KLIMAALAM

STEP UP AND STEP IN TO ACT ON CLIMATE

Written by
Raissa Rivera Falgui

Illustrated by
Harry Monzon

This book belongs to

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Written by
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Adarna House

Oscar M. Lopez Center

Science for Climate Resilient Communities

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Illustrated by Harry Monzon

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For comments and suggestions,
you may email Oscar M. Lopez Center
at info@omlopezcenter.org.

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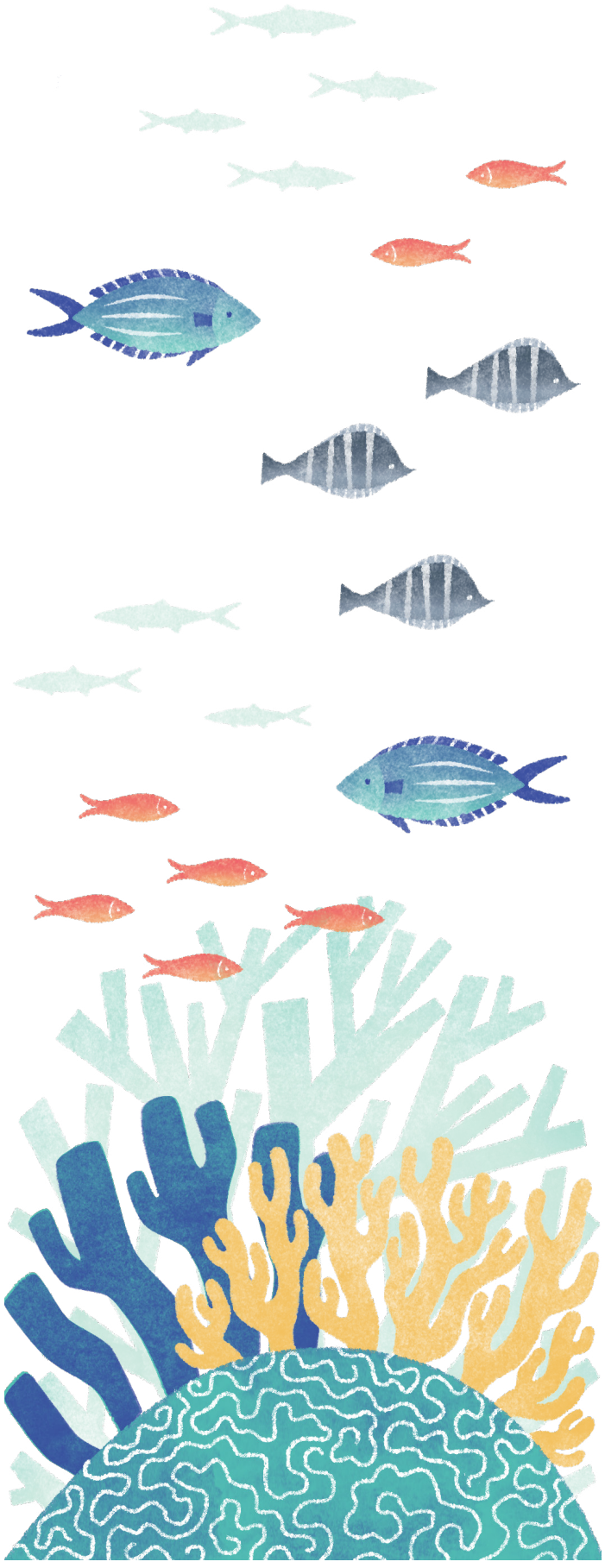


INTRODUCTION FOR TEACHERS AND PARENTS

Why teach climate change?

Living in one of the most vulnerable countries to climate change, young Filipinos are familiar with its impacts—from the threats of flooding and supercharged tropical cyclones in the rainy season to the dangers of extreme heat during the summer months. Their particular experience may take the form of suspension of classes, getting caught in the rain without umbrellas or raincoats, or flooding in the home.

But there is more to climate resilience than just coping with too much or too little rain.

With further temperature increase already locked in for the coming decades, younger generations will disproportionately experience the worst effects of climate change. To adapt to and evolve with the changing climate, young Filipinos must not only be encouraged to participate in constructive conversations, but also become an active part of the solution. The youth have the agency to act now to ensure the healthy and livable future that they deserve through the different decisions they make every day.

