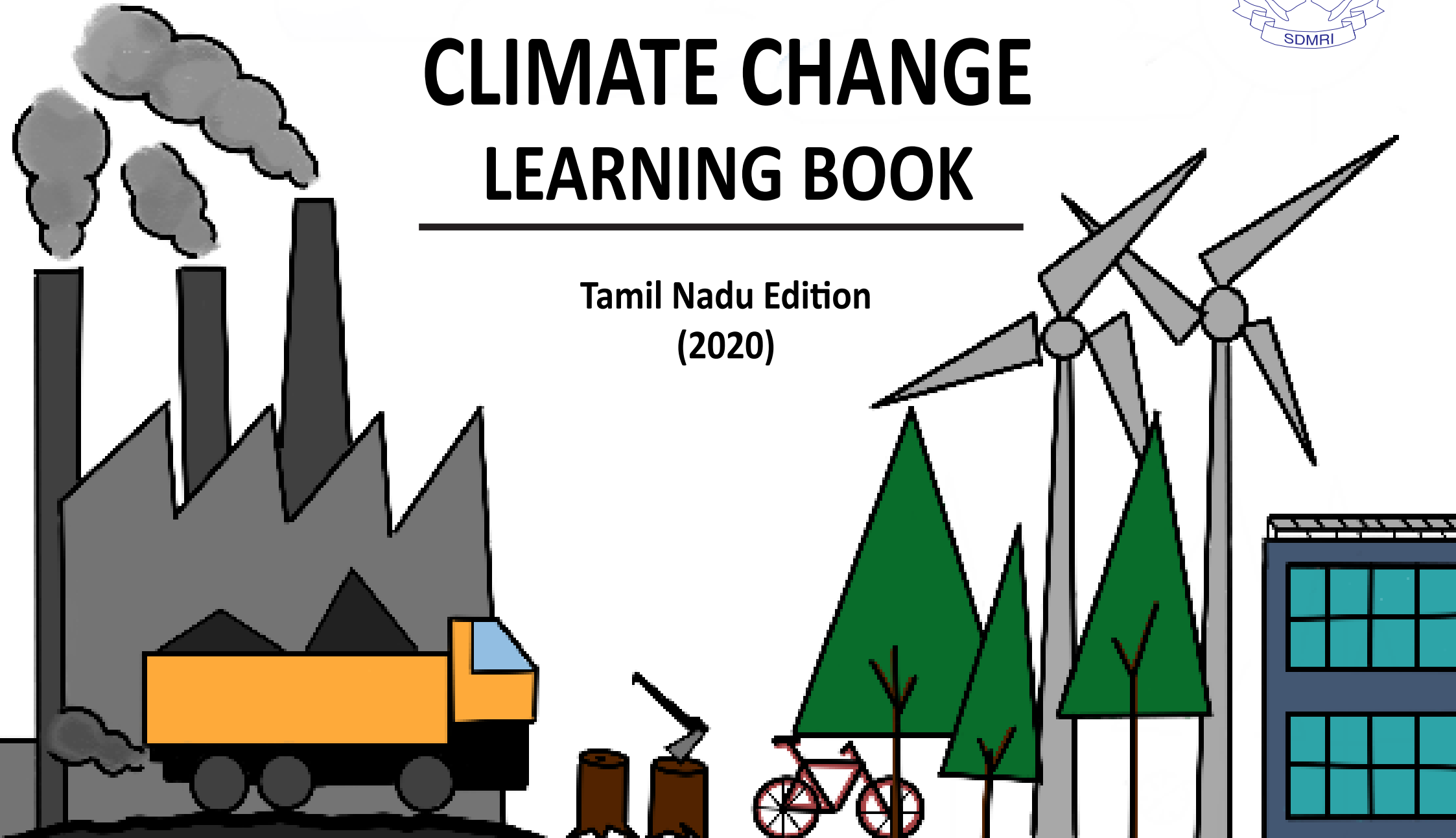
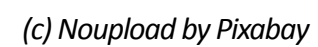


THE CLIMATE CHANGE LEARNING BOOK

Tamil Nadu Edition
(2020)





INTRODUCTION

Climate change is the defining crisis of our time and is happening far more quickly than we imagined. Children across India are growing up in an age of rising temperatures, which are fueling environmental degradation, natural disasters, weather extremes, food and water insecurity, economic disruption and conflict. Sea levels are rising, coral reefs are dying, oceans are acidifying, rivers are drying up and forests are burning. In the global fight against climate change, young people are leading the way, recognizing the urgency that generations before them failed to mobilize.

Our goal is to build a team of inspired young leaders to engage in climate conversations, and reckon with the realities of climate change in India by strengthening climate literacy across the country. Climate literacy is an understanding of our influence on the climate, and the climate's influence on us and our societies. A climate-literate student:

- Understands the essential principles of Earth's climate system
- Knows how to assess scientifically credible information about the climate
- Communicates about climate and climate change in a meaningful way
- Is able to make informed and responsible decisions with regards to actions that may affect climate

At this time, more than ever, it is imperative that education systems focus on ensuring opportunities for every child to learn well, in their community and tailored to their individual contexts. There are several challenges to this, which we have tried to address including, the limited capacity of educators to teach the complexities of climate change and the absence of contextual content with which children can relate to.

Climate change is a long-term reality. Its story is about our communities and lives. It does not impact us in the same ways, around India. We must prepare future generations to live and grow in a rapidly-changing climate and an uncertain world. This activity-based book is focused on climate change and its impacts on coastal Tamil Nadu. It will provide children with a basic understanding of climate science, and encourage them to engage in relevant discussions and undertake meaningful climate actions.

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This booklet is intended to strengthen understanding of climate change amongst children in India. It is distributed free of cost.

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PDF copies of the booklet are available online at: www.sdmri.in and www.eco-niche.org

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WHAT IS CLIMATE CHANGE?

WHAT IS THE DIFFERENCE BETWEEN THE CLIMATE & THE WEATHER?

