation
3. Greenhouse Gases (GHGs) and their impacts on Earths' climate system

Lesson 1.1. Earth's Energy System

Level: Basic

Background

- The Sun meets an essential need of almost all forms of life on Earth – energy. The Sun's energy drives the climate cycle. The Sun's radiation travels towards Earth.
- About half of this is reflected or absorbed by Earth's atmosphere (i.e., by tiny particles called aerosols) and clouds. The rest reaches Earth where some of it is absorbed by the land and oceans. The remaining is reflected off the land (by ice or deserts for instance). Some of this heat that is reflected passes directly through the atmosphere and into space. However, a portion of the heat is captured and retained by the greenhouse gases in our atmosphere. This whole process is known as the greenhouse effect.
- The Sun regulates how much water evaporates, condenses, falls as precipitation, is absorbed by the ground and runs off or flows over the land. About 29 percent of the sun's incoming energy is reflected directly back into space (by the atmosphere and brightly-colored ground surfaces), and another 23 percent is absorbed by our atmosphere. That leaves 48 percent to be absorbed by the Earth's land surface and water.
- When Earth releases the same amount of energy as it absorbs, its energy budget is in balance, and its average temperature remains stable.
- In the 20th century, NASA recorded an approximate temperature of 13.9°C on Earth (measured day and night, across land and ocean). NASA estimates that by the end of this century, Earth's average temperature will have increased by about 2°C.
- The tilt of Earth's axis in relation to its orbit around the Sun, results in changes in the length of daylight and the amount of sunlight received at different regions throughout a year. These changes cause the annual cycle of seasons and associated temperature changes.
- Weather refers to these changes in short-term atmospheric conditions – the temperature and precipitation on a certain day, for example. Weather is the minute-by-minute variable condition of the atmosphere on a local scale.
- Gradual changes in Earth's rotation and orbit around the Sun change the intensity of sunlight received by Earth's polar and equatorial regions. For the last 1 million years, these changes naturally occurred every 100,000 years, producing ice ages and shorter warm periods.
- The Sun is like a giant magnet. Every 11 years its magnetic field flips, and the North and South magnetic poles switch. In between flips the total radiation from the Sun changes (increasing or decreasing) by 0.15%. Satellites have recorded the Sun's energy output over the last 40 years; it has gone up or down by less than 0.1%.
- Climate refers to the average weather/atmospheric conditions that prevail in a given region over a long period of time—whether a place is generally cold and wet or hot and dry, for example. Climate is a conceptual description of an area's average weather conditions and the extent to which those conditions vary over long time intervals. Climate is determined by the long-term pattern of temperature and precipitation averages and extremes at a location. Climate can be described for different time intervals, such as decades, years, seasons, months, or specific dates of the year.

- Climate change refers to long-term shifts in temperatures and weather pattern, mainly caused by human activities, especially the burning of fossil fuels. The warming driven by greenhouse gases from human burning of fossil fuels is over 50 times greater than the slight extra warming coming from the Sun itself, over that same time interval.

Cues for Educators

1. What is the greenhouse effect?
2. What is the role of the Sun in Earth's climate cycle?
3. What is the difference between climate and weather?
4. Is the Sun responsible for the intense climate change we are witnessing today?

Further Information & Resources

- Video (NASA Space Place): [What is the Greenhouse Effect?](#)
- Video (NASA Goddard): [Why does the Sun matter for Earth's Energy Budget?](#)
- Video (National Geographic): [Climate Change 101 with Bill Nye](#)
- Video (NASA Climate Change): [What's the Difference between Weather and Climate?](#)

Activities

- **Individual Activity:** Read the statements below and identify which are referring to the climate and which are referring to the weather.
 - a. Chennai has high humidity all year round. (Answer: Climate)
 - b. It feels hotter than usual in Kolkata right now. (Answer: Weather)
 - c. Freezing temperatures in Ladakh for 14 days in a row. (Answer: Weather)
 - d. The wet season in Goa is from June to September. (Answer: Climate)
- **Group Discussion:** Gather data to track significant changes in weather (temperature and rainfall) in the State in which you live, over the last 2 or 3 decades. Discuss your findings - what kind of patterns do you see in the data?

[Educator Guide: Learners can also submit a request for data from the national Meteorological Department ([India](#), [Nepal](#), Pakistan) to access data which might not be available online.]

- **Group Discussion:** Is the Sun (solar) cycle contributing to, or causing, irreversible global climate change? Learners should find evidence (preferably quantitative) from reliable sources to support their answer and present their findings to their peers.

Lesson 1.2. Earth's Spheres & Their Roles in the Climate System

Level: Basic

Background

- A system is a collection of interdependent parts enclosed within a defined boundary. Within the boundary of Earth's system, is a collection of subsystems (or interdependent parts) called "spheres". Everything on Earth can be placed into one of 4 major spheres: atmosphere (air), biosphere (living things), hydrosphere (water) and lithosphere (land):
 - Atmosphere:** The atmosphere is dominated by nitrogen, oxygen and other gases. Of the gases in our atmosphere the most important are the greenhouse gases which include water vapour, carbon dioxide, methane, nitrous oxide and the ozone. In addition to the gases we have tiny little particles and droplets, collectively called aerosols. Some of these are tiny and reflect the sun's light back to space but dark aerosols like soot from forest fires or coal fired power plants tend to absorb solar radiation.
 - Biosphere:** The biosphere includes all life on our planet. Living things constantly exchange carbon and oxygen with the atmosphere. Vegetation absorbs solar radiation (or light) in forests for examples. Deserts and grasslands reflect light. Humans are part of the biosphere, we release carbon into the atmosphere through deforestation, clearing land for agriculture.
 - Hydrosphere (oceans):** Most of the water is stored in the world's oceans (97%). 2% is stored in glaciers and ice sheets which feed our rivers, and then there are the water crystals in clouds in the atmosphere. A fourth reservoir is water vapour, which is also a greenhouse gas. Dark water oceans absorb light, ice and clouds reflect solar radiation. In fact much of the excess energy in our atmosphere is being absorbed by our oceans, which is causing them to heat up.
 - Lithosphere (sometimes known as the Geosphere):** Our planet consists of rocky material that breaks down to form the soils in which plants grow. Water moves these rocks and sediments around. These sediments and rocks are home to the fossil fuels we mine and burn for energy. In fact >90% of carbon is found in rocks and sediments.
- Many processes, including climatic, are the result of the interplay between these spheres which can work to amplify or mitigate changes to the climate. The interactions among these spheres often occur as a chain reaction in which one interaction leads to other interactions.

Mapping Interactions Between Earth's Spheres That Result From A Volcanic Eruption

1. Volcano >> geosphere >> atmosphere >> hydrosphere >> biosphere

Volcanoes (an event in the geosphere) release a large amount of particulate matter into the atmosphere. These particles contribute to the formation of water droplets (hydrosphere). Rainfall (hydrosphere) often increases following an eruption, stimulating plant growth (biosphere). Particulate matter in the air (atmosphere) falls out, initially smothering plants (biosphere), but ultimately enriching the soil (geosphere) and thereby stimulating plant growth (biosphere).

2. Volcano >> geosphere >> hydrosphere >> biosphere

Volcanoes (events in the geosphere) may release a substantial amount of hot lava (geosphere), which causes mountain glaciers (hydrosphere) to melt. Sediment and mud flows (geosphere), and

flooding (sometimes landslides) can occur downstream from volcanoes impacting communities, natural ecosystems and wildlife (biosphere).

3. Volcano >> geosphere >> atmosphere >> biosphere >> geosphere

Volcanoes (events of the geosphere) release a large amount of carbon dioxide (atmosphere), the raw material for sugar production in plants (biosphere). This may increase photosynthetic production and eventually increase the amount of biomass, which, after a very long time, forms coal and oil deposits (geosphere).

4. Volcano >> complex interactions

Volcanoes (geosphere) may emit large quantities of sulfur dioxide (atmosphere). When atmospheric sulfur dioxide combines with water (hydrosphere), sulfuric and sulfurous acid form. Rain (hydrosphere) may bring these acids to the Earth, acidifying soils (geosphere), lakes and rivers (hydrosphere). Acidic water leaches nutrients from the soil (geosphere) into the water table (hydrosphere), making the soil less fertile for plants (biosphere), and the subterranean water supply (hydrosphere) less potable for humans (biosphere). Acid rain falling on lakes and streams reduces the pH of the water (hydrosphere), which may result in a decrease in phytoplankton and zooplankton growth (biosphere). If photosynthesis is reduced, atmospheric concentrations of carbon dioxide can build up and stimulate global warming (atmosphere) which may contribute to increased melting of glaciers (hydrosphere).

Cues for Educators

1. What are Earth's 4 spheres?
2. What are some of the critical interactions between the spheres that support life on Earth?
3. How do the interactions between Earth's spheres impact our weather and climate?

Further Information & Resources

- Video (Lincoln Learning Center): [Earth's Interconnected Cycles](#)
- Video (My NASA Data): [A Tour of the Water Cycle](#)
- Video (UHS STEM Acadmey): [Earth's Systems & Interactions](#)

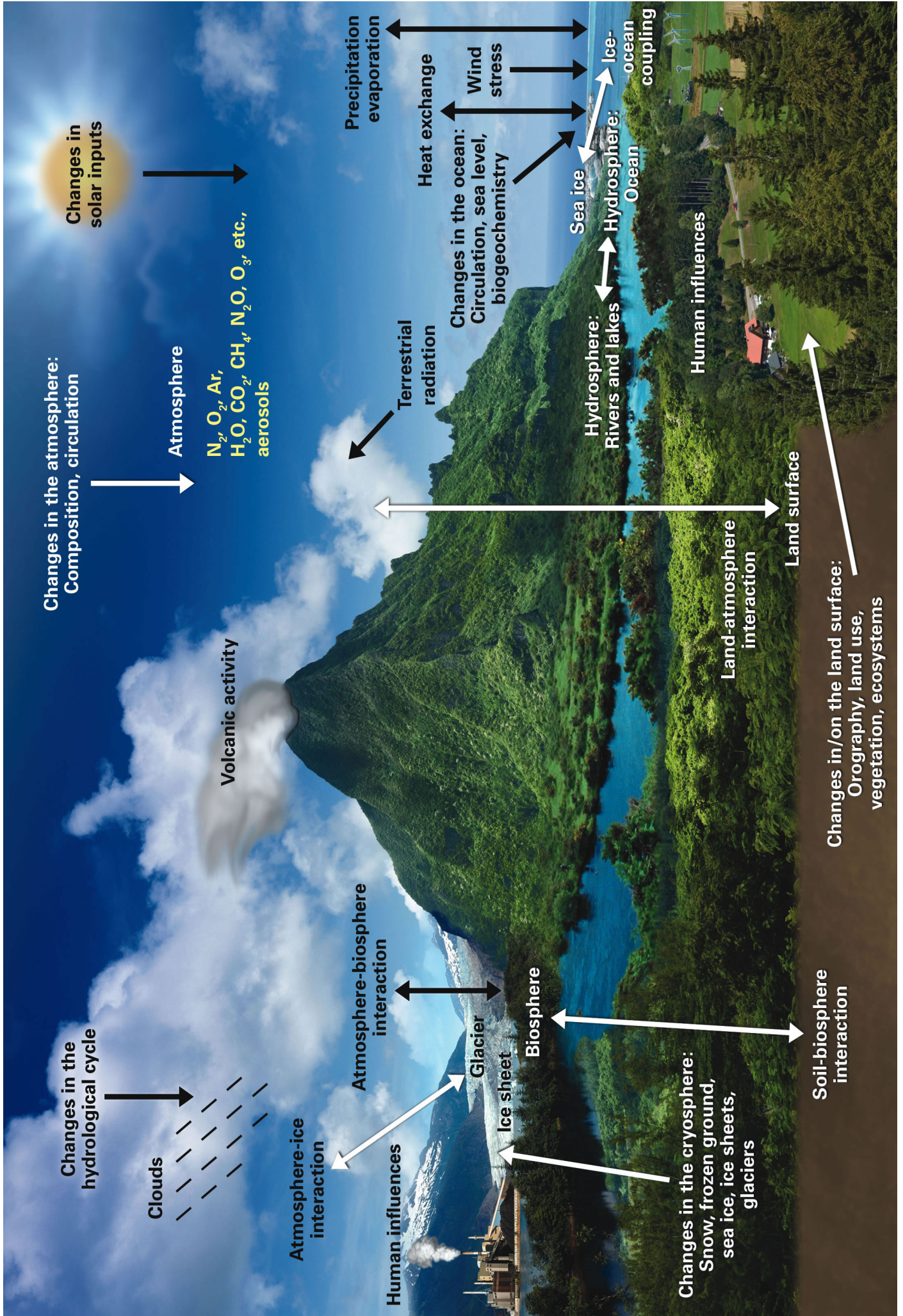
Activities

- **Group Mapping Session:** Using chart paper and pens draw a diagram to map this cycle through each sphere.

[Educator Guide: Rain (hydrosphere) falls from the clouds (atmosphere) on to the land (lithosphere) to form water bodies such as rivers and oceans (hydrosphere) which are then used by plants and animals (biosphere). As such the Water Cycle occurs in all four spheres.]

- **Group Thought Exercise:** Study the diagram of interactions between Earth's spheres. Pick any one sphere. What would be happen if that sphere stopped interacting with the others?

The diagram on the next page displays the Earth's spheres and some of the interactions between them (Source: [US Dept. of Energy - Office of Biological and Environmental Research](#))



Lesson 1.3. GHGs & Their Role in Climate Change

Level: Basic

Background

- Earth's climate is stable because of greenhouse gases (GHGs) in our atmosphere. These gases include water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrogen (N_2) and the ozone. Most of these GHGs have been around for millennia; life on Earth possibly started because of them.
- GHGs trap most of the Sun's heat. If they didn't, Earth would not have an average temperature of around $15^{\circ}C$. This is known as the greenhouse effect. Life on Earth exists today thanks to this greenhouse effect.
- In addition to the greenhouse gases there are tiny little particles and droplets, collectively called aerosols, in the atmosphere. Some of these reflect the Sun's light back to space. However, dark aerosols like soot from forest fires or coal fired power plants tend to absorb this solar radiation.
- Human activities, primarily burning of fossil fuels (coal, oil and natural gas) and changing land cover patterns (e.g., deforestation), are increasing the concentrations of some of these gases, amplifying the natural greenhouse effect. The GHGs that humans produce is being added to the naturally occurring GHGs in the atmosphere.
- Increases in the abundance of atmospheric greenhouse gases since the industrial revolution, mainly the result of human activities, are largely responsible for the observed increases in global temperature (IPCC, 2014). The more the GHG molecules being added to the atmosphere, the more heat is trapped, which leads to a gradual increase in temperature.
- Interesting Fact: With too many greenhouse gases in our atmosphere, Earth would be like Venus, where the intense greenhouse atmosphere keeps temperatures around $400^{\circ}C$.

Cues for Educators

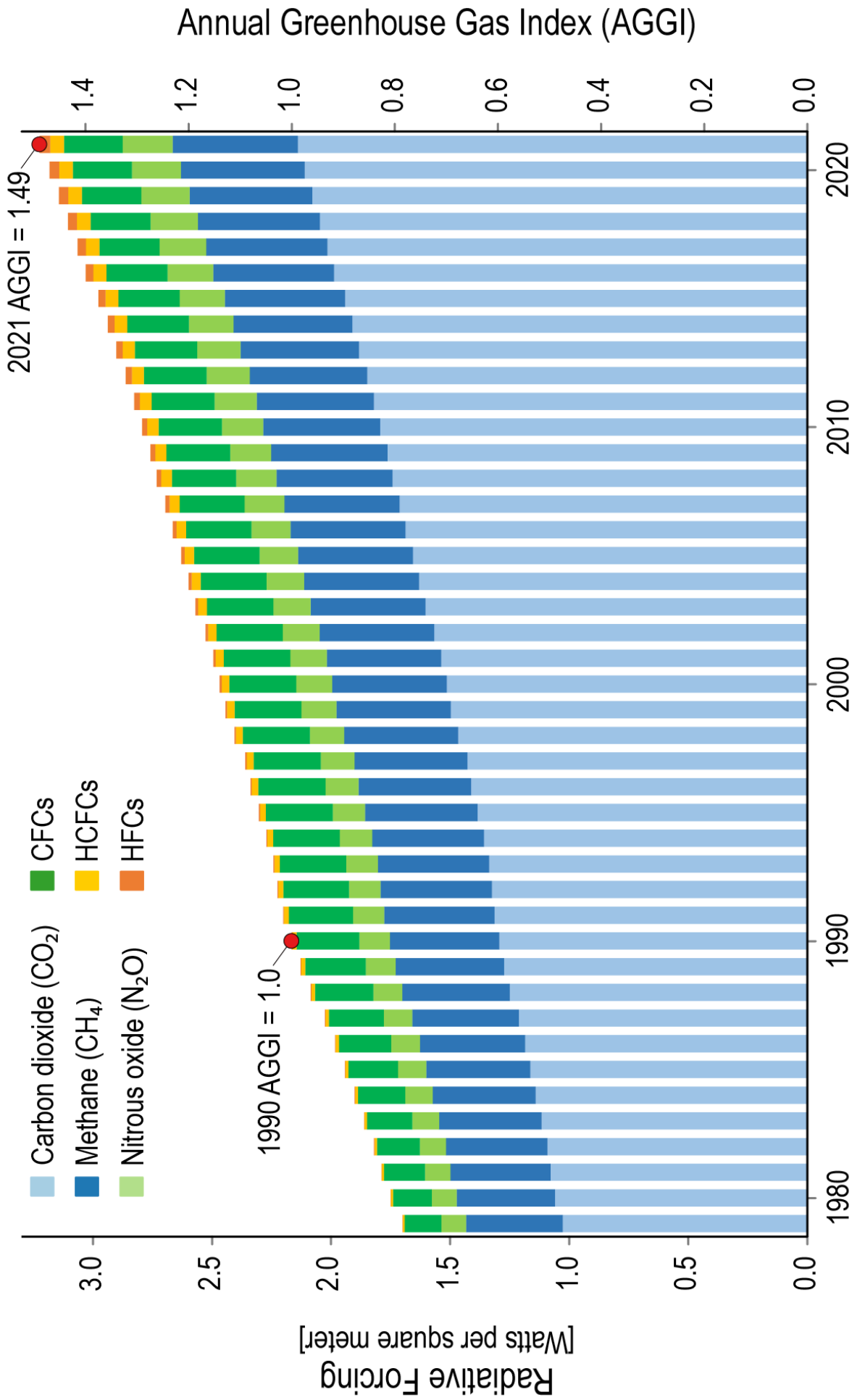
1. If the greenhouse effect is natural, then why is today's climate change such a bad thing?
2. Are human-produced greenhouse gases influencing the climate today?

Further Information & Resources

- Video (NASA Scientific Visualisation Studio): [Greenhouse Gases Effect on Global Warming](#)

Activities

- **Group Activity:** The National Oceanographic and Atmospheric Association (NOAA) has created the [Annual Greenhouse Gas Index \(AGGI\)](#) to calculate the influence of the most significant long-lived greenhouse gases on global warming since 1979. Look up the index to track how GHG emissions have changed in the country in which you live.
- **Individual Research Activity:** Use secondary data to determine which sector is the largest contributor of GHG emissions in the country in which you live. How does this compare with the largest contributor to GHGs in the State in which you live?