The Oscar M. Lopez Center, in collaboration with Adarna House, developed this book with a focus on illustrating practical and relatable ways that climate change affects young Filipinos. The book aims to provide readers not only with the science of climate change, but also examples of how climate change interacts with human and natural systems, and how readers can become agents of change in their schools, households, and communities.

While there are chapters devoted to scenarios for coastal, farming, and urban communities, the book is relevant to all Filipino students regardless of the type of community they live in. Readers are provided with key questions to help them localize and concretize climate impacts in their communities and with the opportunity to learn more about different types of solutions and actions that they can take.

The book also recognizes the importance of education in making Filipinos more climate resilient. Content development was guided by relevant Most Essential Learning Competencies (MELCs) identified by the Philippine Department of Education for Filipino students in Grades 7–10. Thus, teachers may use the content and activities in this book as a supplement to classroom learning. Activities are implementable whether students are in the classroom or in remote learning.

Because the impacts of climate change are complex and systemic, this book intentionally prioritized the framing of the content in the following manner:

- Climate change issues are environmental issues, but not all environmental issues are due to climate change.
- The book includes information on how human activity contributes to climate change, but the content dwells more on helping readers identify their risks and take appropriate action to their identified risks.
- While both adaptation and mitigation strategies are important to climate action, the book focuses more on framing issues from the perspective of adaptation.
- Climate change cannot be discussed without risks, including extreme events. However, because climate change refers to long-term risks and impacts, discussions and activities are focused more on longer-term preparedness measures.

- All activities are structured so that found, recycled, or upcycled objects can be used.

We hope that the discussions and activities allow young Filipinos to build on their learning and understanding of climate change concepts. By providing room for localization of lessons and a more experiential way of appreciating climate variables and issues, we hope that it encourages students to become valuable contributors to climate action in their families and communities.

Young Filipinos are primed for climate action. Providing them with knowledge, skills, and opportunities to learn about climate impacts, to assess the risks in their local realities, and to take appropriate action, enables them to contribute positively to the safety and resilience of their families and communities.

What is this book and who is it for?

Klimaalam: Step Up and Step In to Act on Climate is a supplementary learning resource designed to support Filipino students in Grades 7–10 in:

- Understanding what is climate change, and its connections with systems and people.
- Investigating what are the local climate risks that exist in their communities.
- Discovering different kinds of actions that can be taken to adapt to and evolve with these climate risks.

Where can it be used?

This book can be used in different learning environments and for various subjects, and its contents tailored to be made more applicable to local realities.

- **At home**—supported by older siblings, parents, grandparents, and caregivers
- **At school**—integrated to Araling Panlipunan, Science, Math, Health, Art, or English lessons, or set as homework
- **At student science clubs**

How can adults support young students using this book?

We acknowledge that students' learning journeys are unique and they may need support as they go through this book. Teachers, parents, older siblings, and other carers can support students through:

- Reading assistance
- Supervision of activities
- Supporting students interested in reaching out to others with their call for climate action

Klimaalam: Step Up and Step In to Act on Climate benefits from the involvement of chapter partners—established organizations in the Philippine climate change space whose inputs helped develop and strengthen content. Save Philippine Seas's inputs to Chapter 3: Life Along the Coasts helped ground and illustrate how the country, particularly its coastal communities, are affected by global heating's impact on oceans. The Institute for Climate and Sustainable Cities (ICSC), through The Agam Agenda, helped surface how development in urban areas can be healthier and more sustainable in Chapter 4: Life in Urban Areas. The Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) laid out the crucial interactions between agriculture and climate change in Chapter 5: Life in Rural Areas. The Climate Reality Project Philippines's extensive experience of working with Pinoy Climate Reality Leaders is evident in their practical and useful contributions to Chapter 7: Adaptation and Mitigation in the Home.

FOR STUDENTS

Climate change is an intensifying threat in our lives. Already, we know what it is like for our daily schedules to be under the influence of the changing climate—from water rationing during particularly dry summer months to avoiding flooded areas on days of strong rain despite no typhoon signals.