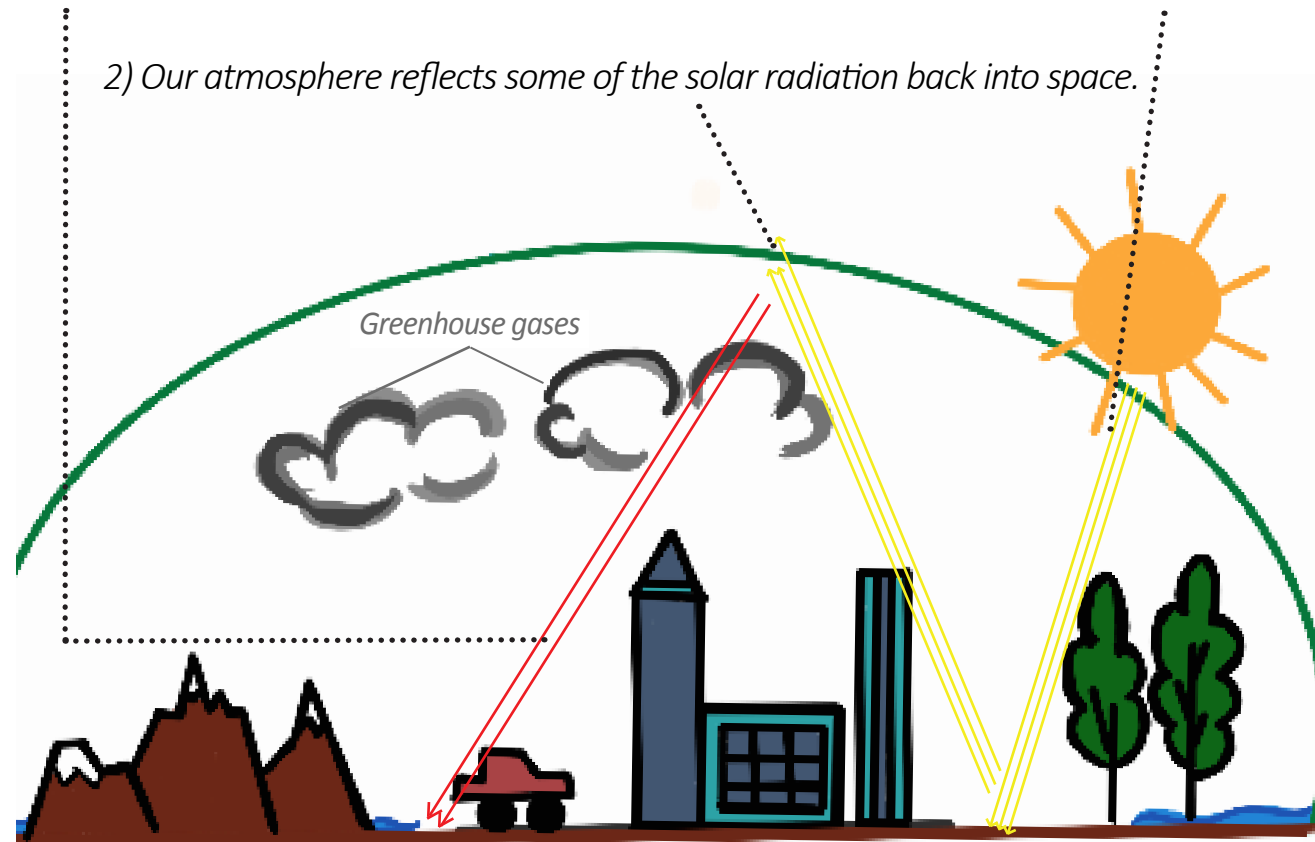
LOOK OUTSIDE YOUR WINDOW! What is the weather like today; sunny, or rainy and cloudy? **Weather refers to the short-term conditions in an area, that can quickly change (sometimes in minutes!). The climate is the average of several weather factors (like temperature, humidity and rainfall) in an area, over 30 years or more.** Climate, does not normally change quickly.

In Tamil Nadu, the climate is usually hot and humid or dry throughout the year. This does not change, even if there is some heavy rainfall and the temperature drops. We would still say that the weather is rainy, but the climate is hot.

3) Some of the rays do not return back to space because the extra GHGs trap and absorb them, causing the Earth to warm up more than normal.

1) The sun's rays pass through the atmosphere and the Earth's surfaces (earth and water) absorb the heat.

2) Our atmosphere reflects some of the solar radiation back into space.