This left axis of this graph shows the change in energy in the top most layer of the atmosphere (radiative forcing) which indicates the amount of solar energy trapped in Earth's atmosphere. The right axis of this graph shows the amount of Greenhouse Gases that have released by humans since 1979. The graph demonstrates that the amount of the Sun's energy trapped on Earth by long-lived greenhouse gases in the atmosphere increased by 49% between 1990 and 2021 (Source: [Annual GreenHouse Gas Index](#))

MODULE 2

THE CARBON CYCLE

Subjects Covered	Module Teaching Time	Skills Developed	
<ul style="list-style-type: none">• Earth Sciences• Data Science• Physical Sciences• Climatology• Biological Sciences	3 hours	<ul style="list-style-type: none">• Research• Critical Thinking• Data Processing• Logical Thinking	
	Average Lesson Time		
	45 mins		

Learning Objectives

The objective of this module is for learners to understand Earth's carbon cycle. This is fundamental to their understanding of how human-induced changes to the natural carbon cycle have led to drastically altering weather and climate. In this module learners will gain knowledge of how:

1. Carbon is transferred between the different spheres on Earth
2. A naturally functioning carbon cycle is important for maintaining a stable climate on Earth
3. Increased human-emitted carbon has disrupted natural cycles and processes on Earth

Lesson 2.1. Earth's Carbon Cycle

Level: Basic

Background

- Carbon is the backbone of life on Earth and an essential element for most known life forms. Whether these life forms take in carbon to manufacture food (e.g., plants) or release carbon as part of respiration (e.g., animals and humans), the intake and output of carbon is a component of all plant and animal life.
- Carbon is in a constant state of movement. It flows from place to place and is stored in what is commonly known as Earth's spheres or "resevoirs". This movement occurs through a variety of processes such as photosynthesis, the burning of fossil fuels (i.e., coal, oil and natural gas), or simply breathing. This exchange of carbon between the resevoirs within Earth's spheres is called the carbon cycle.
- Some examples of resevoirs and the exchange of carbon between them are given below:
 - Carbon is stored in plants and animals, which is why they are considered carbon life forms. Carbon is used by plants to build leaves and stems, which are then digested by animals and used for cellular growth.
 - Forests are also carbon sinks (places that absorb and store more carbon than they release). They continually take carbon out of the atmosphere through the process of photosynthesis. Human activities, like deforestation cause the carbon to be released from living biomass (i.e., the wood, stems and leaves of a plant) and the soil beneath the plant, back into the atmosphere.
 - The ocean is another example of a carbon sink, absorbing a large amount of carbon dioxide from the atmosphere and storing it within its sediments and the seabed. Carbon stored in the ocean is also captured by many types of marine organisms. Some organisms, such as clams or coral, use the carbon to form shells and skeletons.
 - In the atmosphere, carbon is stored in the form of gases, such as carbon dioxide.
 - Most of the carbon on our planet (about 65,500 billion metric tons) is contained within rocks, minerals, and other sediment buried beneath the surface of the planet.
- Earth is a closed system and therefore, the amount of carbon on the planet never changes. However, the amount of carbon within a specific reservoir can change, as carbon constantly moves from one reservoir to another. Any change in the cycle that shifts carbon out of one reservoir puts more carbon in the other reservoirs.
- Nature tends to keep carbon levels balanced, meaning that the amount of carbon naturally released from reservoirs is equal to the amount that is naturally absorbed by reservoirs. Maintaining the carbon balance allows the planet to support life.

Cues for Educators

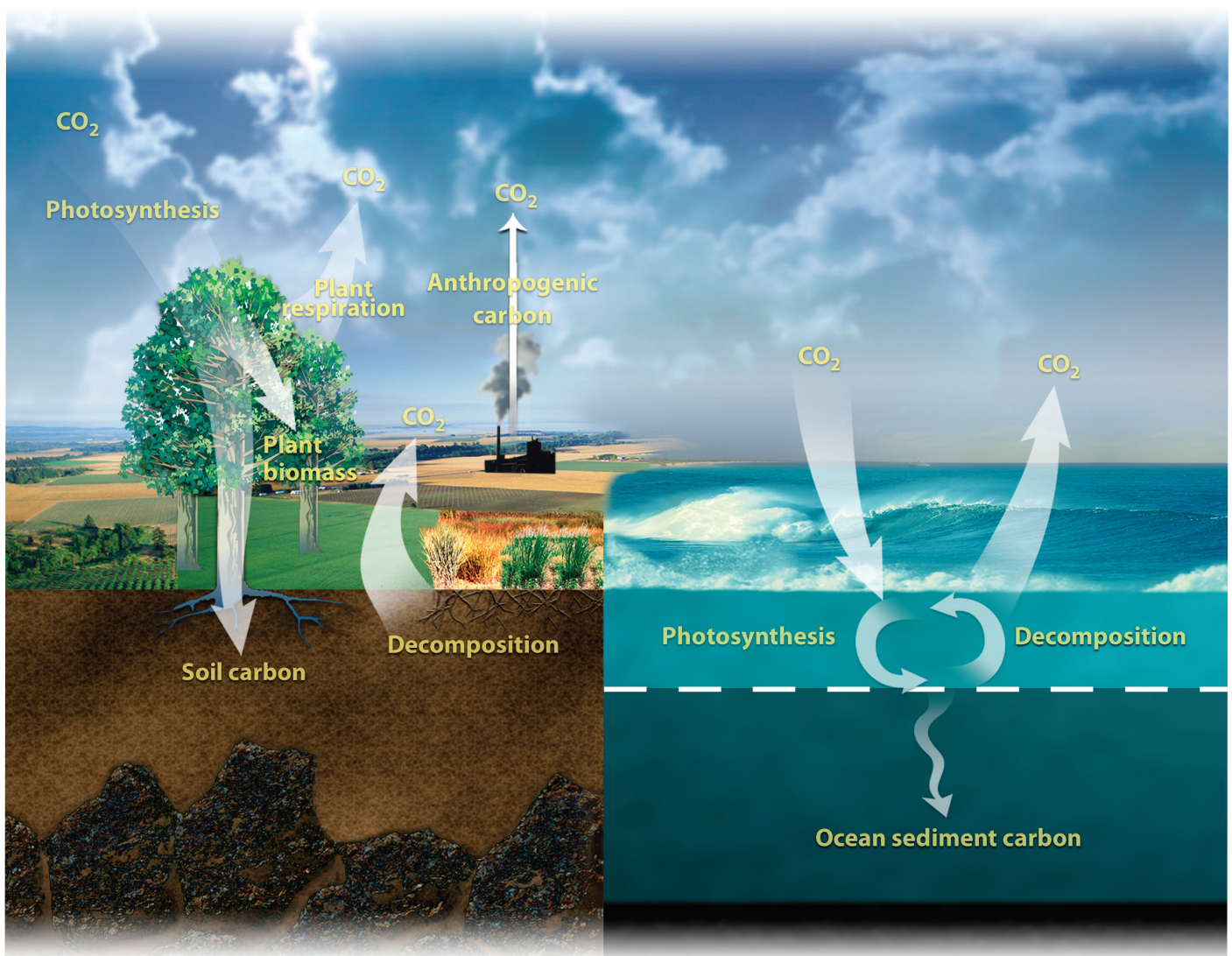
1. What is the carbon cycle?
2. Can you recall the four of Earth's speheres? How does carbon move between these spheres?

Further Information & Resources

- Video (NOAA): [What is the Carbon Cycle?](#)
- Video (Learning Junction): [The Carbon Cycle II Carbon Cycle Processes](#)
- Article (The Guardian): [One of Earth's Giant Carbon Sinks May Have Been Overestimated](#)
- Article (Carbon Brief): [The Oceans Area Absorbing More Carbon Than Previously Thought](#)
- Video (NASAeClips): [Real World: The Carbon Cycle – Essential for Life on Earth](#)

Activities

- **Group Research Activity:** The oceans cover over 70% of the Earth's surface and play a crucial role in taking up CO₂ from the atmosphere. Estimates suggest that around a quarter of CO₂ emissions that human activity generates each year is absorbed by the oceans. Why and how do ocean ecosystems capture more carbon than terrestrial ecosystems?



Processes by which carbon moves between Earth's four spheres (Source: [US Dept. of Energy - Office of Biological and Environmental Research](#))

Lesson 2.2. The Slow & Fast Carbon Cycles

Level: Advanced

Background

The Slow Carbon Cycle

- Earth's temperature is regulated over a few hundred thousand years, as part of the slow carbon cycle. During this time Earth swings between ice ages and warmer interglacial periods.
- Through a series of chemical reactions and tectonic activity, carbon takes between 100-200 million years to move between rocks (lithosphere), soil, ocean, and atmosphere. On average 10¹³ to 10¹⁴ grams (10-100 million metric tons) of carbon move through the slow carbon cycle every year. In comparison, human emissions of carbon to the atmosphere are on the order of 10¹⁵ grams, whereas the fast carbon cycle moves 10¹⁶ to 10¹⁷ grams of carbon per year.
- The movement of carbon from the atmosphere to the lithosphere (rocks) begins with rain. Atmospheric carbon combines with rain (forming a weak acid called carbonic acid) that falls to Earth's surface (in the rain). The acid dissolves rocks (a process called chemical weathering) and releases calcium, magnesium, potassium, or sodium ions.
- Rivers carry the calcium ions to the ocean, where they react with the carbon dissolved in the water (called carbonate). The product of this reaction is called calcium carbonate, is then deposited onto the ocean floor, where it becomes limestone.
- Carbon locked up in limestone can be stored for million - or even hundreds of millions - of years. Only 80% of carbon-containing rock is currently made this way. The remaining 20% contains carbon from living things (organic carbon) that have been embedded in layers of mud.
- In the ocean, calcium carbonate (limestone) is also made by shell-building (calcifying) organisms (such as corals) and plankton. After these organisms die, they sink to the seafloor. Heat and pressure compress the shells, sediment, mud, and carbon over millions of years, forming sedimentary rock such as shale.
- In special cases, when dead plant matter builds up faster than it can decay, layers of organic carbon become oil, coal, or natural gas (instead of sedimentary rock).
- The slow cycle returns carbon to the atmosphere through volcanoes. Earth's land and ocean surfaces sit on several moving crustal plates. When the plates collide, one sinks beneath the other, and the rock it carries melts under the extreme heat and pressure. The heated rock releases carbon dioxide; when volcanoes erupt, they release the gas into the atmosphere.
- At present, volcanoes emit between 130 and 380 million metric tons of carbon dioxide per year. By comparison, humans emit about 30 billion tons of carbon dioxide per year—100–300 times more than volcanoes—by burning fossil fuels.
- Chemistry regulates this dance between ocean, land, and atmosphere. For instance if carbon dioxide rises in the atmosphere because of an increase in volcanic activity, temperatures rise, leading to more rain, which dissolves more rock, creating more ions that will eventually deposit more carbon to the ocean floor. It takes a few hundred thousand years to rebalance the slow carbon cycle through chemical weathering.

The Fast Carbon Cycle

- The time it takes carbon to move through the fast carbon cycle is measured in a lifespan because it is largely the movement of carbon through life forms on Earth (or the biosphere).
- Between 1015 and 1017 grams of carbon move through the fast carbon cycle every year.
- Chains and rings of carbon (e.g., DNA) are the basis of living cells.
- Plants and phytoplankton (microscopic plants in the ocean) are the main components of the fast carbon cycle. They take carbon dioxide from the atmosphere by absorbing it into their cells and combine it with water to form sugar and oxygen.
- There are 4 ways in which carbon is returned to the atmosphere from a plant. Plants break down the sugars to get energy, and in this way carbon dioxide is released. Or animals (including people) eat the plants and break down the sugars to get energy, and in this way carbon dioxide is released. Or plants and plankton die and decay (i.e., are eaten by bacteria) and carbon dioxide is released. Or fire consumes the plants and carbon dioxide is released in the process.
- The fast carbon cycle is closely linked to plant life. In the Northern Hemisphere winter, when fewer plants are growing, many are decaying, atmospheric concentrations of carbon dioxide increase. During spring however, when plants begin to grow again, carbon dioxide concentrations drop.

Cues for Educators

1. Carbon moves in fast and slow cycles. How are these cycles different?

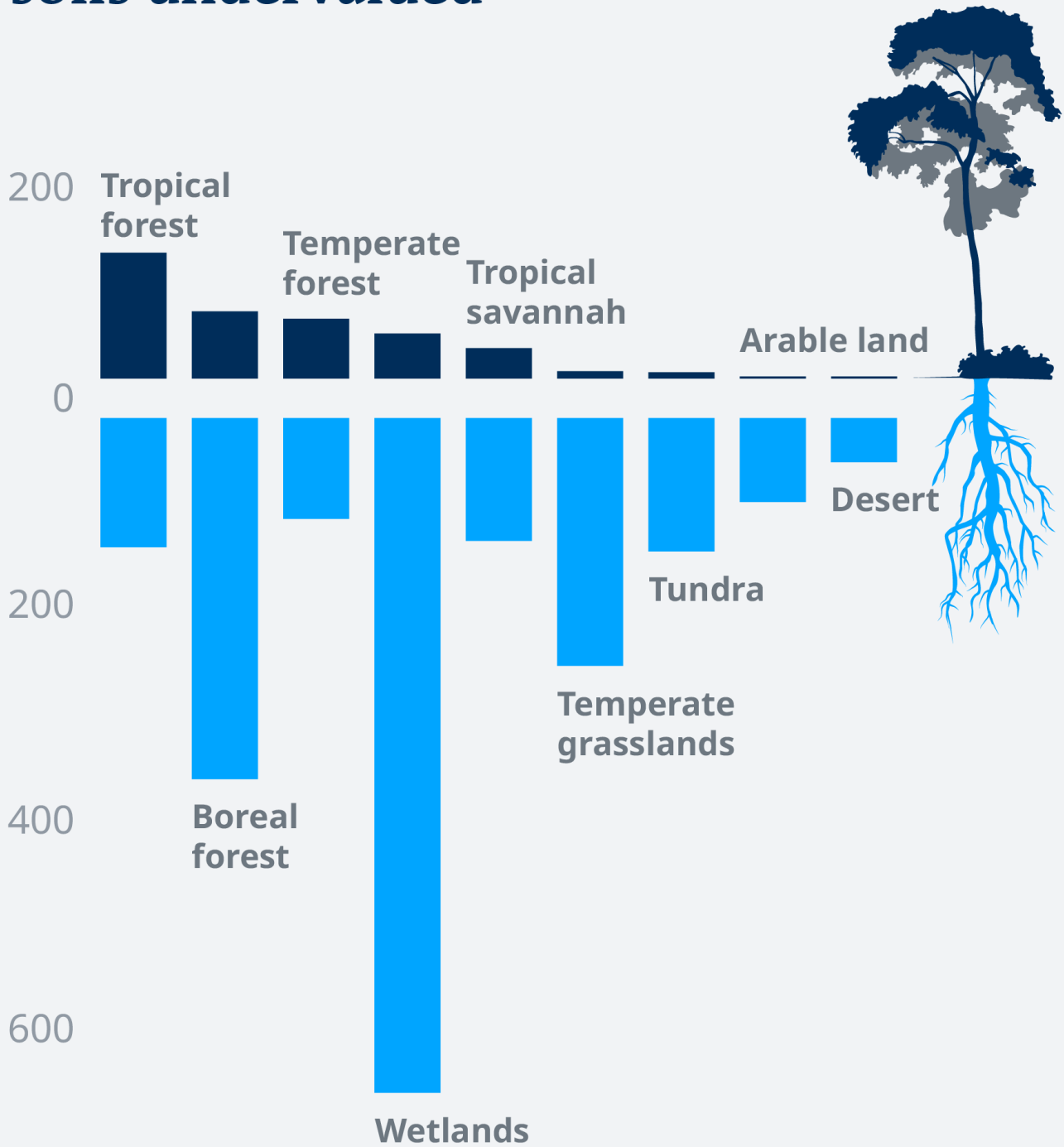
Further Information & Resources

- Video (NOAA): [Fast Carbon, Slow Carbon](#)
- Video (NASAeClips): [Real World: The Carbon Cycle – Essential for Life on Earth](#)
- Article (NASA Earth Observatory): [The Slow Carbon Cycle](#)
- Article (NASA Earth Observatory): [The Fast Carbon Cycle](#)

Activities

- **Group Research Activity:** Forest elephants contribute to carbon stocks in tropical forests by changing the composition of tree species to favour species with high wood density - meaning they have higher carbon density per unit wood. First, forest elephants browse most on low wood density trees species, thereby reducing the number of these species and freeing space for high wood density species. Second, they disproportionately disperse seeds of high wood density species. Through these behaviours, it is estimated that forest elephants might increase forest carbon stocks by 6-9%). Read more about [How Elephants Promote Jumbo Trees, Boosting Carbon Stores in Africa](#). Can you find any other animals that contribute to carbon stocks in an ecosystem?
- **Group Research Activity:** Study the diagram below. How role does soil play in balancing the global carbon budget? Research how this contribution has changed, or is it changing, over time, and why?

CO₂ storage: Flora overvalued, soils undervalued



Average stored carbon in tons per hectare at a ground depth of one meter



Source: World Climate Council (IPCC)

[Educator Guide: The light blue bars indicate the carbon stored in the soils of the various ecosystems, whereas the dark blue bars indicate the carbon stored in the above ground biomass (the stem, bark leaves etc.)]

Lesson 2.3. Human Induced Alterations to the Climate Cycle

Level: Basic

Background

- The rapid and intense release of carbon (amongst other) gases into the atmosphere through human activities is resulting in warmer temperatures on Earth. Scientists believe that humans have upset the carbon balance through processes that release carbon into the atmosphere, known as carbon sources.
- Processes like deforestation release carbon into the atmosphere, and simultaneously prevent the absorption of carbon from the atmosphere in the future (as the plants that would have captured and stored the carbon are now dead). Additionally, when land is cleared, soils are exposed and they release carbon from decayed plant matter into the atmosphere.
- Humans replace this dense forest growth with crops or pasture that store much less carbon. Raising cattle on this cleared land for food also releases a lot of carbon into the atmosphere. We also clear land to build infrastructure like roads, building etc. that do not absorb carbon. Humans are currently emitting just under a billion tons of carbon into the atmosphere per year through land use changes.
- Any process that uses fossil fuels, such as burning coal to make electricity, releases a lot of carbon dioxide (CO₂) into the atmosphere. By burning coal, oil, and natural gas, we accelerate the process, releasing vast amounts of carbon (carbon that took millions of years to accumulate) into the atmosphere every year. *By doing so, we move the carbon from the slow cycle to the fast cycle.*
- Since the beginning of the Industrial Revolution, when people first started burning fossil fuels, carbon dioxide concentrations in the atmosphere have risen by about 40% increase. As of 2020, the atmosphere contained 409 to 416 parts per million of carbon dioxide. This number goes out of date quickly, as CO₂ levels continue to rise. This means that for every million molecules in the atmosphere, 409 to 416 of them are now carbon dioxide - the highest concentration in two million years.
- The amount of CO₂ in the atmosphere is currently higher than at any other point in human history. The last time the world had a CO₂ concentration of approximately 409 to 416 parts per million was approximately 3.5 million years ago, when the world was 3 to 4 degrees warmer than today and sea levels were 15–20 metres higher than today.
- All of this extra carbon we are producing needs to go somewhere. So far forests, wetlands and the ocean have taken up about 55% of the extra carbon people have put into the atmosphere while about 45% has stayed in the atmosphere. The land and oceans may take up most of the CO₂ if they are able, but about 20% will remain in the atmosphere for thousands of years.
- With more atmospheric CO₂ available for photosynthesis, plants are able to grow bigger. This increased growth is referred to as carbon fertilization. Models predict that plants might grow anywhere from 12 to 76% more if atmospheric carbon dioxide is doubled, as long as nothing else, like water shortages or poor soil health (all of which are impacted by climate change), limits their growth. However, there is a limit to how much carbon plants can take out of the atmosphere, and that limit varies from region to region. This is why scientists don't know how

much CO₂ is actually increasing plant growth in the real world. This is because plants also need water, sunlight and nutrients (healthy soils). If a plant doesn't have even one of these things, it won't grow, regardless of how abundantly available the others are.

Cues for Educators

1. How have humans upset the balance of the climate cycle?
2. How will increasing atmospheric CO₂ levels impact plants?
3. When was the last time CO₂ levels were as high as they have been in the past few years?