As students, you may think that you have very little power to fight against climate change, but that is not true. All over the world, young people like you, are actively taking part and leading public conversations, climate solutions in their communities, and demand for appropriate action from government, companies, and other sectors.

It is in recognition of young people's power to create the future you deserve that the Oscar M. Lopez Center, in collaboration with Adarna House, developed this book. ***Klimaalam: Step Up and Step In to Act on Climate*** aims to provide not only scientific and technical information, but also examples of how climate change is actually affecting you and your communities, and more importantly, how you can become agents of change.

This book is relevant to all young Filipinos, regardless of where you are located and what type of community you live in. Key questions are provided to help you recognize and observe how climate change specifically impacts you and to provide you with practical and relatable ways to discover what actions you can take.

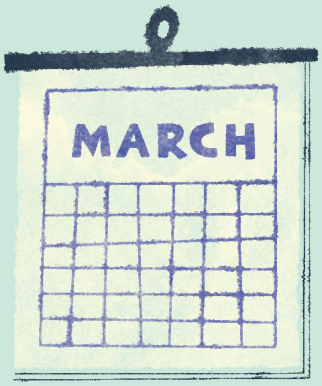
In support of your climate awareness and action journey, this book is anchored on DepEd's Most Essential Learning Competencies (MELCs). It may be used as a supplement to your regular classroom learning resources. Activities outlined in the book may also be used as projects for your science or environment student clubs.

There are, however, some limitations to the content of this book. Because the impacts of climate change are complex and systemic, this book is strategically developed in the following manner:

- Climate change issues are environmental issues, but not all environmental issues are due to climate change.
- Human activity is a major contributor to climate change, but this book focuses more on helping you identify your climate vulnerabilities and taking action based on your identified vulnerabilities.
- We have included different options for action, but this book emphasizes taking action from the perspective of climate adaptation.
- Disasters and extreme events are part of climate risks. This book, however, highlights long-term preparedness to meet climate change's long-term risks and impacts.
- All activities are structured so that found, recycled, or upcycled materials can be used. Activities may also be done at home or in school.

As Greta Thunberg, who rose to worldwide prominence after challenging world leaders to act on climate change at 16, once said during her speech at the Youth4Climate summit last September 2021, "We can no longer let the people in power decide what is politically possible. We can no longer let the people in power decide what hope is. Hope is not passive. Hope is not blah, blah, blah. Hope is telling the truth. Hope is taking action. And hope always comes from the people."

We hope that ***Klimaalam: Step Up and Step In to Act on Climate*** spurs your climate awareness and action journey. If this book inspires you to take action on climate change in your homes and communities, we hope you will share it with other young Filipinos like you.



CHAPTER 1

WHAT IS CLIMATE CHANGE

What's the weather like where you are? Do you think the weather lately has been normal or unusual?

We expect certain weather patterns in a place after it has happened frequently over the years. The expression "as unpredictable as weather" came about because we can never be sure when the weather will divert from this pattern. For example, there are still a few rainy days during the hottest, driest seasons. It's hard to accurately predict when they'll occur.

These occurring weather patterns allow us to determine the climate, as climate is based on averages over many years.

The random nature of weather is a minor inconvenience that we've all learned to live with. It becomes a problem, though, when the changes in patterns become extreme. We and our environment can experience serious consequences when the weather is too often different from what we expect and have gotten used to. This phenomenon is known as **climate change**.

WE'RE ALL IN THIS TOGETHER: CLIMATE CHANGE IN OUR WORLD

Climate change seems like a trendy new phrase for a recent discovery. But actually, for over 650,000 years now, the Earth's climate has been changing. We know this through observations of the layers of ice cores and tree rings that have developed over many years.