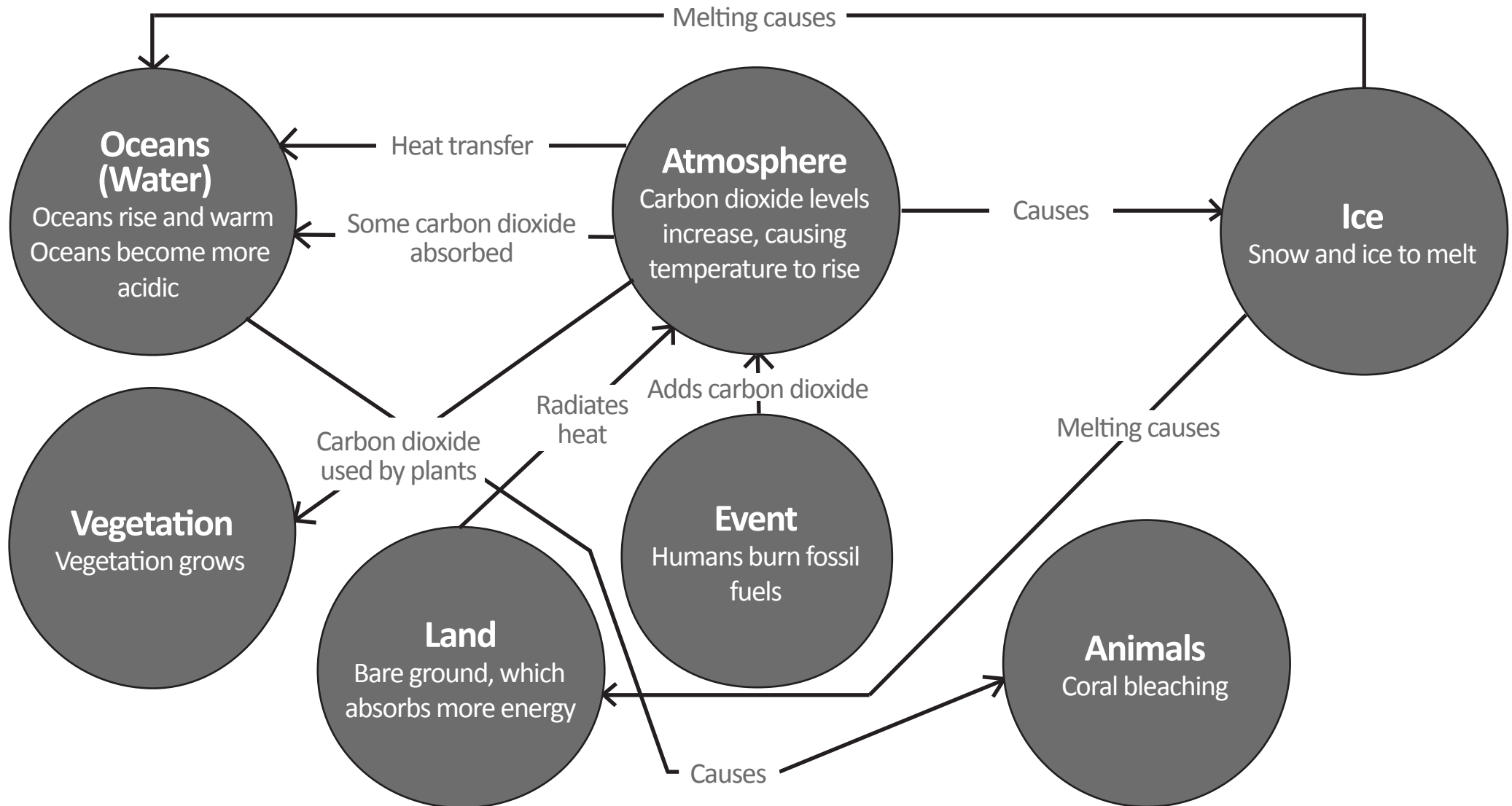


WHAT IS THE GREENHOUSE EFFECT?

Our planet's climate is stable because of green-house gases (GHGs) in our atmosphere. These gases include water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4) and nitrogen (N_2). Most of these GHGs have been around for millennia; life on Earth probably started because of them! GHGs trap some of the sun's heat - if they didn't, the earth would have an average temperature of $-15^{\circ}C$. But, the fossil fuels (coal, oil, natural gas) that we burn to create power for our homes, factories, transportation, also releases GHGs (particularly CO_2). These are added to the ones that already exist naturally. All the extra GHG traps more and more of the Sun's heat within Earth, causing an overall increase in temperature.

In the last hundred years, the planet's average temperature has been 15 - 17°C. But recently, that average has been increasing; Tamil Nadu had a rise in temperature by 0.02°C every year, from 1951 to 2000 - temperatures are now rising even more rapidly.

WHAT IS HAPPENING AS THE CLIMATE CHANGES?



CLIMATE CHANGE & OUR STRESSED OCEANS

DID YOU KNOW! The top few meters of the ocean can absorb as much heat as the Earth's entire atmosphere. Scientists believe that in the last 200 years, oceans have absorbed 33% of the CO₂ and 90% of the extra heat produced by humans, making them hotter and more acidic. Like many animals, coral polyps are sensitive to change. **If sea waters increase by even 1-2°C, for a long time, corals bleach and often die.**



WHAT IS CORAL BLEACHING?



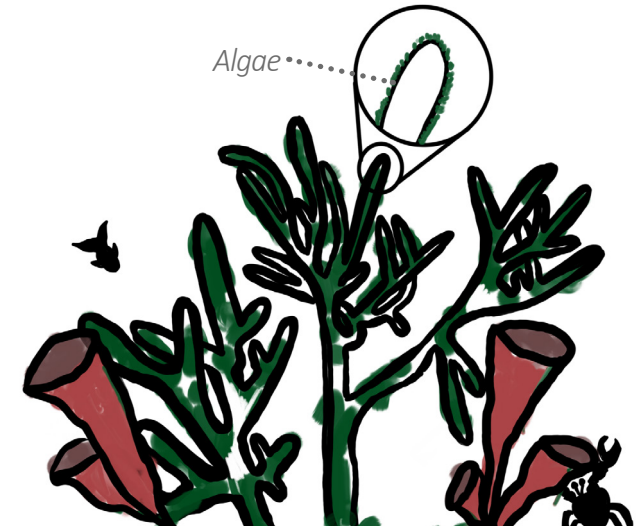
HEALTHY CORAL

Tiny photosynthetic algae, called zooxanthellae, live inside coral tissues. They give healthy corals their bright colors and make make them food.



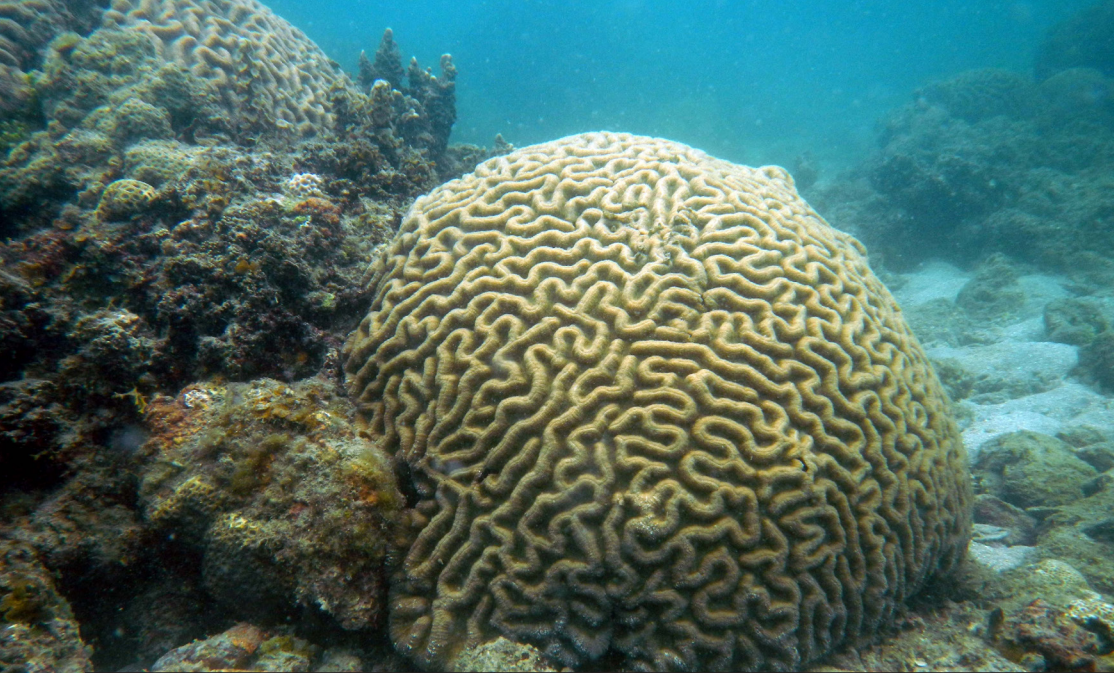
BLEACHED CORAL

When corals are stressed, they 'throw away' their zooxanthellae, and turn white in the process. If conditions improve, the zooxanthellae come back; if not, the coral dies.



DEAD CORAL

Over time, algae start to grow on the dead coral reefs, changing the habitat. New kinds of fish and other animals move into this new habitat.



The Gulf of Mannar has some of the most diverse coral reefs in South Asia, with almost 117 coral species. During huge bleaching events in 2010 and 2016, between 10 and 20% of corals were lost, as sea surface temperatures rose beyond what they could tolerate.