Further Information & Resources

- Report (Asian Development Bank): [Climate Change in South Asia](#)

Activities

- **Answer These Multiple Choice Questions:**

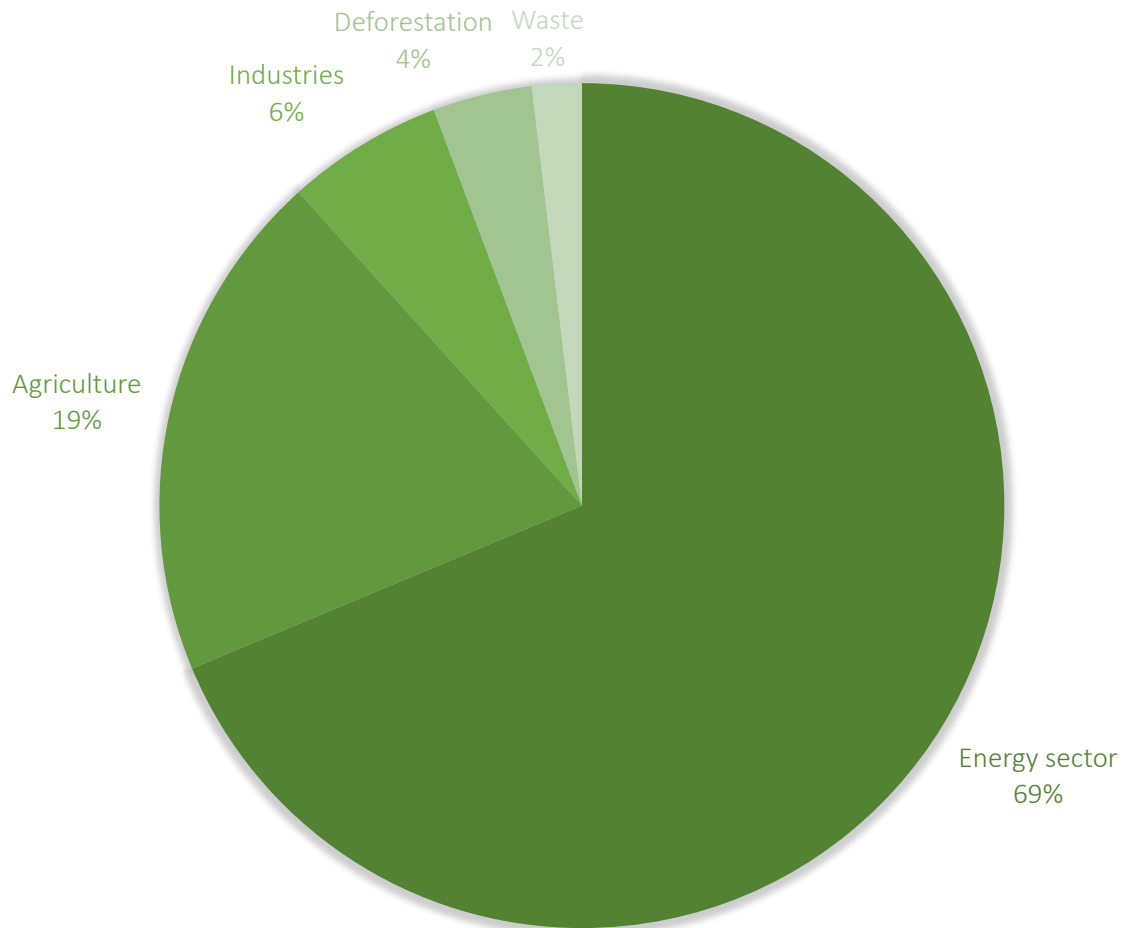
1. *If The Greenhouse Effect Is Natural, Then Why Is Today's Climate Change A Bad Thing?*
 - A. A small rise in GHG can have increased warming.
 - B. Humans have change the natural processes and are creating changes that might normally happen over millions of years.
 - C. Once released into the atmosphere, GHGs remain potent for many years, making it difficult to reverse the process.
 - D. Changes to the climate system will have impacts that will pose difficulties for people, like more extreme weather, spread of diseases etc.
 - E. All of the above
2. *When Was The Last Time That CO₂ Levels Were As High As They Are Now?*
 - A. This is the highest it's ever been.
 - B. CO₂ was at least this high during the warm periods between ice ages
 - C. CO₂ has not been this high for almost one million years.
 - D. The last time CO₂ was this high was 3 million years ago.
 - E. All of the above
3. *Which Activities Are The Largest Contributors To Green House Gases?*
 - A. Deforestation
 - B. Electricity generation
 - C. Industries
 - D. Transportation
 - E. Agriculture

[Educator Guide: Answers are 1. E.; 2. D.; 3.B & D]

- **Individual "Follow the Logic" Activity:** The ocean absorbs a large part of the carbon emitted by humans into the atmosphere. How will this affect life in the ocean?

- **Group Research Activity:** Which states in your country (India, Nepal, or Pakistan) emit the most carbon and why?

[Educator Guide: In 2015 India emitted 2.3 gigatonnes (gt) CO₂ in 2015, making it the third largest emitter in the world (not including the EU) behind the US and China. The graph below indicates which sectors were responsible for the emissions; data was taken from the World Resources Institute.]



MODULE 3

CLIMATE INDICATORS & MEASUREMENTS

Subjects Covered	Module Teaching Time	Skills Developed	
<ul style="list-style-type: none">• Data Science• Climatology• Political Sciences	3 hours	<ul style="list-style-type: none">• Research• Critical Thinking• Data Processing	
	Average Lesson Time		
	45 minutes		

Learning Objectives

The objective of this module is for learners to understand which vital signs scientists measure and track to determine how the climate is changing. This forms the basis for determining what actions countries should be taking, and how soon, to lessen the severity of climate change, and adapt to a climatically altered world. In this module learners will gain knowledge of:

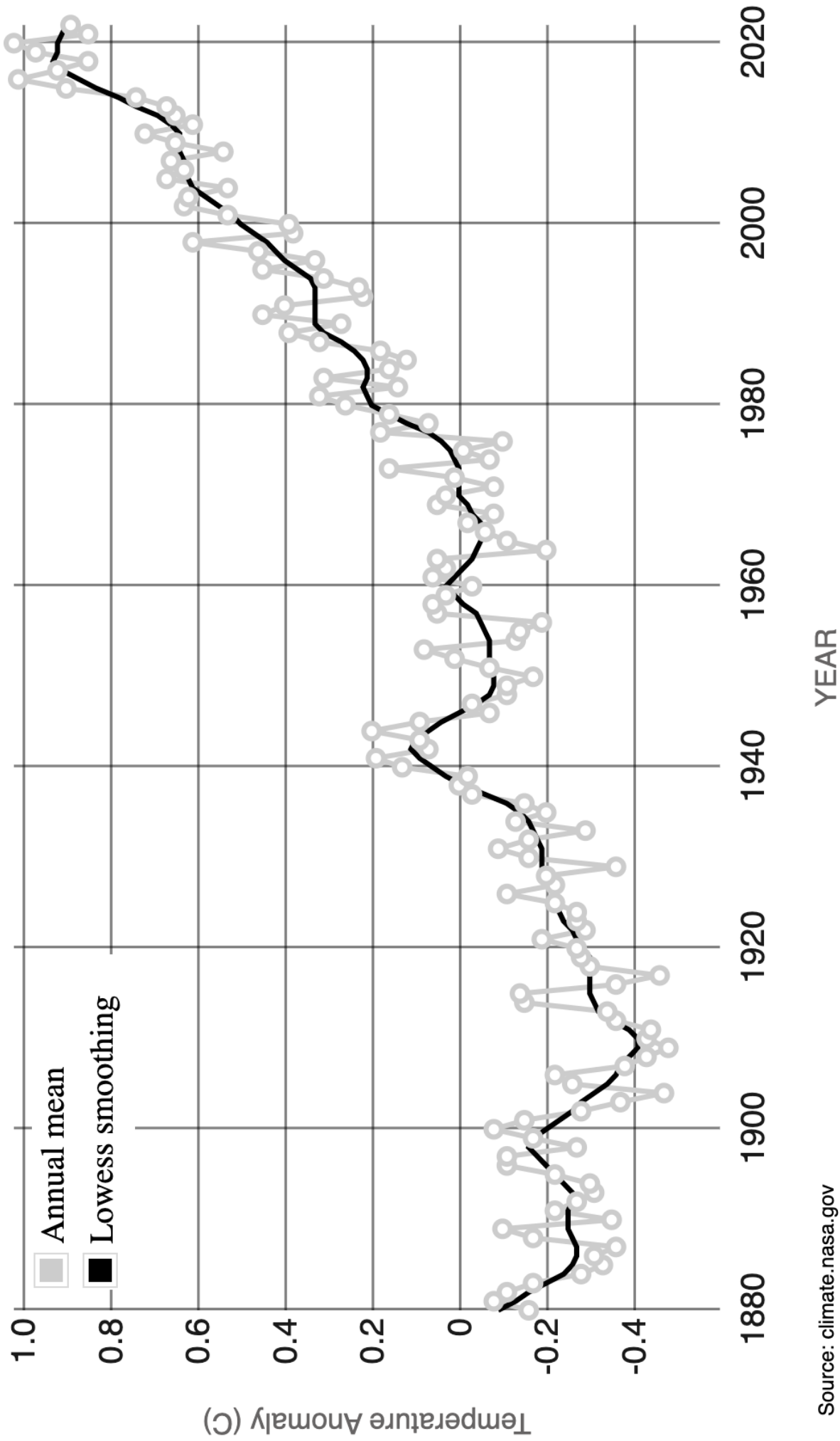
1. Climate indicators and their measurement
2. The climate threshold, or tipping point, beyond which changes to the processes that regulate the stability and resilience of the Earth system, will be irreversible and possibly catastrophic
3. The 1.5°C temperature threshold that countries have pledged not to go beyond

Lesson 3.1. Climate Indicators and Measurements

Level: Basic

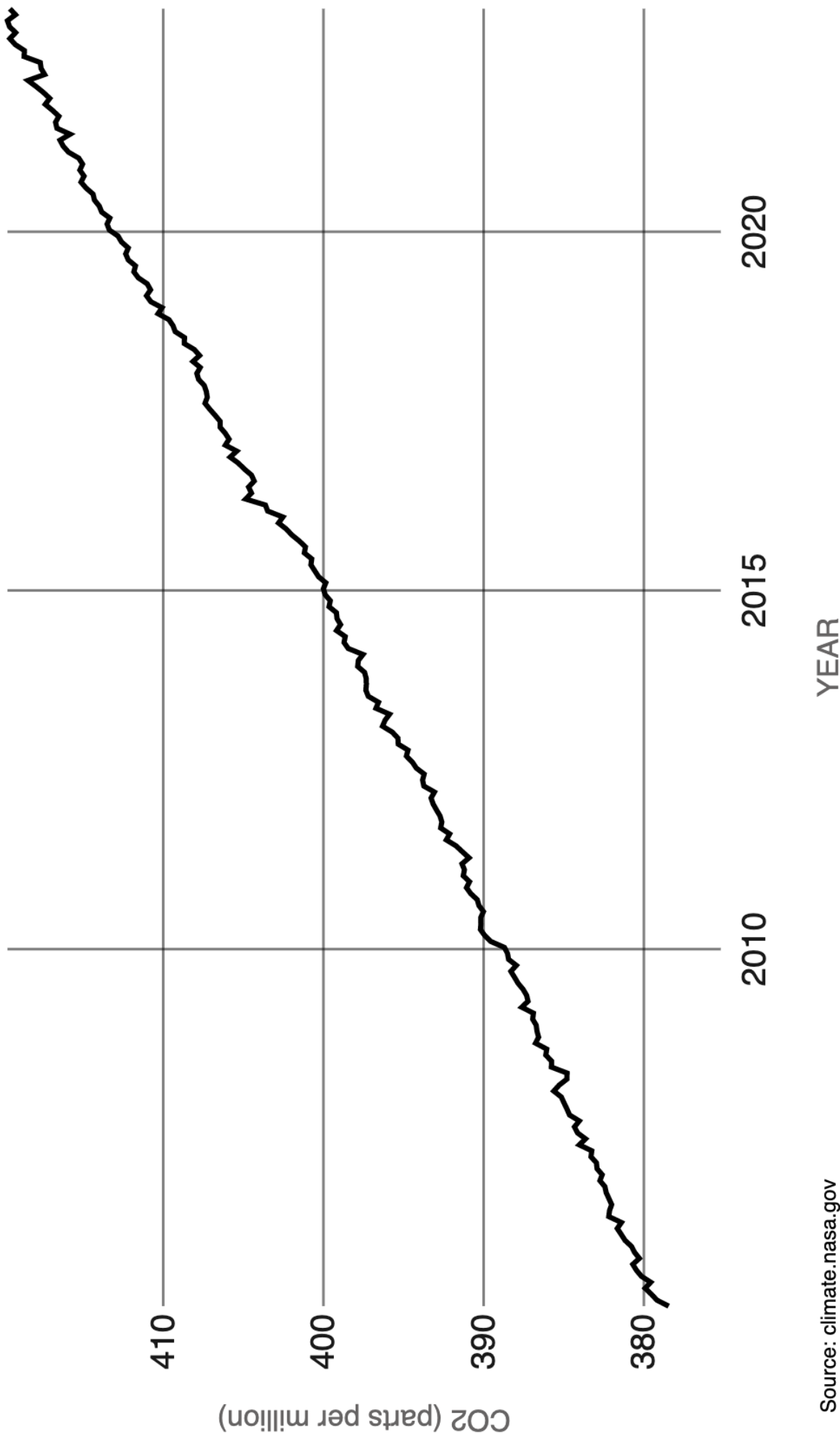
Background

- Scientists know that the climate is changing because they track specific headline indicators:
- **Temperature:** Temperature can be modelled and projected using something scientists call general circulation models which involve energy, mass and heat transfer calculations. The IPCC uses these models to predict what might happen if temperatures continue to increase 20, 50, 80 years into the future. Earth's global average surface temperature in 2020 statistically tied with 2016 as the hottest year on record, continuing a long-term warming trend due to human activities.
- **Carbon dioxide:** CO₂ is a potent greenhouse gas that, once injected into the atmosphere, remains and affects the climate system for centuries. Human activities have emitted increasing levels of CO₂ since the beginning of the Industrial Revolution. As the concentrations of CO₂ and other greenhouse gases, such as methane, increase in the atmosphere, they trap more heat and raise the surface temperature further; this causes global warming. Human activities have raised the atmosphere's carbon dioxide content by 50% in less than 200 years.
- **Sea level rise:** The oceans absorb 94% of the heat being trapped on our planet, if it wasn't for the oceans our planet would not be able to sustain life as we know it. But this is causing another problem – as the ocean warms it causes sea ice to melt. The combined impact of the thermal expansion of the oceans (with heat) and the melting ice sheets is resulting in sea levels rising. As the sea levels rise, low-lying areas like Bombay and Chennai, which are densely populated will be completely inundated.
- **Precipitation:** Scientists would like to track what precipitation (the water that falls to the ground, like in the form of rain or snow) has done in the past and what it will do in the future but it is one of the most difficult ones to measure and model.
- The IPCC does a comprehensive review of these indicators. Using data related to these indicators scientists conduct complex computer simulations every 5 or 6 years to understand the effect of human activities versus natural variations in the climate system. These models calculate the temperature, wind, humidity and other meteorological parameters that are part of the natural climate system.
- Comparing the outputs of models that include only natural factors with models that take into account human activities shows clearly that humans have caused climate change. Models only show a temperature change consistent with the warming experienced and observed, when they include emissions from human activities. This makes it clear that greenhouse gases, emitted through human activities such as industry, transport and agriculture, are the primary cause of global warming since 1850.
- Because scientists know which wavelengths of energy each greenhouse gas absorbs, and the concentration of these gases in the atmosphere, they can calculate how much each gas contributes to warming the planet. Carbon dioxide causes about 20 % of Earth's greenhouse effect; water vapor accounts for about 50%; and clouds account for 25%. The rest is caused by small particles (aerosols) and minor greenhouse gases like methane.



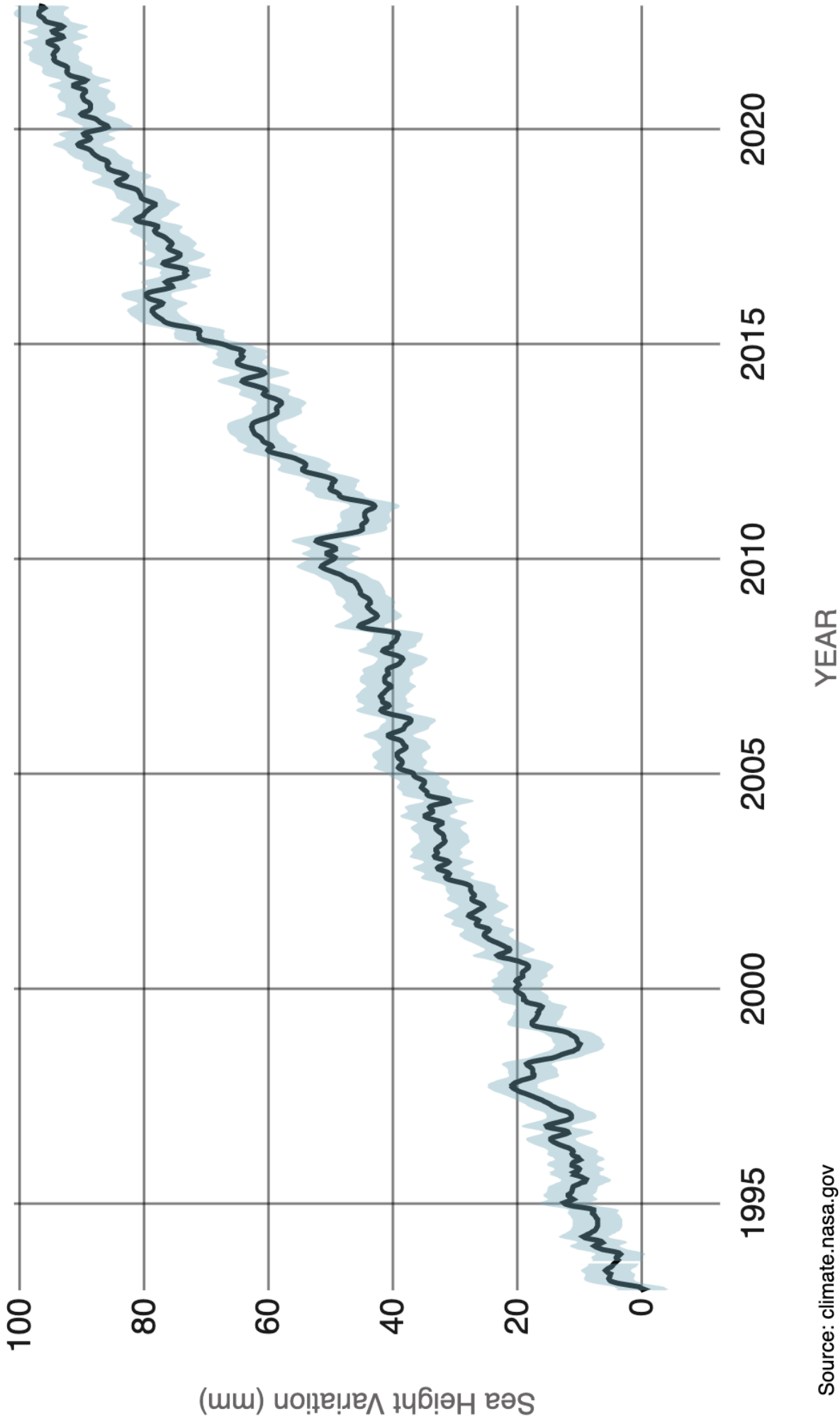
Source: climate.nasa.gov

This graph shows the change in global surface temperature compared to the long-term average from 1951 to 1980. The year 2020 statistically tied with 2016 for the hottest year on record since recordkeeping began in 1880 (Source: [NASA/GISS](https://www.nasa.gov/glossary))



Source: climate.nasa.gov

This graph shows atmospheric CO₂ levels measured at Mauna Loa Observatory, Hawaii, in recent years, with natural, seasonal changes removed. (Source: [NASA/GISS](https://climate.nasa.gov))



Source: climate.nasa.gov

Sea level rise is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers, and the expansion of seawater as it warms. This graph tracks the change in global sea level since 1993, as observed by satellites.. (Source: [NASA/GISS](https://climate.nasa.gov))