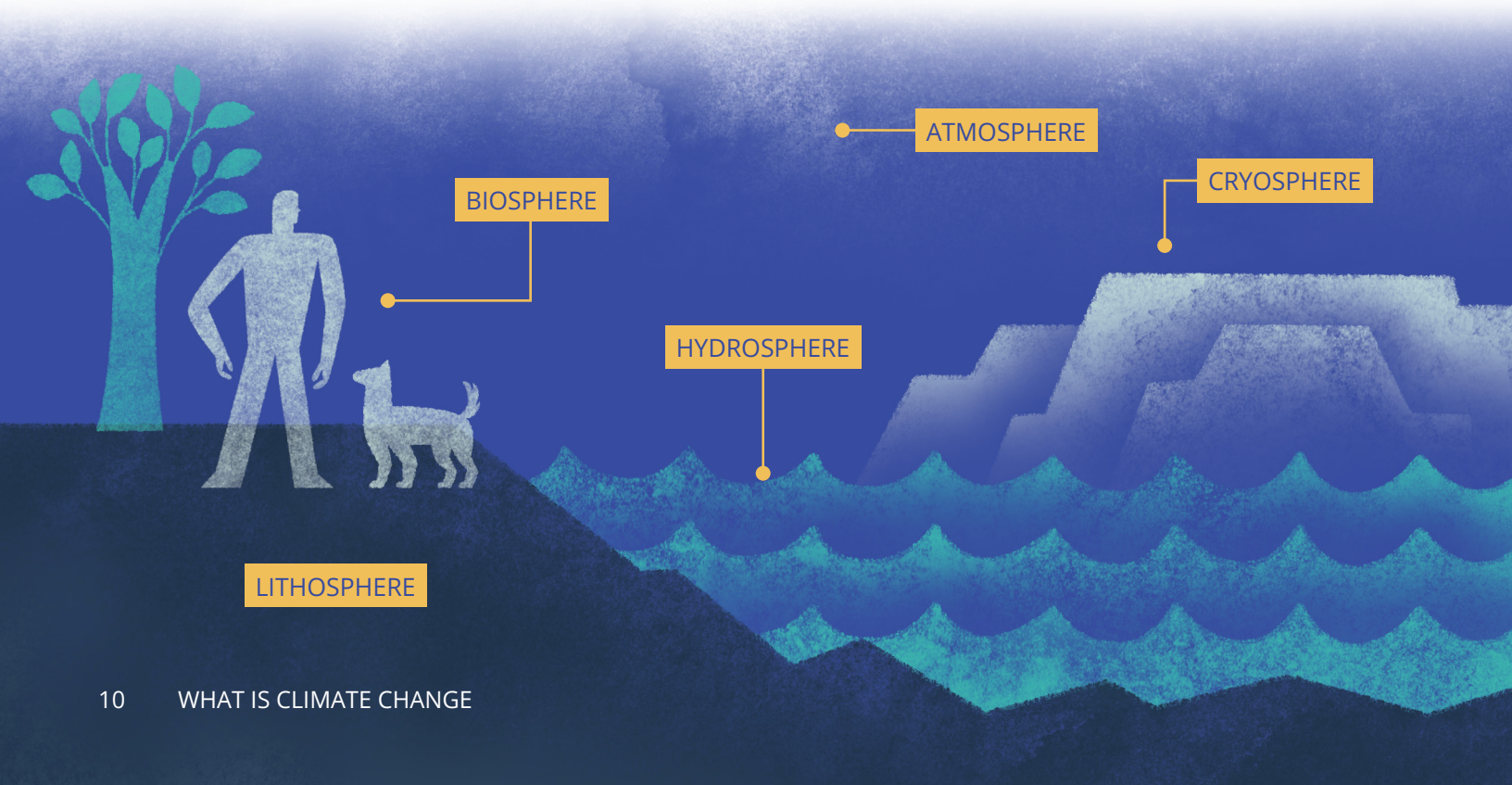
Climate change caused the Ice Ages (all seven of them). It has been happening naturally most of this time, due to factors such as changes in solar cycles and volcanic eruptions.

More recently, human activities are changing our Earth's atmosphere, further contributing to climate change. This means the whole world is affected.

Weather events in other parts of the world have always affected us. Typhoons in our region of the world travel from country to country and their winds may reach us even if they do not come within our area of responsibility. We are affected even by weather on the opposite side of the globe. You may have heard of El Niño, which actually originates in South America, yet is known to affect weather here as well as in the rest of the world. In the same way, changes in climate in other parts of the world have an effect on our local climate. This is because of the interconnections between land, ocean, and atmosphere that make up the Earth's climate system.