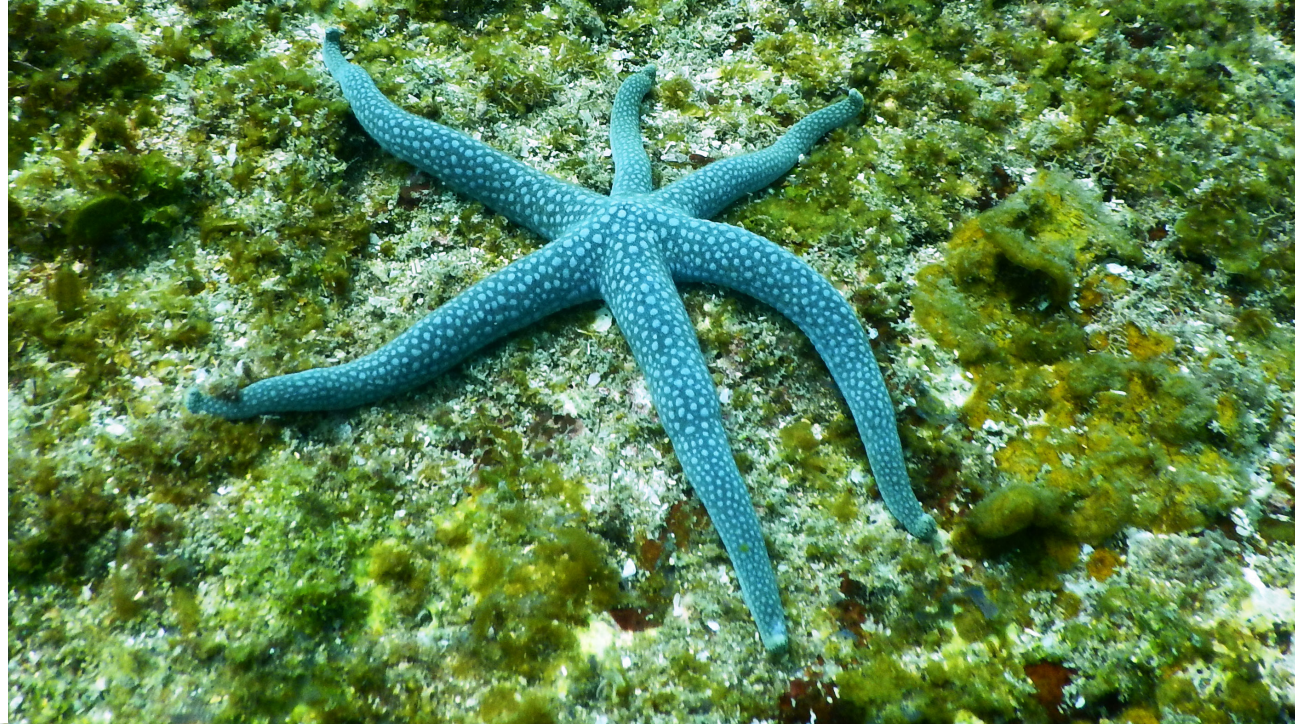
WILL ALL CORAL DIE?

Scientists think that **70 to 90% of all coral will die if sea temperatures rise by 2°C**. Coral reefs support 25% of all marine fish species; if coral die, many animal species will most likely not survive either, affecting more than 500 million people's jobs and food sources. But, scientists have found that some coral species can tolerate higher temperatures. **Certain species in the Red Sea (between Africa and Arabia), can tolerate an increase in sea water temperatures of almost 7°C.**



WHAT IS OCEAN ACIDIFICATION?

When carbon dioxide (CO₂) is absorbed by seawater, chemical reactions occur that reduce the pH of the water (making it more acidic). This in turn reduces the ability of the seawater to dissolve important calcium carbonate minerals that form the building blocks for the skeletons and shells of many marine animals, like corals and starfish. Since the beginning of the Industrial Revolution, the pH of the ocean's surface has fallen by 0.1 pH units, causing many parts of the ocean to have far less carbonate minerals than they should.



DID YOU KNOW! The Pichavaram mangroves can store up to 1.83 metric tonnes of carbon per hectare, per year. This is the same amount of carbon released by using 818 liters of diesel. The mangroves' extensive root system protected hundreds of lives and human property in Tamil Nadu, during the 2004 Indian Ocean tsunami, by reducing the force of strong winds and wave surges.



DID YOU KNOW! Seagrasses are important allies in the fight against climate. Nearly 10% of the carbon stored in the oceans is actually stored in seagrass ecosystems. The Gulf of Mannar and Palk Bay support large seagrass meadows. Seagrasses are the only (flowering) plants to live fully under water. As temperatures warm however, seagrass growth rates and other biological functions are changing, threatening these unique plants. Some animals, like dugongs, depend on seagrass completely for food.



10.06.2014

HOW ARE FISH COPING WITH CLIMATE CHANGE?

Around the world, marine animals are on the move, shifting their homes almost 10 degrees northwards, to cooler waters. **As temperatures rise, species in Tamil Nadu are responding in different ways.**

DID YOU KNOW! CO₂ is important for photosynthesis but more of it in the oceans might not help plants grow better. Imagine if you had lots of food but lived in a very hot place, with limited water and no electricity. Would you be able to survive? The answer is most likely no. This is also true for plants. They need other things to grow, like the right temperature, clean waters, and nutrients.



Scientists believe that oil sardines have shifted their habitat range by over 650 km, in less than 30 years.

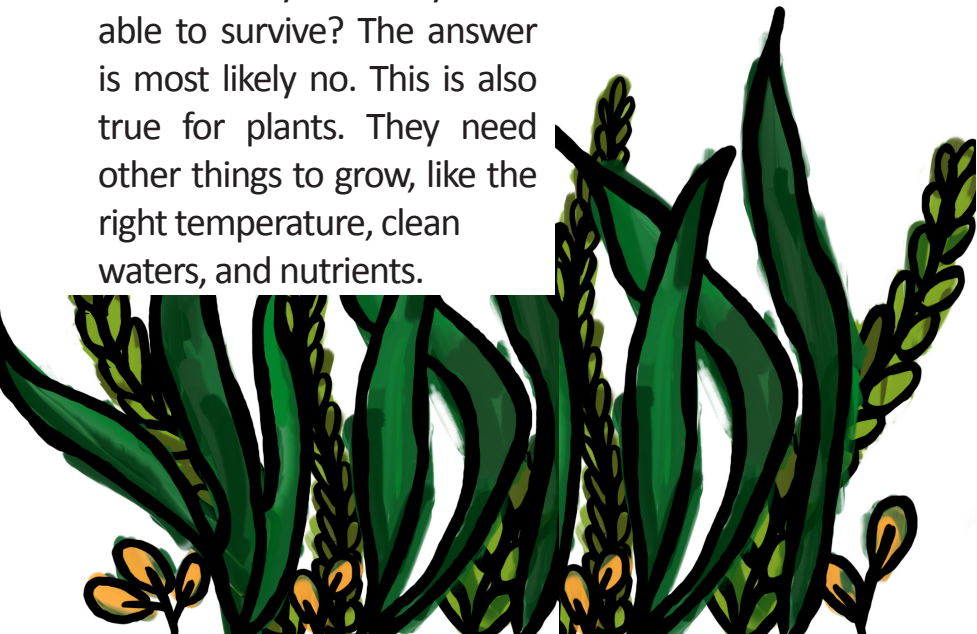
This means that they're moving up the Indian coastline at almost 20 km a year!