Lesson 3.2. Planetary Boundaries & Tipping Points

Level: Advanced

Background

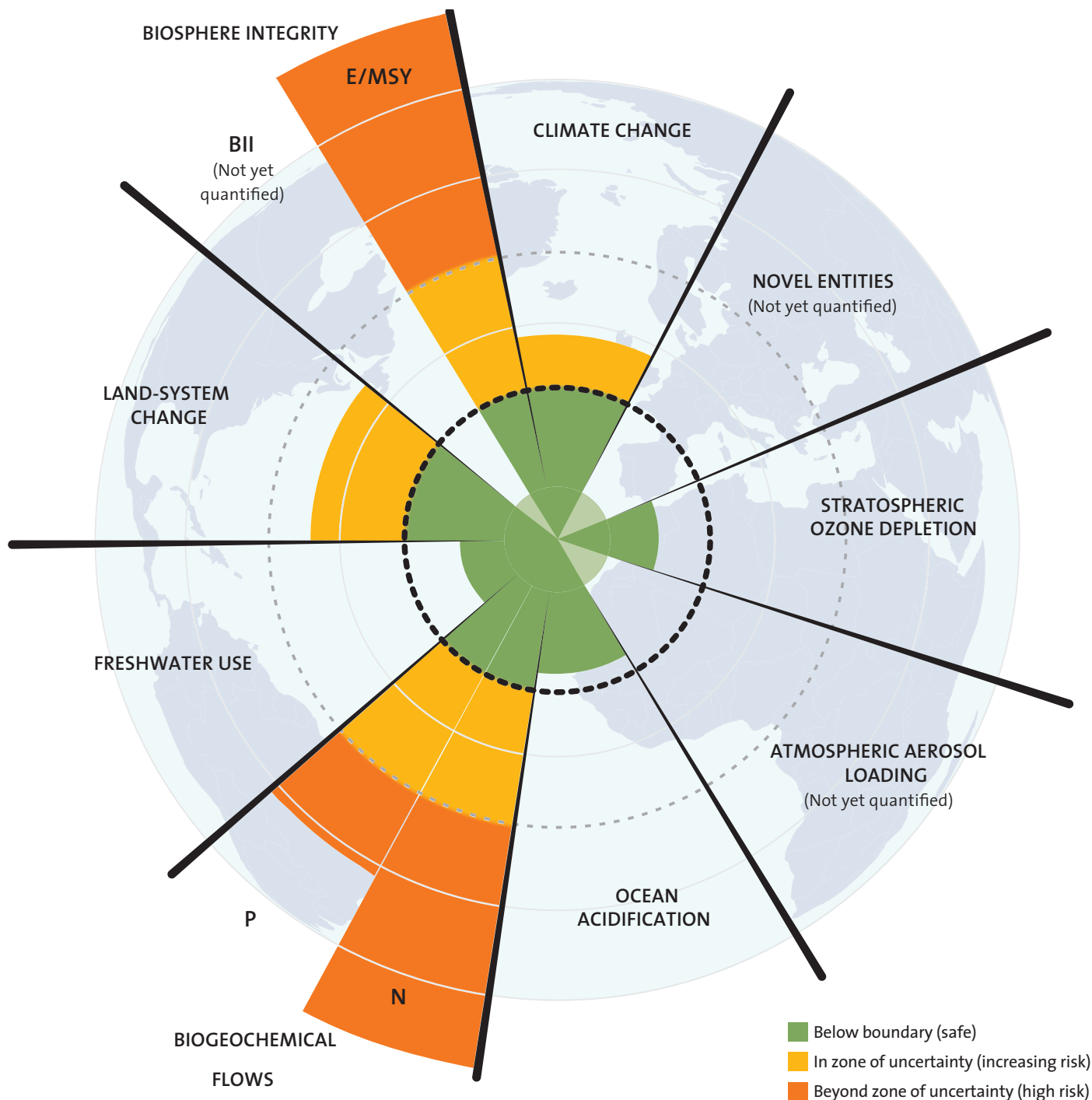
- In 2009, 28 internationally renowned scientists identified 9 processes that regulate the stability and resilience of the Earth system. They then quantified the boundaries within which these processes must operate to allow humanity to thrive and develop for generations to come. This came to be known as the safe and just Earth Systems Boundaries framework.
- “Safe” is defined as ensuring stable, resilient, biophysical conditions on Earth, like those of the last 10,000 years, that have allowed humans to prosper. “Just” is defined as minimizing human exposure to significant harm from changes to the Earth system, and ensuring access to resources for a dignified life, and escape from poverty for everyone.
- The nine planetary boundaries identified cover the global biogeochemical cycles of nitrogen, phosphorus, carbon, and water; the major physical circulation systems of the planet, including the climate, stratosphere, ocean systems; biophysical features of Earth that contribute to the underlying resilience of its self-regulatory capacity, like marine and terrestrial biodiversity and land systems; and two critical features associated with anthropogenic global change: aerosol loading and chemical pollution.
- In quantifying planetary boundaries that are critical for the world economy, social stability and for human well-being, scientists are now able to identify their tipping points.
- Tipping points are conditions beyond which changes in a system will self-continue for an indefinite amount of time, often beyond repair or reversal. These tipping points are critical thresholds that, once crossed, tip a natural system into an entirely different state and lead to potentially irreversible, catastrophic impacts for the planet—including more warming.
- Imagine a child pushing themselves from the top of a playground slide. There is a point beyond which it is too late for the child to stop themselves sliding down. Pass this threshold and the child continues inevitably towards a different state – at the bottom of the slide rather than the top (analogy taken from [Carbon Brief](#)).
- The Intergovernmental Panel on Climate Change (IPCC) notes that more than a dozen natural systems – from ice sheets to the Amazon rainforest – are at risk of “tipping.” And although the actual tipping process could take years or even many centuries, it’s possible that once a threshold is passed, the shift is, essentially, a done deal – even if emissions are halted or reversed. In the case of the Amazon rainforest, for example, hitting a climate tipping point, particularly in the face of continued deforestation, could eventually turn the tropical forest into an arid grass land (savannah).
- As more tipping points are reached the changes will trigger abrupt, irreversible, and dangerous impacts (such as sea level rise, collapsing ice sheets, dieback of biodiverse ecosystems like the Amazon rainforest or warm-water coral reefs, and the release of carbon and heat-accelerating methane from thawing permafrost) with serious implications for humanity.

Cues for Educators

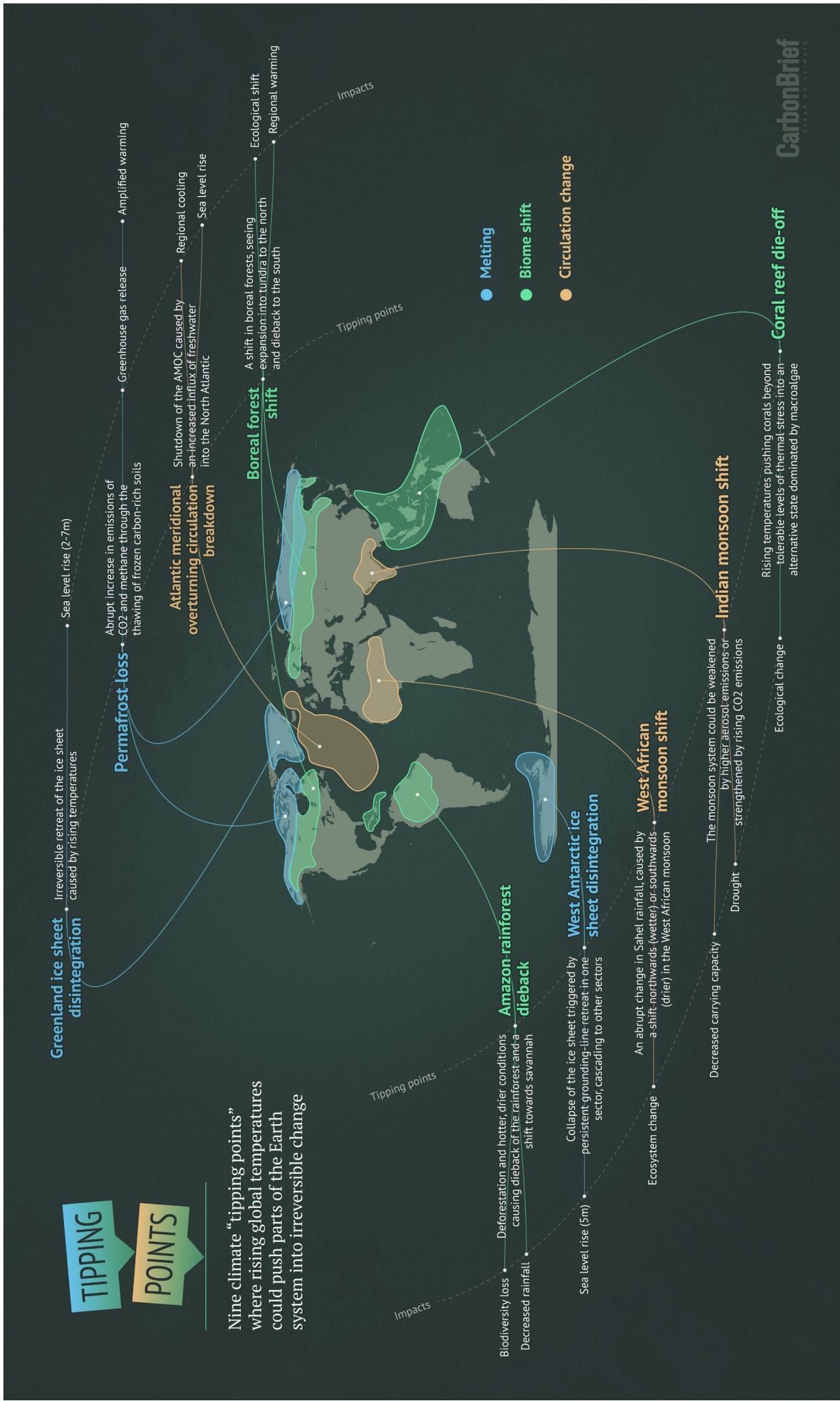
1. What do you understand by the term "planetary boundary"?
2. What is a tipping point?

Further Information & Resources

- Video (TED Talks): [Let the environment guide our development](#)
- Article (Mongabay): [The nine boundaries humanity must respect to keep the planet habitable](#)
- Article (Stockholm Resilience Institute): [Planetary Boundaries](#)



The planetary boundaries framework (Source: [Stockholm Resilience Institute](#))



This diagram explores the nine key tipping points across the Earth system, (Source: [Carbon Brief](#))

Lesson 3.3. The 1.5°C Threshold

Level: Basic

Background

- Scientists say that since the last Ice Age ended nearly 12,000 years ago and human civilization developed, Earth's average global air temperature has never varied by more than 1.5°C above a relatively stable temperature of 14°C. The world ended 2021 between 1.1 and 1.3°C hotter than that pre-industrial average, close to breaching Earth's climate tipping points.
- There is global consensus around the idea that in order to avoid irreparable climate change (and trigger the climate tipping points), we need to keep global average temperature increase at or below 1.5°C compared to the average temperature in the pre-industrial era (i.e. 1880).
- Under the UNFCCC (United Nations Framework Convention on Climate Change) Paris convention (2015) the ambition is to limit the increase in temperature between 1.5 to 2°C from pre-industrial levels. As such temperature is not just an indicator of the changing climate, it is also an indicator of the success of our actions to address climate change. And things are not going well. Based on how things are going, we are likely to hit 1.5°C sometime in the first half of the 2030s.
- We often think of global warming as being linear: emit too much carbon and temperatures go up proportionally. While that is generally true, the resulting climate consequences, like severe drought or flooding, are not proportional in impact. In other words, 10% more increase in CO₂ does not equal just 10% more impact. This means that past the 1.5°C mark, the potential consequences for people and biodiversity become increasingly dire.
- Warming is not spread evenly around the globe. On land, temperatures have already risen about 1.5°C more than over the bigger, cooler oceans. The northern hemisphere is particularly warm, with Europe having seen about 2°C of warming and the Arctic 3°C.
- Even the latest IPCC report, which has historically taken a more cautious view, warns that certain global tipping points will be triggered the warmer it gets, based on our current emissions trajectories.
- Some impacts may now be inevitable, but we can still take steps to avoid further accelerating the consequences of the tipping points we have likely passed or will pass. That's why it's crucial we prioritize and ramp up climate mitigation and climate adaptation. It's not that if we go past 1.5°C everything is lost but there is clear evidence that 1.5°C is better than 1.6°C, which is better than 1.7°C, and so on. The point is we need to do everything we can to keep warming as low as possible.
- How fast do we need to stop burning fossil fuels to limit global temperature rise to 1.5°C? Climate scientists estimate that we need to decrease emissions to near zero by 2040 (we will likely hit 1.5°C by 2030). The world consumed less fossil fuels in 2020, and less energy overall, largely due to the Covid-19 pandemic. However by 2021, consumption had already rebounded past 2020 levels.
- At 2°C 18% of insects, 16% of plants and 8% of vertebrates will be affected. At 1.5°C 70% of the world's coral reefs are lost by 2050 and at 2°C, all the corals will be lost. At 2°C sea level rise will be 10cm higher than at 1.5°C exposing 50 million people to risks including displacement, food insecurity, loss of livelihoods and increased exposure to storms, floods etc.

Cues for Educators

1. What is the significance of the 1.5°C limit?
2. What could be some of the consequences of triggering the climate tipping point by exceeding temperatures by 1.5°C?

Further Information & Resources

- Report (IPCC): [Summary for Policymakers \(Special Report: Global Warming of 1.5oC\)](#)
- Article (UN NEWS): [Climate change: No 'credible pathway' to 1.5°C limit, UNEP warns](#)
- Article (Reuteurs): Explainer: [What's the difference between 1.5°C & 2°C of global warming?](#)
- Article (Climate Analytics): [The Paris Agreement: 1.5°C Temperature Goal](#)
- Research Article (Science): [Exceeding 1.5°C global warming could trigger multiple climate tipping points](#)

Activities

- **Group Activity:** In groups, research which climate tipping points will be crossed as we get closer to hitting the average global temperature increase of 1.5°C. What are the potential impacts of breaching these tipping points in the country you live in, and within the South Asia region?

MODULE 4

HUMAN IMPACTS ON THE CLIMATE

Subjects Covered	Module Teaching Time	Skills Developed	
<ul style="list-style-type: none">• Physical Sciences• Biological Sciences	hours	<ul style="list-style-type: none">• Research• Critical Thinking• Logical Thinking	
	Average Lesson Time		
	45 mins		

Learning Objectives

The objective of this module is for learners to understand the impacts of human actions on Earth's climate system. This forms the basis for determining what actions and changes we should be undertaking as a society to reduce our climate footprint. In this module learners will gain knowledge of the five key human activities (deforestation, burning of fossil fuels, pollution, over-population, and destruction of habitats) that have contributed to the current changes in our climate systems.

Lesson 4.1. Deforestation

Level: Basic

Background

- Research shows that the difference between changes in the climate in the past and now is that the current change is induced due to irresponsible human activities and is proceeding at a never seen before rate. The Intergovernmental Panel for Climate Change's (IPCC) states that scientists are 95% certain humans are the "dominant cause" of global warming since the 1950s.
- As humankind evolved, our life, livelihoods and lifestyles evolved with it. With the advent of agriculture, many early human cultures went from being hunter-gatherers to settlers. Forests were cleared to make room for farming, grazing of livestock, and for obtaining wood for fuel and timber.
- With Industrialization and urbanization, more land was cleared for building infrastructure and for mining of fossil fuels and other natural resources.
- Forests are important because they provide us with clean air, wood for fuel and timber, it provides other living beings with food and shelter, it regulates the climate, it stores carbon. It provides us with ecological as well economic benefits.
- Forests sequester carbon. Which means trees are reservoirs for absorbing and storing carbon. We all know trees absorb CO₂ to prepare their own food through photosynthesis. Through this process, they store vast quantities of carbon in them. As forests are cut down, the stored carbon is released back into the atmosphere as Carbon dioxide, which is a greenhouse gas. GHGs prevent heat from escaping the earth's atmosphere thus increasing the overall temperature of the earth.
- Deforestation also results in the loss of biodiversity, causes soil erosion, and can also lead to desertification of land. It also impacts the livelihoods of communities living around the forests who are dependent on it for resources.
- In 2020, India ranked third among the top 10 countries that had gained forest areas in the decade from 2010 to 2020, according to global forest resources assessment 2020 brought out by Food and Agriculture Organization (FAO) of the United Nations. However, according to the Forest Survey of India (FSI) forest cover is defined as, "all lands more than 1 hectare in area, with tree canopy density of more than 10% irrespective of ownership and legal status." What this means is that even orchards, tea, coffee, and rubber plantations are considered part of forest cover. In the FSI methodology, the tree cover that is considered also includes trees along the highways, trees in someone's garden or trees bordering farms. This is counted and added ultimately to the forest cover measurement. It is a case of mistaking trees for forests, quite literally. In contrast, the forestlands are areas that are categorized as such in the government records. These can be reserved or protected forests in the forest department records or revenue forests in the revenue department records of state. Any land recorded as forest continues to maintain its status even if the land is diverted for mining or hydropower project. So, the disparity is quite apparent in the figures mentioned in the FSI report. According to the report, the total forest land in the country stands at 7,64,419 sq. kms but the Forest Cover inside this recorded forest land is only 5,13,436 sq. kms. This means 2,50,983 sq. kms within the recorded Reserved, Protected or Revenue forests of the country do not have any trees on it.

Cues for Educators

1. What is deforestation and why does it occur?
2. How does Deforestation impact the climate?

Further Information & Resources

- Book Chapter (FAO): [Climate-Smart Agriculture Sourcebook - Forests and Climate Change](#)
- Article (Mongabay): [Deforestation - Facts, Figures, and Pictures](#)

Activities

- **Group Activity:** Create a timeline of forest growth/deforestation in a region/state of India, Nepal, or Pakistan. Use Google Earth to access images from the last 25 to 50 years to understand changing forest covers in that region.
- **Group Research and Discussion:** Sacred Groves have been the traditional way of conserving and protecting forests that are important to the fight against climate change. Find out how and why has this tradition and conservation measure worked in your country?

Lesson 4.2. Burning of Fossil Fuels

Level: Basic

Background

- Fossil fuels are formed from decomposing plant and animal matter. The reserves of fossil fuel that humans have been using have been formed over millions of years or more. Even though they are formed from organic matter, they are considered non-renewable sources of energy because our rate of consumption of fossil fuels is much higher than the rate at which they are replenished.
- Coal, Natural gas, Petroleum (also known as Crude Oil) are some examples of fossil fuels. The main elements found in fossil fuels are carbon and hydrogen which are burned to get energy.
- According to Worldometer (<https://www.worldometers.info/energy/>), based on our current consumption rate and the availability of proven reserves, the world has about 47 years of oil left, about 52 years of gas left, and about 133 years of coal left. And India has about 3 years of oil left, without imports, about 22 years of gas left, and about 111 years of coal left.
- The energy obtained from burning of fossil fuels has become a part of our life and lifestyles. It is used in transportation, construction, industries and for electricity in our homes. From the cars we use to commute, to the phones and laptops we use daily, everything requires energy. And most of it comes from the burning of fossil fuels.
- However, the burning of fossil fuels releases large quantities of CO₂, methane, and other greenhouse gases into the atmosphere. And as noted above, GHGs are responsible for trapping heat in the earth's atmosphere and warming the overall temperature of the earth.
- The extraction of fossil fuels from the earth's surface (land and the oceans) is also destroying ecosystems and habitats. And large amounts of smoke/ emissions due to the burning of fossil fuels leads to pollution.

Cues for Educators

1. What are fossil fuels?
2. Why are fossil fuels considered a non-renewable source of energy?
3. What are the different sectors in which fossil fuel energy is used?