The various systems of the Earth are known as spheres (even though they're not really spherical or circular in shape). For instance, the Earth's land surface is the lithosphere while the living organisms inhabiting the Earth make up the biosphere. The places in the world where ice, snow, and glaciers form are together called the cryosphere.

As the atmosphere interacts with the other spheres, its continuous warming also causes changes in all the other spheres.



ACTIVITY:
SPHERES IN A JAR

Replicate the Earth's major spheres by making a terrarium!

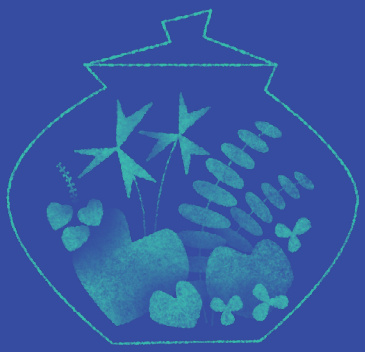
You will need:

- a container for your terrarium (you may repurpose a large clear wide-mouthed glass jar or plastic bottle)
- a small plants like pansit-pansitan, ferns, wood sorrel, oxalis, or golden pothos
- small spade or any tool for digging

1. At the bottom of the jar, dampen the soil and dig enough space for your plants, covering their roots with soil. Make sure they do not touch the sides of your terrarium.
2. Close and seal the terrarium again then put it by a sunny window.
3. Observe your plant. Are they able to survive without being watered? Why?

You should observe some condensation (atmosphere) in the terrarium. The moisture forms and drips on the side of the terrarium, into the soil (lithosphere) from which the plant (biosphere) absorbs the water (hydrosphere) along with some nutrients. The roots of the plant in return stabilizes the soil. As the plant needs are sustained and the soil is stabilized, this set-up/system keeps the plant alive.

If the plants do not grow well in your terrarium, consider whether it offers the right environment for the plants you chose. Research on the plants to see if they do better in drier soil or with less humidity. Plants that can handle constant moisture and humidity are the best choices for a terrarium.



THE CRYOSPHERE CONNECTION

Where can you find the most ice and snow in the world? Using a map, work out the distance. What do you think are the areas with the most snow and ice? If you answered the North and South Poles, you are correct. Observe how far they are from our country on a map.

We do not have snowfall events or ice-covered land surfaces at all in our country, and the places that have these are distant from us—yet their melting snow and ice affect us. The cryosphere helps regulate the global temperature as areas covered by snow and ice are much more effective at reflecting sunlight than the rest of the Earth's surface. We are therefore affected by the melting of the cryosphere as decrease in surface area means less sunlight being reflected by it. The following activity will demonstrate another effect of the thawing cryosphere.

ACTIVITY:
MELTING ICE EXPERIMENT

You will need:

- 2 bars modeling clay
- small objects to represent structures, such as rocks, bottlecaps, plastic bricks, etc.
- an 8x13 inch rectangular food container or baking pan
- tightly closed drinking bottle with height less than the width of the container
- 6 ice cubes

1. Mold clay in the form of two land masses, flat on top.
2. Place them at the opposite ends of the plastic container or baking pan. Pour in water until the clay is about half-covered.
3. Press some small objects into the clay on one end. These represent houses and buildings. You can stack bricks to make some taller structures. Put these in different areas above the waterline.
4. Try bouncing and rolling the plastic bottle towards the clay with bricks to make waves. Note how high they reach. Mark the highest level with a toothpick.
5. Place ice cubes on the clay on the opposite side. These represent glaciers. Leave the whole set-up in a warm area and observe what happens to the brick structures. Are any of them submerged? How high does the water level rise? Try making waves again. How high do they reach this time?
6. When you are finished with your observations, you may pour off the water. Save the setup for a future activity.

You can see from this activity how melting ice from the cryosphere leads to rise in sea levels. It is one of the major causes of sea level rise. As solid ice turns to water, the volume of the ocean increases. The ocean water also becomes gas as it evaporates, adding water vapor to the atmosphere. And in these various phases, the water travels the globe.