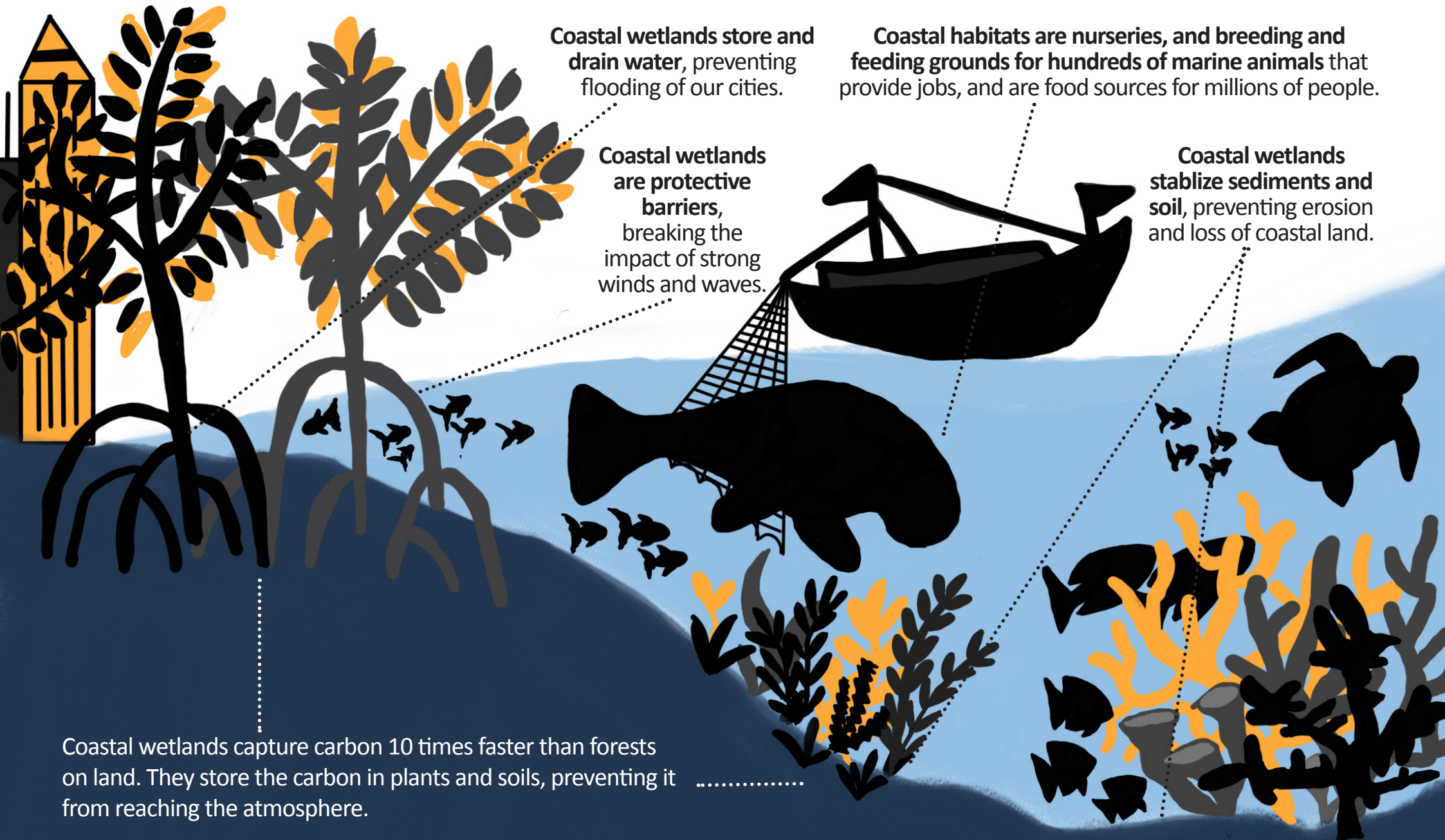
Indian Mackerel are moving deeper, to depths between 50 and 100 meters, where the water is cooler. They have even changed their diets based on the different food available at these depths.

HAVE SPECIES AROUND YOUR HOME DISAPPEARED?

Ask your grandparents, parents, teachers, fishermen and farmers!



WHY PROTECT OUR COASTAL WETLANDS?



Coastal wetlands store and drain water, preventing flooding of our cities.

Coastal habitats are nurseries, and breeding and feeding grounds for hundreds of marine animals that provide jobs, and are food sources for millions of people.

Coastal wetlands are protective barriers, breaking the impact of strong winds and waves.

Coastal wetlands stabilize sediments and soil, preventing erosion and loss of coastal land.

Coastal wetlands capture carbon 10 times faster than forests on land. They store the carbon in plants and soils, preventing it from reaching the atmosphere.

CLIMATE CHANGE & OUR TROUBLED FOOD SYSTEMS

The climate is like nature's clock. Animals depend on the climate to know when to migrate to find mates or food. Humans rely on it to know when to travel safely, how to build our homes, and most importantly, when to grow our food. What is happening now that the clock is changing?

Almost every year, farmers in India lose millions of rupees worth of food crops due to 3 impacts of climate change: rising temperatures (which means less crop growth), too little rainfall or drought (which means no crop growth in areas which depend on the rains for water), and too much rainfall (which means waterlogged soils with low-oxygen conditions - damaging and destroying crops). In addition to this, pathogens and insect populations are strongly dependent on temperature and humidity. As the climate changes, their populations might increase, resulting in crop loss!

DID YOU KNOW! Tamil Nadu has exploited nearly 80% of its water potential for irrigation.