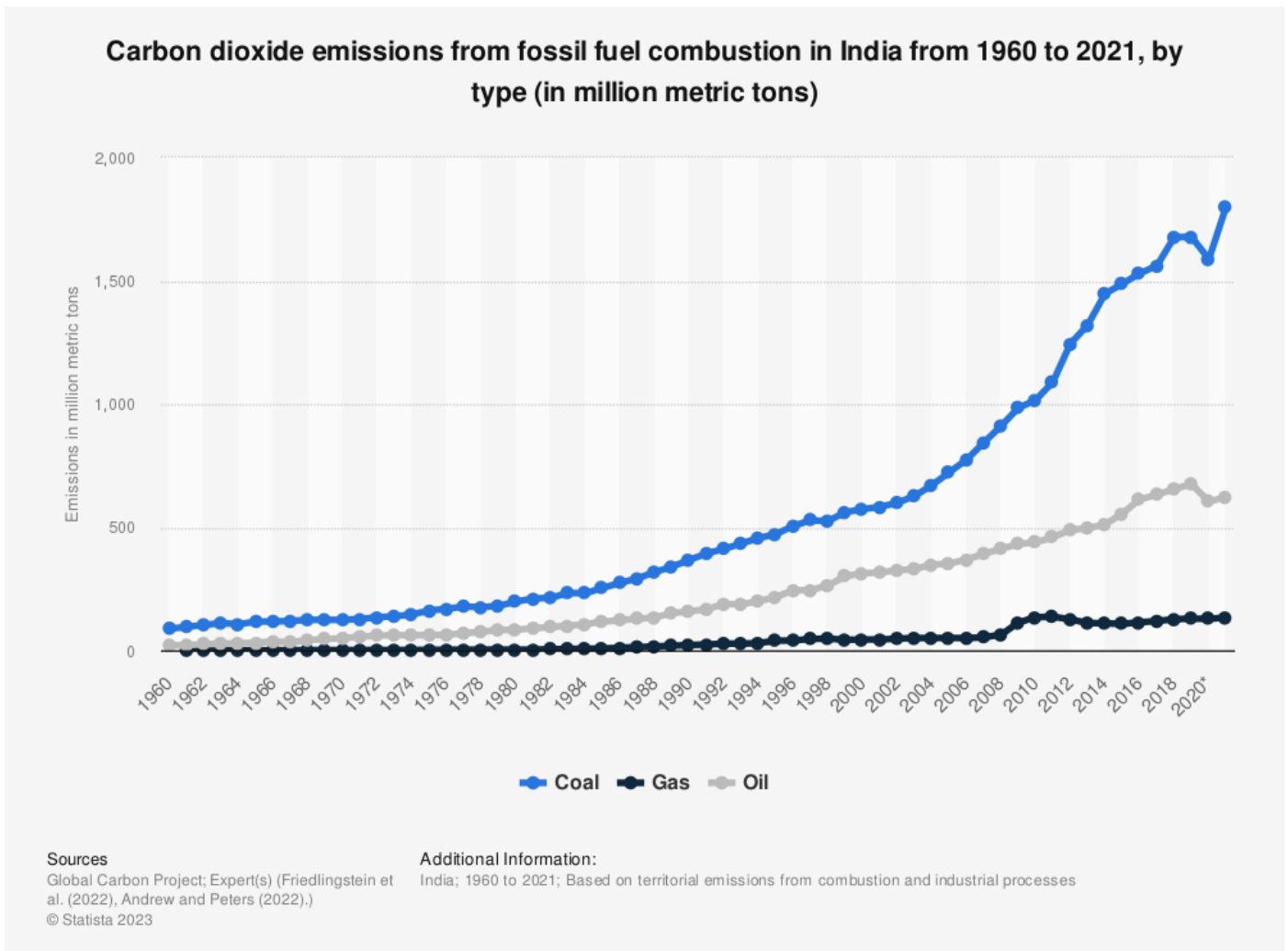
Further Information & Resources

- Encyclopedia (Britannica): [Fossil Fuel](#)
- Article (Our World in Data): [Fossil Fuels](#)
- Article (National Geographic): [What is a fossil fuel and what is being done to make fossil fuels more environmentally friendly?](#)

Activities

- **Individual Activity:** List down all the things in your home that use fossil fuel energy.

- **Group Activity:** List the actions you, your household, or your community can take to substitute the use of fossil fuels in your locality or home; discuss the pros and cons of each option.
- **Group Discussion:** The high altitude desert region of Ladakh has been facing water shortage as the glaciers are melting faster in the summers. This reduces their farming period. To combat this problem, innovator and educator Sonam Wangchuk came up with a simple yet extremely efficient solution based on simple concepts of Physics and building on an earlier model of creating artificial glaciers, the Ice Stupa Artificial Glacier. Watch the video [The Science Behind Sonam Wangchuk's 'Ice-stupas'](#) by The Better India Foundation and discuss what can be learned from it.



Carbon dioxide emissions from fossil fuel combustion in India from 1960 to 2021, by type (in million metric tons). Coal combustion in India produced 1.8 billion metric tons of carbon dioxide (GtCO₂) in 2021. This was an increase of roughly 13% in comparison to the previous year, and the largest figure recorded during the period in consideration (Source: [Statistica](#))

Lesson 4.3. Pollution

Level: Basic

Background

- The release of any substance (solid, liquid, gas) or any form of energy (such as heat, radioactivity) into the environment at a rate that's faster than its dispersal, decomposition, or recycling rate is called (environmental) pollution. Simply put, it can also be defined as the release of substances in the environment in quantities that are harmful for living beings.
- These substances are called Pollutants. Pollutants can be biological (e.g., human waste) or chemical (DDT in pesticides) or man-made (like plastic) or light, sound or heat.
- There are different kinds of pollution:
 - **Air Pollution** - Emissions from industries, transportation, burning of wood and dung for heat and cooking, and from landfills, release harmful gases or smaller particles called aerosols into the atmosphere, leading to an increase in air pollution. This not only leads to health hazards but can also cause acid rains or even block solar radiation from reaching the Earth's surface.
 - **Water Pollution** - Chemically treated water from industries and farmland released into freshwater bodies like lakes and rivers, ground water and oceans leads to pollution of water. Dumping of sewage and plastic waste from cities into water bodies are also major causes of water pollution. Disasters involving oil spills in the oceans are one of the most destructive forms of water pollution.
 - **Land Pollution** - Due to the lack of proper waste-disposal systems, landfills in developing countries like India are overflowing with garbage. These landfills have all kinds of wastes such as e-waste, medical waste, plastic waste, etc. dumped without any regulations.
 - **Soil Pollution** - Apart from this, hazardous chemicals from pesticides and fertilizers used in farming also find their way into the soil. Like oceans and forests, soil also helps in absorbing and storing atmospheric carbon. As chemicals from the waste dumped on the land leach into the soil, its capacity for carbon absorption is affected leading to changes in the climate.
 - **Plastic Pollution** requires a special mention here as it affects land, water, and air. As convenient and cheap plastic is, it is also one of the most destructive material threatening our planet's well being today. From the deepest oceans to the tallest mountains, from the tropical rainforests to the glaciers, plastic is found everywhere. Plastic pollution can alter habitats and natural processes, reducing ecosystems' ability to adapt to climate change, directly affecting millions of people's livelihoods, food production capabilities and social well-being.
- As the air we breathe, the water we drink, and the soil that we grow our food in becomes polluted, it directly impacts our health and the health of other living beings.

Cues for Educators

1. Focus should be on connecting pollution with climate change
2. How does different kind of pollution lead to climate change?

Further Information & Resources

- Video: [The Story of Stuff Project](#)
- Website (Carbon Footprint): [Carbon Calculator](#)
- Article (World Economic Forum): [We know plastic pollution is bad – but how exactly is it linked to climate change?](#)

Activities

Group Activity: Lifestyle changes in the last couple of decades have seen the addition of and heavy reliance on Mobile Phones and automobiles. Break into 2 groups; one group takes mobile phones and the other will take automobiles.

Group 1 can either use an old, damaged mobile phone and take it apart OR use the internet to learn what the different parts of the phone are made of. Make a list of all the parts and the different materials used to make the phone. On a chart paper draw the life cycle of the phone. Right from mining of metals to manufacturing of glass and plastic to what happens after the phone dies.

Speak to the different stakeholders to find out how phones are disposed of in your region. Whether there are safe methods used to recycle the old phone or whether it causes environmental impacts.

Group 2 also uses the similar process of listing down the materials used in the manufacturing of an automobile (bike, car, truck, etc.). Use the internet or talk to local stakeholders to find out. How are the different materials extracted, mined, or manufactured? What happens to it once the vehicle is scrapped? How much of it is recycled and what are the environmental impacts of the scrap? If you have a scrap yard nearby you can also visit the scrap yard to learn more.

Both the groups present their findings to each other and then do a carbon footprint test of both the products.

Lesson 4.4. Over Population

Level: Basic

Background

- The population of our planet reached 8 billion in 2022. We went from 1 billion in the 1800s to 8 billion just 200 years later. With the advent of industrial revolution, the world has seen an unprecedented growth in human population.
- Currently, India ranks 2nd in the world with a population of 1.41 billion. It is estimated that India will overtake China, which ranks no. 1, in the next decade. Presently, it supports 17.7% of the total population of the world on 2.4% of the world's total land area. Around 25% of the total population in India today is urban. It is projected to have 53% of the national population as urban population by the addition of 416 million urban dwellers by the year 2050 (UNDESA, 2018).
- As the human population grows beyond the carrying capacity of a place, it starts to put pressure on the natural resources of that region eventually leading to its depletion. In 2009, a UN report warned that the world would need to produce 70% more food by 2050 to feed its extra population, thereby putting more pressure on land, water, and energy resources.
- More people means more forests are cleared for growing food and for settlements, pasture lands for grazing of livestock, and more minerals are mined. More industries getting set up and more cars on the road mean more burning of fossil fuels.
- As the demand for food increases, the use of pesticides and chemical fertilizers increases and so does the over-harvesting of fish to meet the growing demands of the population. These chemicals leach into the soil and waterbodies thereby polluting them.
- All these eventually lead to local and global impacts on the climate systems.
- Currently more than half the world population lives in urban areas. The United Nations estimates that by the year 2050, about 70% of the world's population will live in cities. Human activity in urban environments alters atmospheric composition; affects components of the water cycle; and modifies the carbon cycle and ecosystems. The current urban lifestyles are also designed to consume more. Our consumption patterns directly impact the natural resources.
- However, even though over-population is considered one of the main causes of human impacts on climate systems, it is currently under debate. According to a study done by Oxfam, 'the poorest half of the global population are responsible for only around 10% of global emissions yet live overwhelmingly in the country's most vulnerable to climate change – while the richest 10% of people in the world are responsible for around 50% of global emissions.'

Cues for Educators

1. How does over population impact climate change?

Further Information & Resources

- Research Paper (Oxfam Media Briefing): [Extreme Carbon Inequality](#)
- Factsheet (UN - WE): [Some Facts of Extreme Urbanisation](#)
- Article (ResearchGate): [Impact of Population Growth on Environmental Degradation: Case of India](#)

Activities

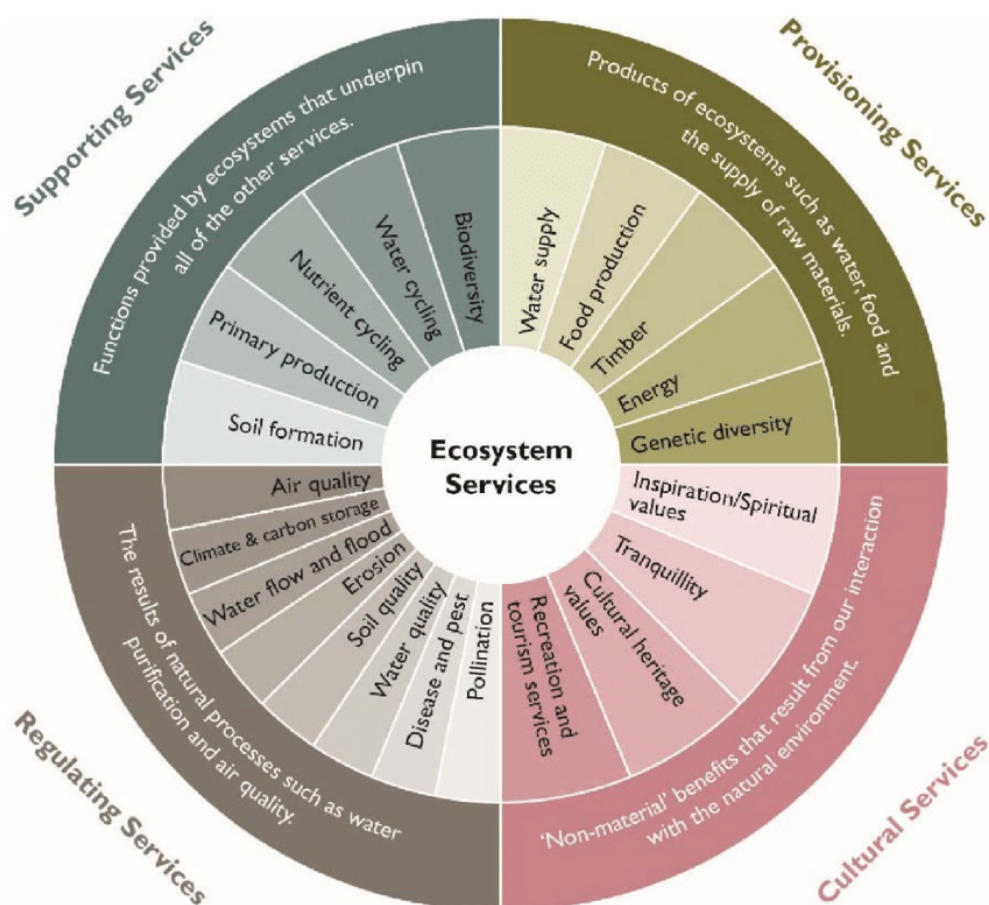
- **Group Activity:** Interview friends and family members. make 2 groups, ones who have migrated and ones you have been living there for more than 3 generations. What made the first group move and what has made the second group stay? Does either of them want to leave? why? Collect the evidence for a systems thinking activity later.
- **Group Activity:** Historically, overpopulation has been considered as one of the contributors to climate change. Given the new data from Oxfam study referenced above, "how are the richest 10% of the world responsible for 50% of global emissions"? Read the study and have a debate in the classroom.

Lesson 4.5. Habitat Destruction

Level: Basic

Background

- A habitat is defined as the natural home of a living organism. It is a place that has suitable environmental conditions required for the growth and survival of a species. Each habitat has its own mix of distinct species. There are different kinds of habitats like the tropical rainforests, deserts, coral reefs, wetlands, grasslands, lakes, mangroves, temperate forests, etc.
- Almost all the habitats of the world are under threat today but some more than others. Like the wetlands, coral reefs, and mangroves are critically threatened by human activities. (Insert pics of wetlands, coral reefs, and mangroves) In many parts of the world wetlands are drained for building industries and ports and mangroves are destroyed for coastal development and infrastructure.
- Like forests, these habitats are responsible for carbon sequestration i.e., absorbing and storing carbon from the atmosphere. And just like deforestation, destruction of these habitats release carbon back into the atmosphere as CO₂. For example, mangroves are known to sequester carbon 4 to 10 times more than terrestrial forests.
- Apart from storing carbon they also play other important roles. For example mangroves protect our coastlines from erosion and storms (which are increasing in frequency due to climate change), Coral reefs help in reducing the impacts of strong wave action and wetlands help to reduce flooding incidents by absorbing excess water.



The 4 categories of services provided by natural ecosystems (Source: [ResearchGate](#))

Cues for Educators

1. What are the different kinds of habitats?
2. How is their destruction impacting the local climates?

Further Information & Resources

- Article (National Geographic): [The Global Impacts of Habitat Destruction](#)
- Article (Natural History Museum): [How are climate change and biodiversity loss linked?](#)
- Article (UN Climate Action): [Biodiversity - Our Strongest Natural Defense Against Climate Change](#)

Activities

- **Group Activity:** Identify a type of ecosystem in your locality. Research and find out the different roles and functions it plays and provides. For example, if it's a wetland, how does it help in preventing flooding during the monsoons. Talk to people living around the ecosystem, and people whose livelihood is dependent on it. Design a local movement/campaign to highlight the importance of the ecosystem and encourage people to protect and conserve it, or Create a photo journal to document/record the status of the ecosystem and people's stories.
- **Group Discussion:** What are some of the ways in which people could be made aware of the importance of natural ecosystems in our fight against climate change and the impacts of their destruction on us?

MODULE 5

CLIMATE CHANGE IMPACTS ON HUMANS

Subjects Covered	Module Teaching Time	Skills Developed	
<ul style="list-style-type: none">• Physical Sciences• Biological Sciences	4 hours	<ul style="list-style-type: none">• Research• Critical Thinking• Logical Thinking	
	Average Lesson Time		
	45 mins		

Learning Objectives

The objective of this module is for learners to understand the impacts of climate change on humanity. This forms the basis for determining what actions and changes we should be undertaking as a society to live in a climatically altered world. In this module learners will gain knowledge and understanding of:

1. the effects of climate change on human societies
2. why extreme weather conditions are increasing in number and frequency
3. the relationship between climate change and increased health risks
4. how climate change is leading to poverty and displacement of people

Lesson 5.1. Extreme Temperatures

Level: Basic

Background

- As the earth gets warmer due to the greenhouse effect, it directly impacts the planet's water cycle which in turn affects the weather patterns. Globally, we are seeing extreme weather patterns affecting daily human lives. The last decade (2011 - 2020) was the warmest on record.
- Extreme weather events are those that are rare at a particular place and time of year (IPCC). The India Meteorological Department (IMD) classifies lightning and thunderstorms, heavy to extremely heavy rainfall, landslides and floods, cold waves, heatwaves, cyclones, snowfall, dust and sandstorms, squalls, hailstorms, and gales as extreme weather events.
- Heat waves are becoming a common phenomenon leading to more heat-related illnesses. This directly impacts the health of people working outdoors like farmers, labourers, etc. As the summers get drier and the temperatures rise, it also increases the chances of wildfires, displacing communities living around the forests and increasing the risks of human-wildlife conflict.
- India witnessed extreme weather events – such as heatwaves and floods, caused by the changing climate – on 88% of days in 2022, as per a report by the Centre for Science and Environment (CSE) and Down to Earth published on November 1. March 2022 was the hottest recorded year in the last 122 years.
- As the intensity and frequency of heatwaves increases in India, the more vulnerable and marginalized communities will, unfortunately, be at the forefront bearing the brunt of this. This will also impact the economic growth of the country as nearly half of our country's GDP comes from heat-exposed work.
- Extreme weather patterns eventually affects us all as the growing season of different crops are disrupted, and ecosystems with natural resources are destroyed due to events like floods, storms, cyclones, and droughts.

Severe Storms

- Storms are caused by disturbances in the atmosphere that result in extreme weather like heavy rains or snow, high winds, lightning and thunder, cyclones, hurricanes, dust, or sandstorms.
- Storms intensify as the oceans get warmer. Evaporation intensifies as temperatures rise, and so does the transfer of heat from the oceans to the air. As the storms travel across warm oceans, they pull in more water vapor and heat. That means stronger wind, heavier rainfall and more flooding when the storms hit land.
- Severe storms are known for the destruction they cause to life, livelihood, and infrastructure. Heavy flooding destroys farmlands and crops, and cyclones cause damage to coastal infrastructure, homes, and an increased risk to life.
- India, with its 7500 km long densely populated coastline, is more vulnerable to cyclones, coastal floods, and tsunamis. Studies show that the intensity, frequency and number of these extreme events will only increase in the coming years due to climate change and will have serious effects on its population.

Cues for Educators

1. What are extreme weather events?
2. How are these impacting humans?
3. What are the factors lead to severe storms?

Further Information & Resources

- Video (National Geographic): [Causes and Effects of Climate Change](#)
- Article (World Meteorological Organisation): [Climate change made heatwaves in India and Pakistan "30 times more likely"](#)

Activities

Group Discussion: Identify the latest (last) extreme weather event that occurred in your locality. Make a list of the different groups of people, communities, and stakeholders that were impacted by this event (e.g., farmers, fishermen, dairy producers, poultry farmers, autorickshaw drivers, flower and vegetable sellers, shopkeepers, construction workers, your family members, neighbours, schools and colleges, offices and industry workers, etc.). Speak to these people if possible, look up secondary literature and research to collect and collate as much information as you can.

Break into groups. Each group will represent as a locally elected climate action youth team. Each group will design a comprehensive action plan to prepare their local area for future extreme weather events, following which they will present their action plan to the other. When one team presents the others are encouraged to ask difficult questions pertaining to the leadership chain, roles and responsibilities of people, budget requirements, the well-being of all stake-holders and the potential challenges and issues that may arise when implementing the plan.