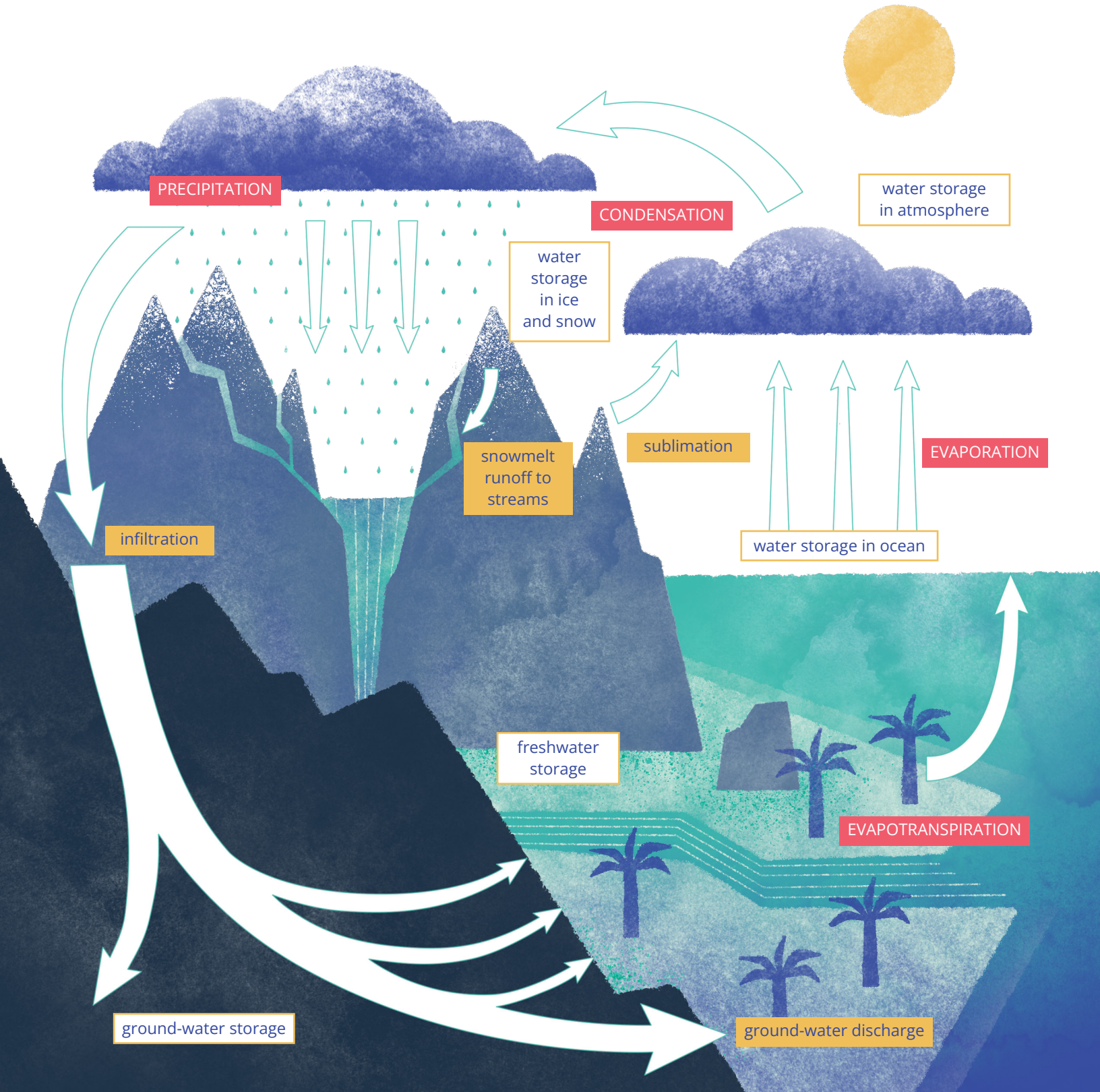
WATER CYCLE

Rain is essential in keeping us supplied with fresh water. Are you familiar with the simple water cycle of evaporation, condensation, and precipitation?

Other sources of water

Do you know in what other ways water can circulate in the world? Study the diagram below.