DID YOU KNOW! Till 1970, India had about 1,10,000 varieties of rice. In the decades since then, rice cultivation practices changed considerably and we now have just 6,000 rice varieties left (that's a 94% loss). Projections for Tamil Nadu suggest that by 2100 climate change will cause a further loss of rice yields by 283 kg per hectare, every 10 years. It is expected that there will be 10% decline in rice yield by the end of the 21st century. This will lead to less rice availability and increase challenges related to hunger within Tamil Nadu, and India.



WHAT IS YOUR EVERDAY WATER FOOTPRINT?

BATHROOM		
Bathing	20 litres per bucket	<i>(multiply this by the no. of times you bathe daily)</i>
Toilet Flushing	10 litres per flush	<i>(multiply this by the no. of times you use the toilet daily)</i>
Brushing Teeth	1 litre if you turn the tap off and only use water when rinsing. More than 15 litres if you keep the water running while brushing.	<i>(multiply this by the no. of times you brush your teeth daily)</i>
Washing hands and/or face	1 litre if you keep the tap off while applying soap. 5 litres if you keep the water running while you soap.	
KITCHEN		
Drinking and Cooking	15 litres	<i>(multiply this by the no. of times meals are cooked daily)</i>
Washing dishes	15 litres	<i>(multiply this by the no. of times dishes are washed daily)</i>
DIRECT WATER CONSUMPTION PER DAY FOR THE HOUSEHOLD		
Mopping the house	5 - 10 litres depending on the size of your house	
Cleaning your car with a hose pipe	200 - 300 litres	
Cleaning your car with a bucket	20 - 60 litres	<i>(multiply this by the no. of times the bucket is filled to wash)</i>

CLIMATE CHANGE & OUR ENERGY CRISIS

For the most part of human history, our ancestors relied on very basic forms of energy: human muscle, animal muscle and burning of biomass (like wood). The Industrial revolution, in the 18th century, gave rise to the use of fossil fuels as a dominant source of energy. Today, energy is required for almost every human activity.



Energy sources are required for 2 crucial activities: power (electricity) generation and transportation. These sources of energy are broadly divided into 2 types: Non-Renewable and Renewable.

HOW DEPENDENT ARE YOU ON ELECTRICITY?

Make a list of all the items that work on electricity in your house.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

WHAT IS NON-RENEWABLE ENERGY?

Fossil fuels make up the non-renewable sources of energy. Coal, natural gas, and crude oil are considered fossil fuels. These are formed from living (plant and animal) matter that existed on Earth thousands of years ago. This plant and animal matter, buried inside the Earth's surface, decomposes over thousand of years under particular conditions, to become fossil fuels. Since they take thousands of years to form, they cannot be renewed at the same rate as they are used; this results in the depletion of the stock.



DID YOU KNOW! Almost 80% of total energy consumption globally, is still **reliant on fossil fuels**. Based on global use and existing reserves, experts believe the world has only:

- 133 years of coal left
- 52 years of natural gas left
- 47 to 50 years of oil left



Fossil fuels have a high carbon content. The burning of fossil fuels began during the Industrial Revolution and ultimately led to increased emissions of the greenhouse gases that are responsible for climate change today. The CO₂ that is released from burning fossil fuels is making the oceans more acidic, killing animals and plants. The extraction of fossil fuels also causes severe damage to natural ecosystems, like forests. With fossil fuels like crude oil, chances of spillage during transportation or due to pipes bursting, causes environmental pollution and is very expensive to clear up.

WHAT IS RENEWABLE ENERGY?

Energy obtained from the sun (solar), wind, water (hydropower, tidal and wave), heat (geothermal and organic matter) is called renewable energy. Unlike fossil fuels, renewable energy sources are available in abundance. Renewable sources of energy, like wind and solar power, don't release greenhouse gases into the atmosphere and are therefore considered *clean* or *alternative* sources of energy. However, renewable energy also comes with its own share of problems. For example, biomass energy which is produced by burning organic matter, releases greenhouse gases like CO₂ in to the atmosphere and causes air pollution. The dams built for hydroelectric power can damage natural river ecosystems, flood vast areas and farmlands, and force people to find other areas to live in.



DID YOU KNOW! Tamil Nadu receives reasonably high solar radiation with almost 300 sunny days in a year. This has inspired the state to come up with a policy to promote solar energy.



DID YOU KNOW! Tamil Nadu has been the leading wind installer in India since 2016. The Muppandal in Kanyakumari is the largest wind power plant in India.

HOW ENVIRONMENTALLY FRIENDLY IS YOUR LIFE ALREADY?

QUESTIONS	NEVER	SOMETIMES	ALWAYS
I choose the products I buy depending on if they cause the least possible damage to the environment.			
I repair broken/used stuff instead of buying new things.			
I use rechargeable batteries.			
I use public transportation when I travel long distances.			
I walk or ride a bike when I need to travel short distances.			
I use energy-saving lamps or bulbs.			
I turn lights off when not in use.			
I disconnect my electronic items when they are off.			
I turn off the tap while I brush my teeth.			
I have water-saving systems installed in my taps and toilet.			
I separate my garbage into at least two categories.			
I reuse disposable containers as much as possible.			
I prepare compost with my organic waste.			
I recycle or drop off inorganic waste for recycling.			
I help raise awareness about climate change			

*If you ticked **Always** the most - Congratulations on starting your environmentally friendly life. If you ticked **Sometimes** the most - Keep at it, you're on your way to leading an environmentally friendly life. If you ticked **Never** the most - try making a few changes in your life today!*

CLIMATE CHANGE & OUR COASTAL CITIES

WHY ARE COASTAL CITIES VULNERABLE TO CLIMATE CHANGE?

Storm drains in cities are not built to handle intense rainfall, even if they are maintained perfectly. Most are often clogged with waste.