Lesson 5.2. Increased Droughts

Level: Basic

Background

- Drought is generally defined as a prolonged dry period in the natural climate cycle. It is a gradually intensified disaster characterized by the lack of rainfall, resulting in water shortages.
- Increase in the overall global temperature puts pressure on areas already prone to hot and dry climates. Hotter temperatures increase the rate of evaporation from freshwater bodies like lakes and rivers and lead to decreased soil moisture (impacting the productivity of the soil and its ability to absorb water when it does rain). The decreased or absence of sufficient rain also means that ground water tables cannot recharge.
- In India, studies show that drought prone areas have increased by 57% since 1997.
- Drought impacts India's dominantly rain-fed agriculture. In 2006, a severe drought year, farmers in Chhattisgarh, Jharkhand and Odisha lost close to USD 400 million as there was insufficient water to produce crops. This led to almost 13 million agricultural-dependent people in the three states, who live just above the poverty line, to fall below it due to income loss, as well as the food insecurity situation in the region to intensify.
- A NITI Aayog report published in 2019 had estimated that about 600 million Indians faced high to extreme water stress and that over 20 big cities would soon run out of groundwater in a matter of years.
- While water scarcity affects everyone involved in different ways, in a country like India the impacts of this are felt heavily by women and children who walk long distances to collect water and who are worst affected by the subsequent food scarcity. Prolonged periods of drought force people to migrate to urban or semi-urban spaces in search of a better life.

Cues for Educators

1. Why do droughts occur?
2. Why has the frequency of drought events in the South Asia region increased?
3. How are different communities, women and children affected by droughts?

Further Information & Resources

- Article (Mongabay): [Flash droughts set to increase in India, finds study](#)
- Paper (Italian Agency for Development Cooperation): [Case Study: Initiatives for Objective Assessments and Mitigation of Drought in India](#)

Activities

- **Group Activity:** Create a mind map of the connections between various social and environmental topics that cause and are impacted by drought. Topics include migration, loss of soil productivity, gender inequality, decreased precipitation.

- **Group Evidence-based Discussion:** How do increased drought events in a region impact the overall well-being of the people in the region, and impact the country as a whole?

[Educators Guide: The example of the prolonged drought in the agricultural regions of Maharashtra can be used here.]

Maharashtra used to receive over four months of steady rainfall, which was highly beneficial to farmers and crops as the rain would be distributed evenly over long periods. However, in recent years, the State has received infrequent and heavy downpours, which led to several crops dying out due to uneven water distribution during the important stages of crop growth. Owing to the insufficient rainfall that had left the farmlands barren since early 2016, over 700 villages in Maharashtra faced acute water shortages. Adding to this, the groundwater levels continued to fall dramatically due to overconsumption and unsustainable extraction of water. This led to food insecurity as there was decreased availability of grains and pulses for the population, decreased incomes, and eventually farmer suicides]

Lesson 5.3. Warming Oceans & Rising Waters

Level: Basic

Background

- Oceans absorb a large amount of heat from the atmosphere. As the atmospheric temperature continues to rise due to the greenhouse effect, more heat is absorbed by oceans. The warmer the oceans get, the more they expand in volume due to the property that water has of expanding when heated. This brings about a rise in the overall sea/ ocean levels.
- It is widely known that warmer temperatures are causing the glaciers of the earth to melt at an alarmingly faster rate. But how does this affect us? The water from melting glaciers gets added to the water already in oceans, lakes or rivers, causing water levels to rise and leading to flooding. This in turn results in loss of life and property to the human inhabitations around these water bodies.
- The most vulnerable communities are the people living in the mountainous and coastal regions of the world. Flooding in the mountains also leads to landslides, which is exacerbated due to the chopping down of forests along the hillsides. With no tree roots to hold the soil together, landslides are becoming a common occurrence.
- The rise in sea levels is threatening coastal and island communities across the globe. But studies show that, almost all along the Indian coast, sea levels are rising at a much faster rate than the global average.
- The global mean sea level has risen by 1.7mm per year since 1901 and the rate accelerated to 3.3mm per year since 1993. The Indian Ocean has seen sea levels rise non-uniformly, at 1.06 to 1.75mm per year till 2004 and 3.3mm in the recent decades. It is estimated that sea levels may rise 100 -180 cm under high emissions scenario, exposing millions of people living in vulnerable coastal areas.

Cues for Educators

1. Why are sea-levels rising?
2. How will rising sea levels (i.e., expanding waters from heating and melting glaciers) impact coastal populations?

Further Information & Resources

- Video (NASA Climate Change): [NASA's Earth Minute: Sea Level Rise](#)
- Video (NASAJPL Edu): [Watching Rising Seas from Space](#)

Activities

- **Individual Activity:** Learners can take this fun online test by NASA to figure out how much they understand about [Sea Level Rise](#).

Lesson 5.4. Food Scarcity

Level: Basic

Background

- Another serious consequence of changing climate is its impact on food systems. While extreme weather events like droughts and floods affect the quality of the soil, damage farmlands, and ruin crops, many other crops that are sensitive to extreme heat, cold, or rainfall are becoming less productive and more susceptible to pests and diseases.
- Similarly, extreme weather patterns impact the reproductive cycles of livestock and also make them more vulnerable to diseases. Habitat fragmentation and disappearance of grazing/pasture lands are resulting in the decline of livestock, which in turn are affecting different communities like the herders.
- A large percentage of the world's population depends on marine resources. Globally, 7% of our protein intake comes from seafood. On the one hand, warmer oceans and ocean acidification are diminishing the world's fish stocks, while on the other, over-harvesting of fish is also leading to reduced fish population. Overfishing has become a serious global problem. Over-harvesting of fish does not give fish populations time to recover thus reducing their overall population.
- Climate change and food systems (production, transportation, processing, storage, and distribution) have a complex relationship. Unsustainable practices at any stage of the food system - production, transportation, etc. - lead to factors influencing climate change, while extreme weather events due to climate change impacts the different stages of food systems leading to food insecurity and scarcity.

Cues for Educators

1. How are Climate change and food scarcity linked?
2. What are the different ways in which climate change is impacting our food systems?

Further Information & Resources

- Research Paper (Nature): [Food Insecurity](#)
- Article (UN): [The World's Food Supply is Made Insecure by Climate Change](#)
- Report (IPCC): [Food Security](#)
- Video (Context): [How Climate Change is Making Food Insecurity Worse](#)

Activities

- **Group Activity:** Gather information about the local weather patterns, geography, indigenous plants and vegetables, staple crops, and predominant livelihoods in the region in which learners live. Is there any particular fruit or vegetable that was found in abundance years ago which has now disappeared? Investigate and research why that particular food item has disappeared. Gather anecdotal evidence by talking to the elders in the locality about the local weather changes in the last 10, 20 or 30 years and how this has impacted lives and livelihoods. Use creative ways like art exhibition, wall art, theatre, an interesting presentation, newspaper report or social media strategy to disseminate the information to the local communities.

Lesson 5.5. Climate Change and Health Risks

Level: Basic

Background

- The climate is changing at a much faster rate than ever before; this is preventing life (including humans) on earth from adapting to the changes fast enough. And as the weather becomes more and more uncertain, it has started impacting human health.
- Health issues related to climate change are varied and sometimes complicated. Some impacts are felt directly as extreme weather events affect physical health. They are also being felt indirectly as vector-borne diseases and mental health issues increase.
- Heat waves result in heat-stroke and exhaustion and worsen chronic health conditions. In 2010, around 1300 people died in the city of Ahmedabad alone due to heatwaves. The impact of heatwaves is felt more by those engaged in outdoor physical activities like labor or farm-work.
- Hot temperatures, accompanied by increased humidity favor the breeding of insect vectors like mosquitoes and ticks. Vector-borne diseases like malaria, dengue, and chikungunya are affecting human health and resulting in increased number of deaths every year. Studies show that, globally, as the temperatures get warmer, these insects are migrating northwards to temperate climates, taking with them these deadly vector-borne diseases. This means that populations that have not been previously exposed to these diseases are now susceptible.
- An increase in the frequency and intensity of extreme weather events like cyclones, floods, and storms leads to injuries, diseases, and death. Fresh water bodies are at greater risk of contamination during heavy rains, resulting in diseases like diarrhea and cholera. The Lack of access to clean drinking water leads to an increase in the number of illnesses and deaths.
- Prolonged periods of droughts bring their own challenges. As the quality and productivity of staple crops are impacted, it results in more malnourishment and under-nourishment.
- The stress and trauma that comes from facing and living through extreme weather events leads to serious mental health issues as the quality of life is compromised.
- While no one is safe from these risks, the people whose health is being harmed first and worst by the climate crisis are those who contribute least to its causes, and who are least able to protect against it - people in low-income and disadvantaged countries and communities.
- Over 930 million people - around 12% of the world's population - spend at least 10% of their household budget to pay for health care. With the poorest people largely uninsured, health shocks and stresses already currently push around 100 million people into poverty every year, with the impacts of climate change worsening this trend.

Cues for Educators

1. How does a changing climate impact human health?

Further Information & Resources

- Video (World Health Organisation): [Climate Change and Health](#)

Lesson 5.6. Climate-led Poverty and Displacement

Level: Basic

Background

- The impacts of climate change on humans are all tied together. Unfortunately climate change will continue to impact the most vulnerable of communities, genders, and regions. These are the people who have contributed least to climate change.
- In particularly vulnerable areas around the world, the increased intensity and frequency of climate shocks and stressors will lead to the mass movement of people in search of safer lives. Cyclones, storms, and floods damage properties, infrastructure and affect livelihoods. Prolonged droughts affect water and food security, and particularly agricultural livelihoods. The rise in sea-levels is impacting coastal and island communities.
- As the impacts of climate change intensify, rural populations will migrate to urban cities, coastal communities will start moving inland, and those in the mountains will start moving towards the plains. This will put further pressure on the limited resources in certain areas leading to conflict.
- Widely recognized as a climate change hotspot, the Sundarbans is extremely vulnerable, with many islands slowly succumbing to rising sea levels. NASA Landsat satellite imagery shows that the sea level has risen in the Sundarbans by an average of 3 cm (1.2 inches) a year over the past two decades, and the area has lost almost 12% of its shoreline in the last four decades. The sea level rise and subsequent salinization of soil has rendered many livelihoods unviable, producing what we can definitively say are some of the world's first climate refugees

Cues for Educators

1. How does climate change intensify poverty?
2. What/who are climate refugees?

Further Information & Resources

- Article (National Geographic): [Environmental Refugee](#)
- Article (Mongabay): [Migration aiding Sundarbans youth, women adapt to climate uncertainties](#)
- Article (Mongabay): [Environment factors push people out of their homes on India's east coast, leaving behind 'ghost villages'](#)

Activities

- **Group Research Activity:** Despite not being the primary contributors to climate change, the poor are being and will be disproportionately affected by its impacts. Many of them, particularly from South Asia are likely to end up as climate refugees. Through secondary research identify which areas in the country you live, are already being severely impacted by the shocks and stressors of climate change, leading to the displacement of people from those regions.

MODULE 6

MITIGATING CLIMATE CHANGE

Subjects Covered	Module Teaching Time	Skills Developed	
<ul style="list-style-type: none">• Physical Sciences• Biological Sciences	4 hours	<ul style="list-style-type: none">• Research• Critical Thinking• Logical Thinking	
	Average Lesson Time		
	45 mins		

Learning Objectives

The objective of this module is for learners to understand all aspects of climate mitigation. Learners will gain deeper insights into:

1. what climate mitigation is
2. climate mitigation measures, approaches and strategies
3. mitigation policies and programs
4. how the business sector is addressing climate mitigation

Lesson 6.1. An Introduction to Climate Mitigation

Level: Basic

Background

- The Intergovernmental Panel on Climate Change (IPCC) defines mitigation (of climate change) as "a human intervention to reduce emissions or enhance the sinks of greenhouse gases".
- Climate mitigation is the long term solution to climate change and it is absolutely necessary to reduce emissions of heat-trapping greenhouse gases, to prevent the planet from further warming. For mitigation to be effective it needs to be on a large scale. Hence, interventions should be collective as individuals, communities, businesses, States, Nations and collectively, as a world.
- Mitigation mainly looks at reducing greenhouse gas emissions and removal of greenhouse gases from the atmosphere. By reducing greenhouse gas emissions, we can slow the rate of warming and limit the risks associated with climate change. Mitigation efforts can also help to reduce air pollution, improve public health, and create new economic opportunities. Without mitigation efforts, the impacts of climate change continue to worsen over time, leading to more frequent and severe shocks and stressors such as natural disasters, food and water shortages, and the displacement of millions of people.
- Mitigation is essential to protect vulnerable populations and ensure a sustainable future for the planet. However, building climate mitigation solutions is a complex, global-scale process that involves all levels and is relevant to all sections of society. Mitigation requires multi-faceted, differentiated, participatory and collaborative responses at different levels. It includes State and Non- State Actors i.e. Public Sector, Private Sector and Civil Society, to consciously adopt mitigation as a step to combat climate change. The main actor remains the Government as they develop policy from which actionable imperatives are outlined for different sectors and civil society.
- Mitigation responses are built on science, policy, knowledge, technology and finance. All these together enable mitigation responses to physical and biological impacts of climate change.

Cues for Educators

1. What is mitigation? Why is mitigation needed?
2. Who should be designing and delivering mitigation solutions?

Further Information & Resources

- Article (WWF): [What's the difference between climate mitigation and adaptation?](#)

Activities

- Group Discussion: Watch this NASA video: [How do we know the Earth is Changing?](#) Answer these questions: 1) Do we need to mitigate climate change?, 2) Why or why not? 3) Can you identify and elaborate on five mitigation responses to climate impacts?, and 4) Who should we involve in mitigation responses?

Lesson 6.2. Climate Mitigation Measures

Level: Basic

Background

- The overall aim of climate change mitigation is to sustain ecosystems so that the processes that regulate Earth's interconnected spheres are maintained. It requires that GHG emissions are cut drastically. Mitigation measures must be approached in parallel, as there is no single solution to limit global warming to 1.5 or 2°C. Mitigation measures can be categorised as follows:
 - Sustainable Energy and Sustainable Transport: Wind and sun can be sources for large amounts of low-carbon energy at competitive production costs.
 - Sustainable agriculture production and green industrial processes
 - Enhanced carbon sinks: Carbon dioxide removal (this includes carbon sequestration) by natural ecosystem or through man-made means.
 - Energy conservation (this includes efficient energy use)
- Mitigation measures include policies concerning:
 - Energy, which that can promote development and use of renewable energy, decrease production and use of fossil fuels, and reduce overall energy demand
 - Transportation, that promote fuel efficiency and active transport, such as walking and bicycling
 - Food and agriculture, that can promote sustainable practices, enhance food security, promote growth and consumption of fruits and vegetables, and decrease consumption of meat
 - Land-use, that aim to protect existing forests and promote growth of new forests
- There are also co-benefits of climate change mitigation. For example, in the transport sector, possible co-benefits of mitigation strategies include: air quality improvements, health benefits and more public transport options. The increased use of green and blue infrastructure can reduce the urban heat island effect and therefore heat stress on people. Climate change mitigation may also lead to less inequality and poverty.

Cues for Educators

1. Is it possible to mitigate climate change and if so how can mitigation be done?
2. What are some co-benefits to implementing mitigation measures?

Further Information & Resources

- Article (World Resources Institute): [International Climate Action](#)
- Article (Acciona): [Mitigation and Adaptation to Climate Change](#)
- Article (Emissions Gap Report): [Bridging the gap – the role of equitable low-carbon lifestyles](#)
- Article (World Resources Institute): [Insights on the First 29 Long-term Climate Strategies Submitted to the United Nations Framework Convention on Climate Change](#)

Activities

- **Group Discussion:** Each group takes one sector (energy, transport, oil & gas, agriculture, waste management) and identifies/assess possible mitigation measures, discusses the pros and cons of the measures including how to implement it in their areas, and identifies ways in which to engage Governments, communities and other stakeholders in the implementation of these measures. Present your results creatively.
- **Group Activity:** Explore the highest contributors (sector-wise) to GHGs, outline their impacts and discuss the following:
 1. What are the possible mitigation measures to limit global warming to 1.5 or 2 °C?
 2. How can these be implemented at a Governmental and Community level?
 3. Who are the actors to facilitate these mitigation measures?

Lesson 6.3. Mitigation Policies and Programs

Level: Basic

Background

- There have been several international agreements signed over the years to address climate change and promote mitigation efforts. To limit global warming to well below 2, preferably 1.5°C, compared to pre-industrial levels, countries came together to hold themselves accountable under the UNFCCC Paris Agreement. The agreement is a milestone of international cooperation to tackle climate change – first legally binding document in the history of climate action.
- Climate negotiations are not just an effort to mitigate climate change but also a call for international cooperation and a shared responsibility to take action to reduce emissions.
- In anticipation of the Paris Agreement, 2015, countries publicly outlined what post-2020 climate actions they intended to take under the new international agreement, known as their Intended Nationally Determined Contributions (INDCs). The climate actions communicated in these INDCs largely determine whether the world achieves the long-term goals of the Paris Agreement: to hold the increase in global average temperature to well below 2°C, to pursue efforts to limit the increase to 1.5°C, and to achieve net zero emissions in the second half of this century.
- Many Nations revised the INDCs and adopted updated ones at the Glasgow Climate Pact, aiming to turn the 2020's into a decade of climate action and support. Almost 197 Countries signed the climate pact, committing to reducing GHGs emissions and transition to a low-carbon economy. Some countries in South Asia has pledged the following:
 - India expressed its intent to intensify its climate action by presenting five elements of India's climate action through enhanced climate targets as a step towards achieving India's long term goal of reaching net-zero by 2070.
 - Pakistan intends to set a cumulative ambitious conditional target of overall 50% reduction of its projected emissions by 2030, with 15% from the country's own resources and 35% subject to provision of international grant finance that would require USD 101 billion just for energy transition. Pakistan aims to shift to 60% renewable energy, and 30% electric vehicles by 2030 and completely ban imported coal. Moreover, Pakistan seeks to expand NbS by implementation of TBTP, Recharge Pakistan, and PAI. Pakistan's emissions as per 2018 are 489.87 MtCO₂e; Billion Trees Afforestation Project (BTAP) and TBTP will sequester CO₂ around 500 Mt CO₂e by 2040, if implemented fully. Pakistan requires to strengthen its scientific and technical capacities to reach the set transition targets.
 - Nepal is among the most vulnerable countries to climate change. It is at high-risk due to the country's fragile topography, the climate-sensitive livelihoods of the people and their limited adaptive capacity. Nepal is committed to acting on climate change in line with the Paris Agreement, despite the country's negligible emissions. The Government of Nepal hereby presents its enhanced Nationally Determined Contribution (NDC) that takes into account the principle of common but differentiated responsibilities and respective capabilities, in light of national circumstances.

Cues for Educators

1. - What are the International Treaties and Climate action policies?
2. - What mandates Nations to act under these treaties?

Further Information & Resources

- Report (UNFCCC): [India's NDCs India's Updated First Nationally Determined Contribution Under Paris Agreement](#)
- Report (UNFCCC): [Pakistan's NDCs Pakistan Updated NDC 2021](#)
- Report (UNFCCC): [Nepal's NDC nepal's third national communication to the United Nations framework convention on climate change](#)
- Article (World Resource Institute): [A Framework for Describing Fairness and Ambition in Intended Nationally Determined Contributions](#)
- Article (World Resource Institute): [What is an INDC?](#)

Activities

- **Individual Activity:** Write a brief research paper related to the country in which the learners live.
1. What are the international and national climate-related treaties ratified by the country?
 2. What are the country's INDCs? Analyse whether they are meeting their targets or are on the corrective path?
 3. Analyze the barriers to meeting the INDCs.

Lesson 6.4. Private Sector Initiatives and Sustainable Business Practices

Level: Basic

Background

- Global emissions are rebounding post-pandemic and 2023 is on track to see the highest levels of CO₂ emissions in human history.
- Large numbers of companies, including consumer-facing firms such as IKEA, PepsiCo and Levi's, are also signing up to the Science-Based Targets initiative (SBTi). The Science Based Targets initiative (SBTi) mobilises companies to set science-based greenhouse gas emissions reduction targets in their operations and boost their competitive advantage in the transition to the low-carbon economy. More than 3,000 businesses and financial institutions are working with the Science-Based Targets Initiative to reduce their emissions in line with climate science. More companies have signed up in the first half of 2021 than in the whole of 2020.

The Energy Sector

- The products of just 100 private and state-owned fossil fuel companies were linked to 71% of global industrial greenhouse gas emissions since 1988. Energy consumption is by far the biggest source of human-caused greenhouse gas emissions, responsible for a whopping 75.6% worldwide.
- At least a fifth of the world's 2,000 largest public companies have now made some kind of "net zero" pledge to cancel out their carbon emissions. They are investing billions in clean energy, moving to electric vehicles, pledging to halt deforestation, and urging the Government to step up climate action. Tech companies have some of the most far-reaching goals.
- Some companies have gone much further and completely transformed their business model: Danish firm Ørsted sold its oil and gas business in 2017 and has now installed more than a quarter of the world's offshore wind capacity.

The Transport Sector

- The transport industry, responsible for around one-fifth of global CO₂ emissions, is gearing up for bolder climate pledges. GM Motors announced in January it would be carbon-neutral by 2040 and sell only zero emissions vehicles by 2035. The aviation sector, which has been slow to make climate pledges, is considering whether to set a goal of becoming net-zero by 2050.

The Agricultural Sector

- The Global Methane Pledge was launched to catalyse action to reduce methane emissions. Led by the United States and the European Union, the Pledge now has 111 country participants who together are responsible for 45% of global human-caused methane emissions. By joining the Pledge, countries commit to work together in order to collectively reduce methane emissions by at least 30% below 2020 levels by 2030.
- The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity.

- Companies and government are using the SDG framework as a roadmap to guide their climate and sustainability actions.
- The 17 SDGs are integrated – they recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.
- Climate action is a key component of the SDGs, as climate change is recognised as one of the most pressing challenges facing the world today. Specifically, SDG 13 is focused on climate action and aims to "take urgent action to combat climate change and its impacts." This includes reducing greenhouse gas emissions, promoting renewable energy, increasing climate resilience and adaptation, and mobilizing finance and technology to support climate action in developing countries. In fact, progress made towards limiting global temperature increase would significantly ease the path to many other SDGs, such as those related to poverty, hunger, access to water, and terrestrial and marine ecosystems.
- The other SDGs are also closely linked to climate action, as they address many of the root causes and consequences of climate change:
 - SDG 7 calls for access to affordable, reliable, sustainable, and modern energy for all, which is essential to reduce greenhouse gas emissions from energy use.
 - SDG 12 promotes sustainable consumption and production patterns, which can help reduce emissions and mitigate climate change.
 - SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 3 (Good Health and Well-being), are directly impacted by climate change. For example, climate change can exacerbate poverty and hunger, increase the incidence of diseases, and compromise access to clean water and sanitation.
 - SDG 6 (Clean Water and Sanitation) and SDG 7 (Affordable and Clean Energy) are also important for climate action, as access to clean water and sustainable energy sources can help to reduce greenhouse gas emissions and build resilience to the impacts of climate change.
- Addressing climate change is not only essential for achieving SDG 13 but also for realizing the broader vision of sustainable development enshrined in all the SDGs.

Cues for Educators

1. What mitigation measures are being taken by the private sector?
2. What are SBTi's? How do they apply to companies?
3. What are SDGs? Do they address climate action?

Further Information & Resources

- Article (CDP): [New report shows just 100 companies are source of over 70% of emissions](#)
- Report (IEA): [The Global Methane Pledge – Global Methane Tracker 2022](#)
- Article (UN): [Support Sustainable Development and Climate Action](#)
- Video (UN DESA): [Environmental Global Commons GSDR](#)
- [Science-based Targets Initiative](#)
- Article (IUCN): [Nature's Future, Our Future - The World Speaks](#)

Activities

Group Discussion: Post-Covid GHG emissions have reached an all time high especially from the energy sector. This is contrary to the intended mandate to reduce or limit global warming or the SDGs. Assess the damages and possible impacts of these actions - what are the possible responses at community, national and international levels? Discuss strategies to make country's INDCs a commitment which is binding and not just on paper.

Lesson 6.5. Climate Mitigation in Action

Level: Basic

Background

- With many low-lying coastal cities exposed to flood and typhoon risk, dramatic increases in heat and humidity expected across the region, and extreme precipitation forecast in some areas but drought anticipated in others, Asian societies and economies will be increasingly vulnerable to climate risk without adaptation and mitigation.
- Below are some examples of how different countries are trying to mitigate climate change:
 1. Forest conservation efforts in Meghalaya, India can claim carbon benefits: India's first pilot project recognised under the UN's mechanism for reducing emissions from deforestation and degradation (REDD) is in the East Khasi Hills in Meghalaya. A watershed project, started jointly by a California-based non-profit and a tribal community in 2005 in the northeastern state aims at checking deforestation. For the past six years Community Forestry International (CFI) has been working with the Mawphlang tribal community to preserve a sacred grove. Rich in biodiversity, the grove covers about 75 hectares in the Umiam basin's watershed area. Umiam Lake is a reservoir in the hills 15 km from Shillong. Between 2001 and 2005—the year the project started—the forest cover in East Khasi Hills decreased by 5.6 per cent. The Mawphlang tribal community has established ownership rights over forest resources. Madhu Sarin, a forest rights activist, is skeptical. She asks, "In projects such as this how much control will communities retain when entering a fundamentally complex mechanism with international stakeholders?" She warns that transferring control over projects from communities to international entities is against the principle of local empowerment.
 2. Into the Pai Forest of Pakistan: Once a natural riverine forest and a game reserve for the former rulers of Sindh, Pai Forest was cut off from its water source when a flood protection embankment was built along the river bank. Pai is now an irrigated forest, watered by the Rahib Shah Minor Canal, an offshoot of the Rohri Canal. Spread over some 4777 acres and surrounded by cultivated fields, Pai Forest supports a flourishing ecosystem. Tree species, such as the babul, kikar and kandi common to Sind's riverine forests flourish here. While these species are indigenous to Pai, other species introduced to the Forest, shisham and eucalyptus have done well too. The forest is also home to many animals including the endangered hog deer. According to him there are no more than 14 hog deer in the forest. Other than its importance as an ecological unit Pai Forest is a life support system for 21 villages situated on its periphery. Most of the people living around the Forest are poor and marginalized. Their main sources of livelihood are agriculture, forestry and fisheries and thus they are dependent upon the natural products of the forest to meet their daily requirement of food, fuel wood and earnings. Unfortunately this rich ecosystem is under enormous pressure due to a number of factors, the most pernicious of these being a chronic water shortage. Added to near drought-like conditions that have parched the Forest in recent years, Pai also faces serious threats of extinction due to encroachments by land grabbers and wood cutting by the local inhabitants. Recognizing the importance of conserving and rejuvenating this very essential ecosystem, Indus for All Programme in partnership with the Sindh Forest Department agreed on a program for the rehabilitation and restoration of the internal irrigation system of Pai Forest and habitat conservation of the same. At the same time the Programme hoped to educate the local communities and raise awareness about the importance of preserving this immensely important eco resource.

3. **Pakistan restores mangroves:** In Pakistan, the Sindh Forest Department, which oversees a “protected Forest” zone comprising 600,000 hectares of mangroves, estimates that more than 28 thousand households are located in areas neighboring mangroves. For them, mangroves provide fishing-based livelihoods, fuelwood, herd animal forage, and act as a natural barrier against natural disasters. Mangroves are also a central part of the Pakistan government’s ambitious ‘Ten Billion Tree Tsunami’ drive. Pakistan has committed to planting 10 billion trees by 2023. Millions, if not billions, of these trees will be mangroves. “Mangroves are an important tool in the fight against climate change. They reduce carbon in the atmosphere and they also make financial sense. Restoring mangroves is five times more cost effective than building ‘gray infrastructure’ such as flood walls, which also don’t help with climate change,” said Makkio Yashiro, regional ecosystems coordinator for UNEP. But mangroves are under threat. Climate change, logging, agriculture, aquaculture, pollution and coastal development are all eroding their habitats. UNEP and partners found that over 67% of mangroves have been lost or degraded to date.
4. **Reviving Nepal’s community forestry success story:** After restoring forest cover, Nepal should now prioritise harvesting and regeneration of forests to raise living standards. Nepal’s community forestry success story has been praised internationally. Other developing countries have tried to emulate it, and in November even The New York Times noticed this success, running a story titled ‘How Nepal Grew Back Its Forests’. Large swaths of national forest land were handed to local communities, and millions of volunteers were recruited to protect and renew their local forests, an effort that has earned praise from environmentalists around the world. Emerging issues including increased wildlife and rural migration. No one attends the meetings for the community forest anymore. The forest has become a jungle of weeds and unwanted shrubs, increasing the risk of fire, a community forestry leader in Kavre said. Twenty years ago, people used to pay for small tree branches and even leaves, but today, people are not interested in receiving any forest products even when I offer free delivery. In another community forest in Kavre, mature trees had fallen and were lying on the forest floor, left there for months or perhaps even years.
- There are several barriers that need to be overcome for effective mitigation. To overcome these barriers, a coordinated and collaborative effort is needed from all stakeholders, including government, businesses, civil society, and individuals. Education and awareness-raising campaigns can help to address social and cultural barriers, while financial incentives and regulatory frameworks can help to overcome political and financial barriers. Technological barriers can be addressed through research and development, and institutional barriers can be overcome through collaboration and coordination among stakeholders.

Cues for Educators

1. How can we see mitigation being implemented at State levels?
2. Do we need to lobby for better and more effective mitigation strategies?
3. What are the barriers to mitigation and how do we strategise to overcome them?

Further Information & Resources

- Video (WWF International): [How to Save Our Planet](#)
- Video (Connect4Climate): [Time #ForNature, A Collective Poem](#)
- Video (350.org): [Because the World Needs to Know](#)
- Video (McKinsey & Company): [Future of Asia](#)

MODULE 7

LIVING WITH CLIMATE CHANGE

Subjects Covered	Module Teaching Time	Skills Developed	
<ul style="list-style-type: none">• Biological Sciences• Social Sciences• Governance	4 hours	<ul style="list-style-type: none">• Research• Critical Thinking• Logical Thinking	
	Average Lesson Time		
	45 mins		

Learning Objectives

The objective of this module is to engage and empower learners to understand the relation between climate change and the need to build resilience, discover coping and adaptation strategies and develop campaign tools to advocate for better strategies to live with climate change. Through this module learners will gain a deeper understanding of the:

1. strategies for mitigating,
2. differences between mitigation and adapting to its impacts,
3. importance of equity and justice in addressing these challenges

Lesson 7.1. Introduction to Climate Resilience

Level: Basic

Background

- Human beings have been adapting to the variable climate around them for centuries by developing practices, cultures and livelihoods suited to local conditions. However, climate change raises the possibility that societies will experience climatic shifts (in temperature, storm frequency, flooding and other factors) that previous experience has not prepared them for.
- There are two main responses to climate change – mitigation and adaptation. Mitigation addresses the root causes by reducing greenhouse gas emissions, while adaptation seeks to lower the risks posed by the consequences of climatic changes. Both approaches are necessary, because even if emissions are dramatically decreased in the next decade, adaptation will still be needed to deal with the global changes that have already been set in motion.
- Resilience is the ability to cope with adverse shocks and stresses, and to adapt and learn to live with changes and uncertainty. It is the 'ability to resist, recover from, or adapt to the effects of shocks or change'. Resilience is a long-term approach, not only focussed on the ability to bounce back but also integrating adaptation and transformation while undergoing change. Resilience has been defined in various ways by combining keywords such as ability, mitigation, adaptation, recovery, shocks, stresses, address risks, vulnerability, but most of the elements have been identified and are comparable.
- Resilience seeks to reduce the risks posed by climate changes, and to benefit from any associated opportunities where possible. It can be understood as:
 - Capacity to withstand or absorb from sudden or chronic shocks = resistance
 -
 - Capacity to cope with temporary disruption while minimize the damages and costs from hazard = preparedness
 -
 - Capacity to restore or bounce back after an event = recovery
 -
 - Capacity to manage or maintain basic functions and structures to become suitable for future situation = adaptation
 -
 - Capacity to create opportunities to change the abilities to take advantage of an adverse situation = transformation
- Climate Resilience takes place at multi-level involving individual, household, community, system and/or society. Individuals, households and communities are the first actors to be affected or those that do not have sufficient resources to cope with climate shocks. Resilience means to empower communities to use their own resources and strengthen their capacity to deal with shocks and stresses, rather than focussing on their vulnerability or their needs during an emergency.

Cues for Educators

1. What is meant by climate resilience?
2. Why do we need to build individual and community resilience?

Lesson 7.2. Climate Resilience Strategies

Level: Basic

Background

- Adapting to climate change will entail adjustments and changes at every level – from the individual, to community to national and international. All climate interventions need an agency lens, i.e. as vehicles for expanding people’s range of choice on how to adapt by assessing their choices, not simply as delivering a given infrastructure or technology.
- There are three ways to build resilience - absorptive, adaptive and transformative capacities. These three capacities need to be enhanced to achieve resilient outcomes, that is, the realisation of rights and wellbeing in spite of climate related shocks, stresses and uncertainty.
- Outcomes indicative of strengthening absorptive capacities include:
 - Early warning systems are in place and functioning giving people, communities, authorities and institutions timely and relevant information about shocks such as storm surges, tsunamis, cyclones, droughts enabling appropriate action to be taken by people and authorities to reduce the impact of anticipated shocks.
 - Structures and systems are in place and are protecting natural capital e.g. mangroves, forests, reefs and soils and physical capital such houses, shelters, roads, and water systems inclusive networks of family, neighbours, friends, and community groups are maintaining social capital.
 - Social protection schemes (particularly those focussed on insurance), and safe mechanisms of remittance transfer are protecting assets and maintaining financial capital.
 - Health and education systems and access to nutrition and support for psycho-social wellbeing are in place and protecting human capital
 - Disaster risk reduction laws, policy frameworks and well resourced contingency plans are in place and are enabling communities, private sector actors and authorities to function effectively and collaboratively in post shock situations.
- Outcomes indicative of strengthening adaptive capacities include:
 - Natural resources including land, soil and water are being used in ways that are inclusive, sustainable and adaptive to climate change.
 - Platforms are in place and bring together women and men and different stakeholders, public and private, to make forward looking decisions, and learn from experiments involving new ideas and approaches.
 - Enhanced and inclusive access to productive resources including credit, markets, livestock, and linkages to input suppliers.
 - Social networks are accessible, equitable and innovative and have strong and diverse participation (e.g. self-help groups, savings groups).
 - Incremental technological and social innovations are being adopted such as new seed varieties, agricultural practices, ICTs, enterprise developments and new forms of partnerships.

- Legal and policy frameworks that support institutions to adapt and continue to provide services under changing conditions are in place and informing practice.
- Outcomes indicative of strengthening transformative capacities include:
 - Women and men are making conscious changes to gender based power structures at the household, community and institutional level.
 - Individuals, civil society and institutions are engaged in long term processes of change that address root causes of climate change.
 - Women and men, groups and institutions who have previously been in conflict are working collaboratively together for example through processes in the shared management of natural resources.
 - People are collectively generating, describing and working towards plausible scenarios of sustainable and just futures.
 - People who have limited formal power are engaging fully and with dignity in decision-making processes that result in new laws and policy frameworks or ways of managing or organising.
 - The lived experience of poor and vulnerable women and men are generating knowledge and shaping new ways of thinking and acting.
 - Development and persistence of inclusive forms of governance that for example redistribute benefits, give more equal access to resources or allow people living in poverty to fully participate in the design, monitoring and accountability of policy processes.

Cues for Educators

1. Is it possible to live with climate change?
2. What are some ways in which individuals and communities can cope with climate impacts?

Further Information & Resources

- Video (GIZ): [Climate Change Adaptation: it's time for decisions now](#)
- Video (Henrik Kniberg): [Friendly Guide to Climate Change - and what you can do to help](#)

Activities

- **Mock Panel Discussion:** Watch the following video - [Nurturing a Forest: How SHGs in Puri scaled nature-based solutions against climate risks | CEEW](#) or read the following case study.

The Mountain Institute (TMI), as part of High Mountains Adaptation Partnership (HIMAP), played a major role in the designing, partnering, and initiating a Local Adaptation Plan for Action (LAPA) for the Khumbu Valley. The key steps undertaken by them include:

- a. Expanding linkages with local communities and civil society organizations, as well as with local and national government agencies and entities (e.g., Department of National Park and Wildlife Conservation, Buffer Zone Management Committee, Sagarmatha Pollution Control Committee, etc.) as a means of enabling, supporting, and facilitating the LAPA production for the Khumbu.

- b. Facilitating community consultations; follow-up on meetings with stakeholders in Kathmandu; and LAPA introductory and climate change impact assessments in communities in the valley.
- c. Facilitating final community consultations; adaptation prioritisation, funding source identification, and intervention mainstreaming workshops.

The project integrated three components designed to enhance the utility and sustainability. They include:

- i. assisting stakeholders in the identification of prospective funding sources for each of the priority climate change adaptation interventions identified;
- ii. purposely mainstreaming high priority climate change adaptation interventions with district- and local-level development priorities (e.g., adding water collection systems and climate smart designs to the construction of new community buildings) and
- iii. actively leveraging co-financing for the implementation of priority climate change and risk reduction interventions (e.g., National Geographic Society alternative energy grants, UNDP/ Nepal subcontracts).

Break-out into groups Create panelists advocating for and against resilience strategy. Each panel may be broken down into groups. Time for discussions to be given to each group and a plenary should be conducted where each group can present their arguments. One person from each group needs to be selected as a judge to collectively decide in favour or against the arguments presented, keeping in mind which interventions will have the most adaptive - absorptive and transformative impact.

Lesson 7.3. Climate Resilience in Action

Level: Basic

Background

- Here are some stories of resilience strategies implemented and some of the challenges faced.
- **Tikamgarh, Madhya Pradesh, India**

When the people first learned how to seed ponds with fish fry, productivity rocketed. However upper caste landowners saw the opportunity to make money and excluded the traditional fishing communities. The communities responded. They formed cooperatives, with the help of an upper caste former civil servant whose NGO, Vikalp, played a key role in supporting their organization, and started to win back control of a few ponds. People's action persuaded the State Government to revise its fisheries policy, spelling out their rights. The government is now leasing the ponds to fishing communities rather than the upper caste landlords, at lower rates and for longer periods. And the fishers' organization, Machhuwara Sangathan, has consolidated itself and no longer needs NGOs to intercede with the authorities on its behalf. Processes of learning and innovation enabled the women and men to adopt a new technology (seeding ponds) and enhance their adaptive capacity, however existing power relations were changed and this required community members and other actors to become proactive agents of deeper social change. Social capital was extended and enhanced and new ways of organising and of influencing power enabled community members to bring about change in a higher level of the system i.e. the creation of a policy framework that recognises their rights. These processes and their results indicate that the communities' capacity to transform the causes of their exclusion has been enhanced.

Guddi Bai, from Madia village, sells fresh fish at Prithvipur market; the fish were caught from the women's pond. Twenty three of the ponds are now run by women's cooperatives and everyone agreed they are more productive, because the women take care of the fish better and the police are more worried about incidents of theft involving violence against women, so react faster when thieves try and steal their fish. The fishing communities come from the lower Kewat caste, and the deep psychological roots of caste remain. But they say they feel proud of their identity these days, celebrate the birth of their caste heroes, and both men and women stand for local elections, and win. All unthinkable until this process kicked off.

Processes of empowerment are bringing about changes in the deep structures of gender and caste, and a new sense of identity which are further enhancing the communities' capacity to transform the structural causes of exclusion. But it's not all milk and honey. The upper castes are responding in turn and seizing the fertile soil exposed when the dry season comes and the pond waters recede. Farming that land is crucial to the fishing communities in getting through the hot summer months.

Then there's the drought, now in its third year. Only about 10% of the ponds still had fish and water, and it's still two months until the monsoon comes. Incomes drop, land conflicts break out, and some people have to temporarily migrate to the cities to find casual labour to see them through.