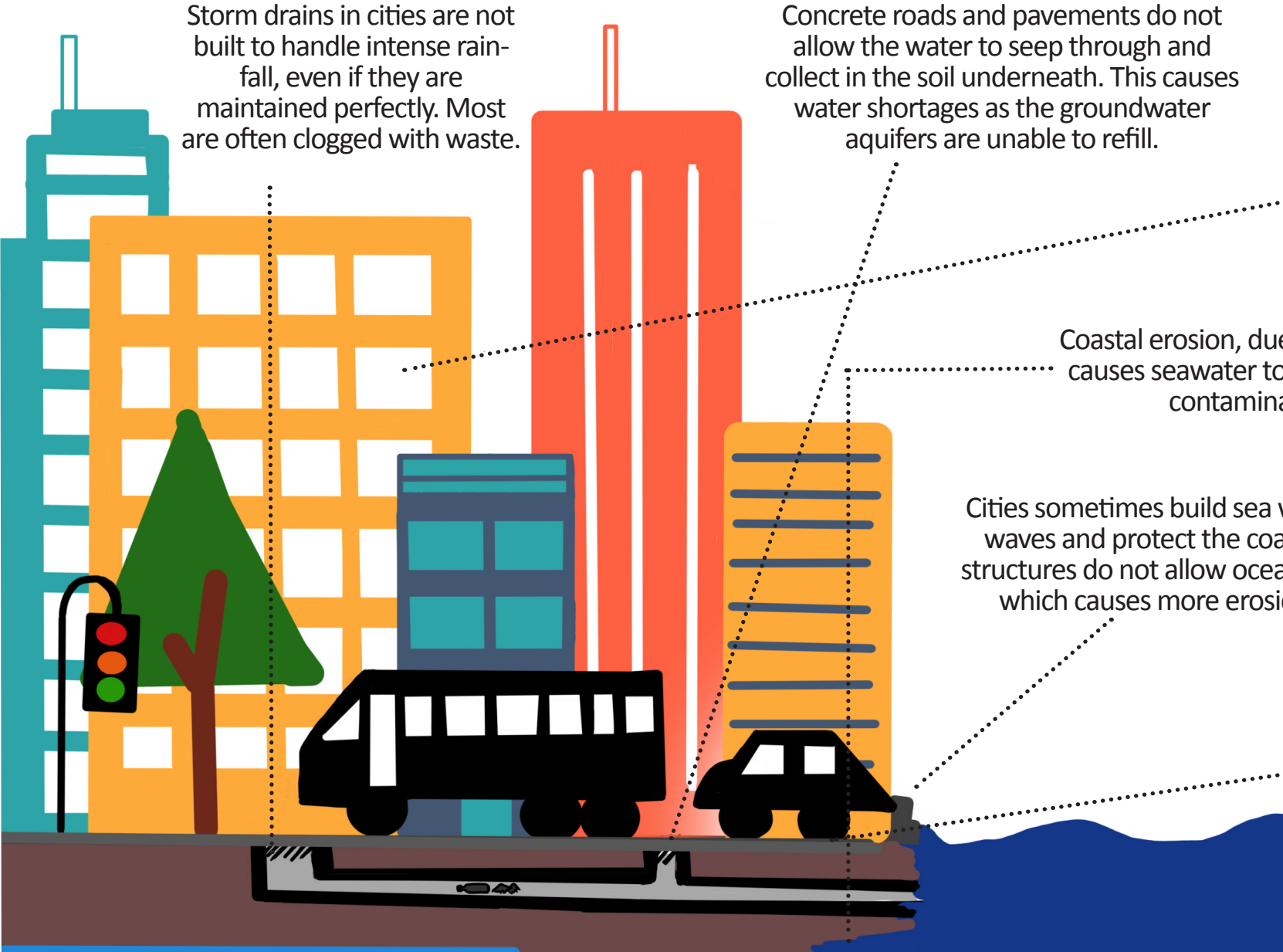
Concrete roads and pavements do not allow the water to seep through and collect in the soil underneath. This causes water shortages as the groundwater aquifers are unable to refill.

Concrete and glass buildings, transportation and use of airconditioners and other cooling items, generate a lot of heat. This heat gets trapped within cities, making them a few degrees hotter than their surrounding areas.

Coastal erosion, due to unsustainable development, causes seawater to seep into the soils on land, and contaminate freshwater sources.

Cities sometimes build sea walls to protect against strong waves and protect the coastline. However, man-made structures do not allow ocean sediments to flow naturally, which causes more erosion and loss of coastal land.

Unlike wetlands, concrete does not enable drainage and storage of water. This causes flooding because the water has nowhere else to collect.



HOW IS CHENNAI BEING AFFECTED BY CLIMATE CHANGE?

2004 - 2011

Chennai received the longest streak
... of excessive rainfall since 1870.

2015

Extreme rainfall caused flooding of 2.3
million homes in Chennai and killed 500 people.

2018

Cyclone Gaja killed 45 people in
Chennai and caused flooding.

2016 - 2017

Chennai experienced its worst drought in 140
years – it received 62% less rain than required
to meet the needs of its people, agriculture
and industries.

2018 - 2019

Chennai continued in a state of
drought and is now dependent on
tanker trucks to provide water to its
people.



HOW WILL CHENNAI BE AFFECTED BY CLIMATE CHANGE?

Scientists predict that over the next few decades, temperatures in
Chennai will increase by over 3°C.

Parameters	2020s	2050s	2080s
Maximum Temperature	+0.9°C	+1.9°C	+2.9°C
Minimum Temperature	+1.1°C	+2.2°C	+3.3°C



Like many coastal cities, Chennai faces future threats from sea
level rise. Experts estimate that by 2100, many parts of the city
will be fully under water, with over 740,000 people affected.



CLIMATE CHANGE & OUR FIGHT AGAINST IT

WHAT ARE WE DOING TO ADAPT TO AND PREVENT FURTHER CLIMATE CHANGE?

The **Paris Climate Agreement** is an international effort to keep global temperatures below 2°C. The **International Panel on Climate Change (IPCC)**, a group of scientists from around the world that provides scientific information on climate change, predicts that if global temperatures reach 2°C and beyond, critical natural ecosystems and services will fail, badly affecting human lives. India signed up to the Paris Climate Agreement in 2015, making 3 commitments to reach by 2030:

1. To reduce our GHG emissions by 33-35%
2. To ensure that 40% of our electricity is from non-fossil fuel sources
3. To increase CO₂ sinks by 2.5 to 3 billion tonnes through protection of our forests and restoration of additional tree cover

India released its first **National Action Plan on Climate Change (NAPCC)** in 2008 to meet its commitments. Many states in India, like Tamil Nadu, also have their own climate change action plans.

WHAT CAN WE DO AS INDIVIDUALS?

- **Raise our voices against the destruction of coastal wetlands and forests.** Deforestation will release all the carbon that is currently stored in the plants and soil, and prevent these ecosystems from absorbing the remaining carbon in the atmosphere.
- **Write to political leaders and decision-makers** to take action against climate change.
- **Raise awareness about climate change and the impacts it is already having** on nature and people, in our homes and schools, amongst families and friends.
- **Support those working to prevent climate change and consider pursuing green careers that help protect our planet from environmental challenges.**



WHAT WILL YOU DO TO HELP PREVENT FURTHER CLIMATE CHANGE?



DID YOU KNOW! In 2018, India was declared the 12th most vulnerable country to the impacts of climate change. **FridaysForFuture India** is a people's movement, fighting for ethical implementation of our National Action Plan for Climate Change (NAPCC), so that all those affected by climate change get the support they need. This movement was born after the global climate movement, FridaysForFuture, that started in August 2018, when (then) 15-year-old Greta Thunberg (a Swedish high school student) began a school strike for climate. List some of the things you can do to help prevent and prepare for the impacts of climate change.

THE CLIMATE ALPHABET SOUP

Match these climate-change related terms with their definitions!

1) CARBON FOOTPRINT

A. The ability of a society or a natural system to adjust to the (changing) conditions, including weather extremes, that support life in a region.

2) GREEN HOUSE EFFECT

B. Materials that come from old life forms that decomposed over a long period of time, like coal, petroleum, and natural gas, that can produce energy.

3) OCEAN ACIDIFICATION

C. A process that occurs when gases in Earth's atmosphere trap the Sun's heat.

4) FOSSIL FUELS

D. A reduction in the pH of the ocean over a long period of time, caused mainly by the absorption of carbon dioxide (CO₂) from the atmosphere.

5) SEA LEVEL RISE

E. The Intergovernmental Panel on Climate Change (IPCC) is a global group of scientists dedicated to providing information relevant to understanding climate change.

6) RENEWABLE ENERGY

F. The long-term heating of Earth's climate system due to human activities, mainly fossil fuel burning, which increases heat-trapping greenhouse gases in Earth's atmosphere.

7) CLIMATE MITIGATION

G. The amount of CO₂ released into the atmosphere because of one's own energy needs.

8) CLIMATE ADAPTATION

H. Energy from sources that are naturally replenishing, and almost inexhaustible over time but limited in the amount of energy that is available per unit of time.

9) GLOBAL WARMING

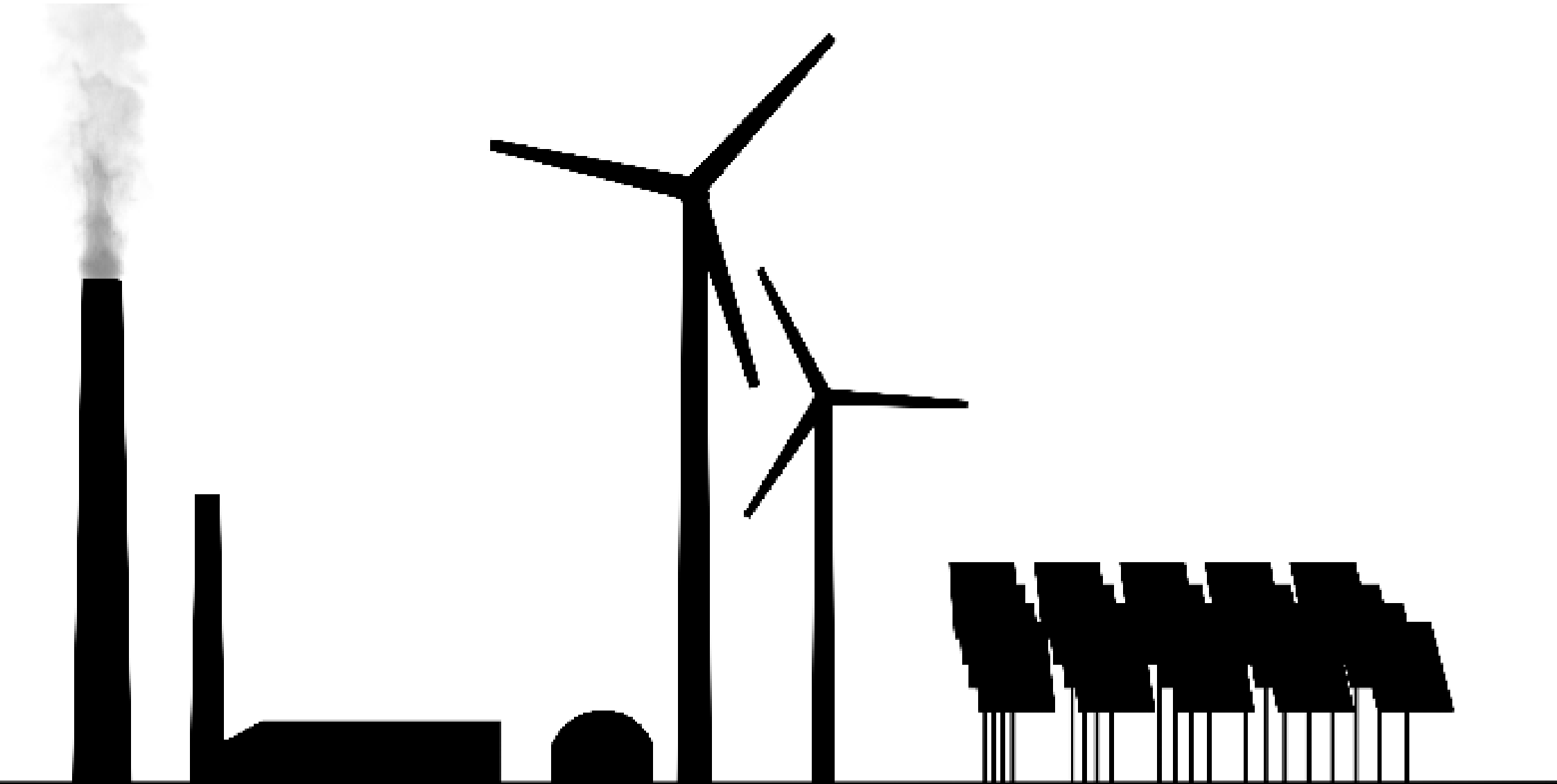
I. An increase in the level of the world's oceans due to the effects of global warming.

10) IPCC

J. Actions to reduce the rate and intensity of global warming and its impacts. This generally involves reductions in human emissions of greenhouse gases (GHGs).

ANSWERS TO THE CLIMATE ALPHABET SOUP

1) G.; 2) C.; 3) D.; 4) B.; 5) I.; 6) H.; 7) J. ; 8) A.; 9) F.; 10) E.



ABOUT SDMRI

The Suganthi Devadason Marine Research Institute (SDMRI) is a marine research and higher education organization, established in 1998, in Tuticorin, Tamil Nadu, India. SDMRI aims to meet the research needs of coastal and marine ecosystems in India; to promote higher education in marine sciences; to enhance societal involvement in marine resource conservation, and to assist coastal communities in improving their socio-economic conditions.

SDMRI undertakes ecosystem assessments, monitoring, rehabilitation, capacity building and awareness creation.

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ABOUT ECONICHE

EcoNiche is a conservation consultancy, based in Goa, India. With a mission to catalyse positive and large-scale conservation change across the country, EcoNiche works with partners to collaboratively develop evidence-informed, equitable, inclusive and sustainable actions to address challenges facing our natural environment. EcoNiche provides guidance and support to produce, synthesise and assess what works, how, for whom and at what cost.

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