These challenges indicate that there may be limits to the communities' absorptive and adaptive capacities that need to be addressed to strengthen their resilience over time. These questions may help prompt further action:

What actions are needed to enable the ponds to retain water during periods of drought?

What actions would increase the coping choices of households so they did not have to rely on short term migration? How can women and men better manage the impacts of migration? If cyclical, shorter term risks are not addressed, will the capacity of the communities to transform the structural causes of their exclusion break down?

And what longer term changes are needed? Is it possible for people from different castes to co-manage shared resources or mutually reinvent a more just and adaptive system for sharing resources? What changes in values, ways of organising and policy frameworks would be required?

- **Pakistan: Improved Capacity To Reduce Flooding Impacts**

Pakistan has experienced large-scale internal displacement caused by a range of natural and human-made disasters. Since 2011, a Disaster Risk Management project has been implemented to reduce morbidity and mortality risk by improving community resilience to natural disasters. More than 50,000 persons benefited from structural measures such as small-scale irrigation channels for agriculture, rehabilitation of water and sanitation facilities, retaining and flood protection walls, and hazard proof water supply schemes that mitigate the effects of floods. Furthermore, software activities, like local early warning systems, village disaster management plans, and awareness campaigns at school, strengthen the capacities of communities to be better prepared for floods, and enhance the sustainability of the project.

- **Climate Smart Agriculture: How an Ahmednagar Farmer is Adapting to Drought**

Rajendra has a small land holding and has been practising agriculture in a region where the soil is of low fertility and requires more fertilizers and water. Now, he also has to cope with erratic rains and longer, harsher summers – the impacts of climate change. “In 2005, 2007, 2013 and 2016, Maharashtra faced massive droughts. Forget agriculture; we didn’t even have water to drink. Farmers abandoned their fields and migrated to cities for work,” Rajendra says.

Being a rain-fed area, people in the region had begun cultivating traditional crops that needed less water, such as millets, horse gram, moth bean and sunflowers. However, the water shortage has become acute in the last few years with unpredictable and declining rainfall, making agriculture unviable, Rajendra says.

However, Rajendra and several other farmers have found ways to adapt to the challenges. They have taken to watershed management and efficient cropping techniques with the help of grassroots-level organisations. “We benefited greatly from watershed programs that helped prevent run-off from the hills. Gradually, the groundwater recharged, replenishing water in wells and lakes,” Rajendra says. Water availability also helped him shift to other crops, such as onion, soybean, pomegranate and papaya, which fetched more money in the market. To adapt to droughts, Rajendra has also started burying diffusers connected to existing drip lines in his pomegranate garden. During dry spells, the diffusers help to optimise water usage as they keep the soil around the roots moist. The practice is an ideal example of using traditional wisdom to build resilience against the climate crisis.

Cues for Educators

1. What are some of the ways to build resilience within communities?

Further Information & Resources

- Reading (Academia): [Coping with Climate Change - Case studies on Climate Change Mitigation](#)

MODULE 7: MITIGATING CLIMATE CHANGE

- Reading (UNICEF): [What is climate governance?](#)
- Article (UNDRR): [Hyogo Framework for Action](#)
- Readings (EPA): [Case Studies for Climate Change Adaptation](#)

Activities

- **Group Discussion:** Assess the possible risks and vulnerabilities to your community and propose simple steps towards building resilience through outlined strategies.

Lesson 7.4. Climate Justice and Equity

Level: Advanced

Background

- Climate change poses the greatest threat to those least responsible for it. Low-income and disadvantaged populations, women, racial minorities, marginalised ethnic and social groups and the elderly are affected the most. To make matters worse, these groups are already vulnerable to other deep-rooted challenges. Conversely, those who have contributed the most to climate change have much better capacity to protect themselves from its impacts.
- As the effects of climate change mount, so does the urgency to ensure equity while pursuing responses. Inadequate action will mean more lives lost, worsening inequality, mass migration and major economic disruptions. For example, low-income communities may lack the resources to relocate or rebuild after a devastating storm, while indigenous peoples may lose their traditional lands and ways of life due to sea-level rise or changes in temperature and precipitation patterns.
- **Understanding Climate Equity:** Climate equity describes a country, or world, in which no single group or community faces disadvantages in dealing with environmental hazards, disasters, or pollution. Ideally, no one should need extreme wealth or political connections to protect the well-being of their families and communities. Environmental equity is a basic human right. Climate equity is the idea that the responsibility for addressing the climate crisis should be shared fairly among all people and countries, taking into account historical and current contributions to the problem.
- **Understanding Climate Justice:** If climate equity is a basic human right, climate justice is the act of protecting that right. Climate justice is a concept that addresses the just division, fair sharing, and equitable distribution of the burdens of climate change and its mitigation and responsibilities to deal with climate change. Climate justice examines concepts such as equality, human rights, collective rights, and the historical responsibilities for climate change. Climate justice involves the actions and activism necessary to highlight inequities and level the playing field. Equity is the outcome of environmental justice. An equitable society is one in which justice has been served. They are complementary, not one in the same. Climate justice examines concepts such as equality, human rights, collective rights, and the historical responsibilities for climate change. "Justice", "fairness", and "equity" are not completely identical, but they are in the same family of related terms and are often used interchangeably in negotiations and politics.
- **The Intersection of Climate Change and Social Justice:** Climate change exacerbates existing inequalities and injustices, making it a social justice issue. Additionally, the root causes of climate change are often linked to social and economic systems that are unfair and inequitable. For example, the burning of fossil fuels for energy is a major contributor to greenhouse gas emissions that cause climate change. However, the benefits of using fossil fuels, such as access to electricity and transportation, are often enjoyed by wealthy individuals and countries, while the negative impacts, such as pollution and climate change, are borne disproportionately by the poor and marginalized.
- Addressing climate change therefore requires a focus on social justice and equity, ensuring that the most vulnerable populations are not left behind. International climate negotiations and agreements have recognised the need to promote climate justice and equity.

- The Paris Agreement, for example, recognizes the importance of equity and the differentiated responsibilities of developed and developing countries in addressing climate change. It also includes provisions for supporting adaptation in vulnerable countries and for providing financial and technological assistance to help developing countries transition to low-carbon economies.
- Also, climate justice and equity is promoted through grassroots activism and community organizing. It involves working to ensure that marginalized communities have a rallying platform at the table in decision-making processes related to climate change, advocating for policies that address the specific needs of vulnerable groups, and supporting initiatives that promote sustainable and equitable development.
- Addressing the needs of vulnerable communities is essential for achieving climate justice and equity. By doing so, we ensure that vulnerable communities are not left behind in the transition to a sustainable and just future. Some ways that climate justice and equity can be addressed for vulnerable communities:
 - Prioritise the needs of vulnerable communities in climate policies: Climate policies and actions should be designed with the needs of vulnerable communities in mind. This involves conducting assessments to identify the communities most at risk, and then target policy interventions to address their specific needs. For example, policies could focus on providing access to clean water, improving infrastructure to withstand extreme weather events, or providing financial assistance to help communities transition to sustainable livelihoods.
 - Support community-led initiatives: Communities are often the most knowledgeable about their own needs and vulnerabilities, and they should be actively involved in the decision-making process. Supporting community-led initiatives help ensure that vulnerable communities have a say in how climate policies are designed and implemented. This involves providing resources for community organizations, creating spaces for community engagement, and building partnerships between communities and government agencies.
 - Address underlying social and economic inequalities: Climate change is often linked to social and economic inequalities that disproportionately affect vulnerable communities. Addressing these underlying inequalities is crucial for achieving climate justice and equity. This involves policies that reduce poverty, increase access to education and healthcare, and promote sustainable economic development. It also involves addressing systemic racism, sexism, and other forms of discrimination that contribute to social and economic inequality.
 - Build resilience and adaptation capacity: Building resilience and adaptation capacity is key to ensure that vulnerable communities are better prepared for the impacts of climate change. This involves investing in disaster preparedness and response, promoting sustainable agriculture and land management practices, and providing education and training on climate adaptation.
 - Promoting Equity and Justice in Climate Action: To promote climate justice and equity requires a multifaceted approach that involves education and awareness-raising, support for vulnerable communities, promotion of clean energy and sustainable practices, accountability for polluters, and international cooperation. Some of the ways we can participate:
 - Raise awareness: Raising awareness through education and outreach campaigns about the linkages between climate change and social justice is essential for building support for climate action.
 - Support vulnerable communities: Supporting vulnerable communities by providing financial and technical assistance and promoting their participation in decision-making processes.

- **Promote clean energy and sustainable practices:** Transitioning to clean energy and promoting sustainable practices such as policies that promote energy efficiency and renewable energy, as well as initiatives that support sustainable agriculture and land management practices, is essential for addressing the root causes of climate change. It is important to ensure that these efforts are equitable and do not disproportionately burden vulnerable communities.
- **Hold polluters accountable:** Holding polluters accountable for their contributions by implementing regulations and policies that require polluters to pay for the damages they cause, as well as promoting transparency and accountability in the corporate sector.
- **Support international cooperation:** Climate change is a global issue that requires international cooperation to address, as it can help ensure that the burden of addressing climate change is shared fairly among nations.

Cues for Educators

1. Engage the group with conversations on who is responsible and who are the most affected.
Can a trend be analysed across this?
2. What happens if climate action is not considered from the justice and equity perspective?

Further Information & Resources

- Article (IUCN): [Climate Equity or Climate Justice? More than a question of terminology](#)
- Article (World Resource Institute): [Climate Equity](#)
- Article (RTI International): [Climate Justice and Equity](#)
- Report (UNEP): [Climate Change and Human Rights](#)

Activities

- **Group work:** Create a campaign for climate action on one specific theme. Address aspects like what is the specific target of the campaign, who are the affected parties – who are responsible – action needs to happen at which levels, who is the campaign addressed to and what does it seek to achieve. The campaign can be represented in the form of letters, postcards, audio-visuals and presentations. Bring in the community dimension if possible.

Lesson 7.5. Climate Action Opportunities

Level: Basic

Background

- Addressing climate change means building resilience and adopting both mitigation and adaptation responses. Looking only at mitigation or adaptation can be counterproductive and dangerous, especially for coastal villages, farmers, small island nations and other communities at the frontlines of climate impacts. Below are five solutions that can both curb climate change and help cope with its impacts at the same time:
- **Protect Coastal Wetlands:** Salt marshes, mangroves and seagrass are unique coastal ecosystems that serve as natural water filtration systems and marine habitats. They defend coasts against sea level rise by buffering storm surges and floodwaters, and store tons of carbon in their roots and soils. Increasing protected coastal wetlands and recovering about 40% of the ecosystem's global coverage by 2050 could mitigate one gigaton of CO₂ per year – over three years of emissions. Efforts to maintain coastal wetlands must include local communities that rely on these ecosystems for their homes and livelihoods.
- **Promote the Benefits of Sustainable Agroforestry:** With land use changes from forestry and agriculture accounting for nearly 25% of anthropogenic greenhouse gas emissions, it's clear that current land management schemes need to change. Agroforestry practices integrate diverse trees or shrubs with crops and livestock. In particular, pastures with trees can sequester five to 10 times more carbon than treeless areas of the same size. Farmers can also be more productive by growing crops and raising livestock simultaneously using significantly less land. Diversifying crops and including livestock on these lands can give farmers additional sources of income and reduce the risks to livelihoods caused by climate change and unpredictable weather. Expanding the use of this method to 554 million acres globally, could help farmers realize \$699 billion in financial gains from revenue diversification. Adding trees to farms and pastures allows farmers to diversify their income while their land absorbs more carbon.
- **Decentralize Energy Distribution:** Climate variability will negatively impact countries' electricity transmission and distribution infrastructure. At the same time, development and population growth are increasing energy demand and usage. Centralized energy systems – with large power plants and infrastructure connected over long distances – are more vulnerable to climate change since disruptions at one point in the system can affect the entire network. Decentralized systems – often powered by renewable energy, with shorter transmission lines and smaller distribution areas – are more climate-resilient. In the event of a disaster, a community with its own decentralized energy supply isn't affected by power outages in other areas. Smaller, more manageable power sources can also recover from disasters more rapidly. Low-carbon technologies such as solar panels and batteries can also provide reliable, clean energy to critical services, like hospitals in remote areas that aren't already connected to the grid or experience frequent power outages. Installing solar panels on rural health clinics like this one in Rwanda can make health services more resilient to extreme weather.
- **Secure Indigenous Peoples' Land Rights:** Indigenous and local communities manage almost 50% of land on the planet, which up to 2.5 billion people depend on for their livelihoods. These communities have practiced adaptation principles on their lands over generations, developing a deep body of traditional knowledge that can help others understand how to adapt to a changing environment. Places where indigenous people have legal rights to their land have at least two times lower deforestation rates than similar areas without secure tenure, as seen in Bolivia, Brazil and Colombia. Indigenous people and local communities have

protected forests that hold a quarter of all above-ground carbon in tropical forests. Yet these communities legally own less than one-fifth of this land. Securing indigenous peoples' rights will ensure they can hold onto their land, protect natural resources and better sustain their livelihoods in the face of climate change.

- **Improve Mass Transit:** Road transport accounts for 72% of global transportation-related emissions, a percentage which will continue to grow unless more low-carbon transportation options become available and accessible. Transportation infrastructure is also extremely vulnerable to climate change impacts like storms and extreme heat. Disruptions to the network due to extreme weather will disproportionately affect low-income people and other vulnerable urban populations who have fewer mobility options. Resilient, low-carbon mass transit addresses both challenges. Expanding urban public transportation by 40% by 2050 could decrease the projected number of cars on the road and avoid 6.6 gigatons of carbon emissions. Retrofitting and designing mass transit to withstand climate risks such as natural disasters, sea level rise or extreme heat ensures these transport options are safe and reliable in the long-term. These improvements can influence usage and better accommodate future growth. Some cities like Rome and Buenos Aires have integrated additional adaptation measures like heat-proofing buses and greening stops and routes to improve the commute experience. Increased public transportation also has the added benefits of relieving traffic congestion, reducing accidents and fatalities, and improving air quality. Improved buses and stations in Buenos Aires encourage residents to choose low-carbon public transport, even as temperatures rise.
- **Increased Engagement of Young People in Climate Action:** Action for Climate Empowerment (ACE) is a term adopted by the UN Framework Convention on Climate Change to denote work under Article 6 of the Convention and Article 12 of the Paris Agreement. The overarching goal of ACE is to empower all members of society to engage in climate action, through the six ACE elements - climate change education and public awareness, training, public participation, public access to information, and international cooperation on these issues. The world is home to 1.8 billion young people between the ages of 10 to 24 – the largest generation of young people in history. Young people are increasingly aware of the challenges and risks presented by the climate crisis and of the opportunity to achieve sustainable development brought by a solution to climate change. Young people's unprecedented mobilization around the world shows the massive power they possess to hold decision-makers accountable. Their message is clear: the older generation has failed, and it is the young who will pay in full – with their very futures. Young people are not only victims of climate change. They are also valuable contributors to climate action. They are agents of change, entrepreneurs and innovators. Whether through education, science or technology, young people are scaling up their efforts and using their skills to accelerate climate action.
 - Some ways that young people are part of climate action:
 - i. Education and awareness: Young people are agents of change by educating themselves and others about the causes and impacts of climate change. They can also raise awareness about the importance of climate action through social media, public speaking, and community events.
 - ii. Individual action: Young people take individual actions to reduce their carbon footprint, such as reducing energy consumption, using public transportation, and eating a plant-based diet. They can also encourage others to adopt sustainable practices.
 - iii. Collective action: Young people join or start climate action groups in their schools or communities to advocate for climate action. They organize rallies, marches, and other events to raise awareness and call for policy changes.
 - iv. Political engagement: Young people engage in political action by voting for candidates who prioritize climate action and holding their elected officials accountable for their climate policies.

They also contact their elected officials to express their concerns about climate change and advocate for policy changes.

- v. Innovation and entrepreneurship: Young people develop innovative solutions to address climate change, such as creating new technologies or business models that promote sustainability. They also start their own businesses or social enterprises that prioritize sustainability and climate action.
- Opportunities for Young People to Get Involved in Climate Action: As young people are increasingly recognized as important agents of change in the fight against climate change, some of the active ways in which they have the opportunity to get involved are:
 - i. Join a youth-led climate organization: There are many youth-led organizations focused on climate action, such as UNV, Fridays for Future, the Sunrise Movement, and Zero Hour. Joining one of these organizations provides opportunities to connect with like-minded individuals, participate in climate protests and events, and engage in advocacy and policy work.
 - ii. Participate in climate strikes and protests: Climate strikes and protests are a powerful way for young people to show their support for climate action and demand action from governments and other institutions. By participating in these events, young people help raise awareness about the urgency of the climate crisis and demand action from those in power.
 - iii. Get involved in local climate initiatives: Many communities have local initiatives focused on climate action, such as community gardens, sustainable transportation initiatives, and renewable energy projects. Getting involved in these initiatives provides opportunities to learn more about climate action and make a tangible difference in your own community.
 - iv. Advocate for climate action: Young people can advocate for climate action by contacting their elected officials, writing letters to the editor of their local newspaper, and engaging in social media campaigns focused on climate action. By using their voices to demand action on climate change, young people help push the issue to the forefront of public consciousness and demand action from those in power.
 - v. Educate themselves and others: Education is a crucial aspect of climate action, as it helps build awareness and understanding about the climate crisis and the need for action.

Cues for Educators

1. Why do we need sustained efforts in climate action?
2. What are some of the ways to sustain climate action?
3. Who are the stakeholders to sustain climate action?
4. What is the role of us as civil society in climate action?
5. What is the role of young people in climate action?

Further Information & Resources

- [The Climate Reality Project](#)
- [The Climate Group](#)
- International Movement: [350.org](https://www.350.org/)
- Project Drawdown: [Climate Solutions](#)

Activities

- **Group Activity:** Develop a proposal for a climate action project. Consider the challenge to address, design a goal and objectives to address the challenge, the kind of activities that need to be delivered to address the challenge, the stakeholders to involve and the budget. Also consider the sustainability of interventions - how can these activities be continued in the long term.

Lesson 7.6. Tracking the Effectiveness of Climate Actions

Level: Advanced

Background

- Young people can advocate and find ways to lobby for Governments to adopt these monitoring and measuring practices. Some ways are listed below:
 - Tracking greenhouse gas emissions: This involves monitoring emissions from various trusted sources on transportation, energy production, and agriculture, and measuring progress towards reducing those emissions over time. Young people can advocate for access to reliable information and sources; social audits for accountability, and that monitoring is done at various levels i.e. national or regional or village levels. This can provide insight into whether emissions reduction targets are being met.
 - Monitoring climate impacts: To measure the effectiveness of climate action efforts is to monitor the impacts of climate change, such as rising sea levels, more frequent and intense heat waves, and changes in precipitation patterns. By tracking these impacts, it can be assessed and determined whether adaptation efforts are keeping pace with the changing climate.
 - Assessing policy implementation: The effectiveness of climate action efforts are measured by assessing the implementation of climate policies and initiatives. This involves evaluating the effectiveness of policies such as carbon pricing, renewable energy targets, and energy efficiency standards, and identifying areas for improvement.
 - Analyzing investment flows: To measure the effectiveness of climate action efforts is to analyze investment flows in clean energy and other low-carbon technologies. By tracking the amount of investment going towards renewable energy and other low-carbon technologies, it can be assessed and determined whether there is sufficient financial support for the transition to a low-carbon economy.
 - Engaging stakeholders: Engaging stakeholders such as local communities, civil society organizations, and the private sector is also important for measuring the effectiveness of climate action efforts. By soliciting feedback and input from these groups, gaps and opportunities for improvement are identified.
 - Asking for responsible reporting: Businesses that have publicly stated their intentions to curb their emissions, whether as per compliance requirements (dictated by the Government) or voluntarily, it is a citizen's right to ask how these businesses are meeting their commitments.

Cues for Educators

1. What are some of the ways in which youth can monitor and measure the effectiveness of climate action?

Further Information & Resources

- [Climate Action Tracker \(Climate Analytics and NewClimate Institute\)](#)
- [The Annual Climate Action Monitor \(OECD\)](#)