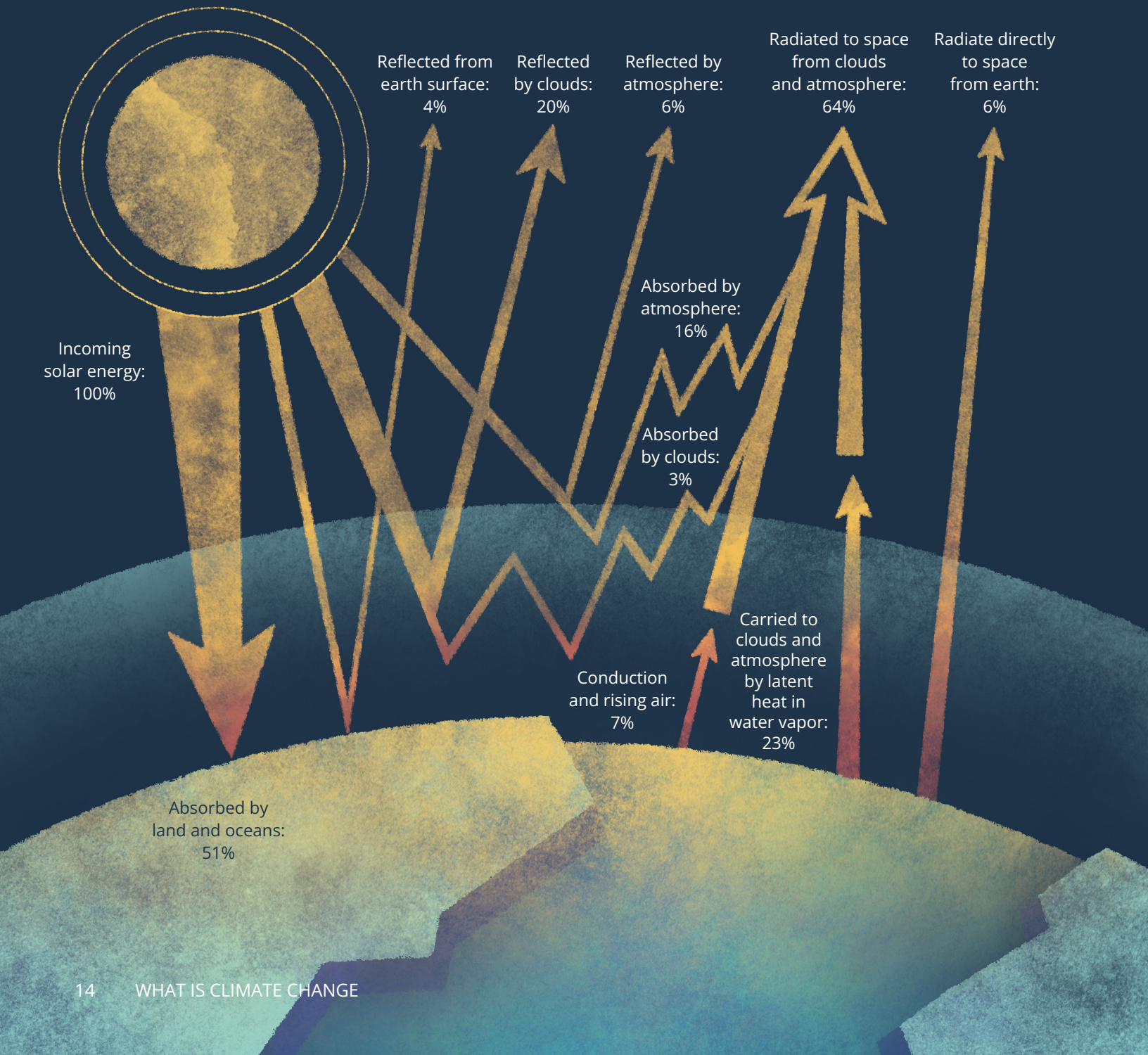
Highlight the arrows showing processes which occur in your immediate area. What could be the challenges to water supply in your area? What role does the heat play in the water cycle? Where does it come from? The sun!



WHY WEATHER HAPPENS

The sun is the main driver of the Earth's climate. What does this mean? The energy from the sun heats up the Earth, the atmosphere, and the ocean, and is what gives the Earth a livable temperature that allows it to support life.

It is also the way this energy is distributed that produces different types of climate. The uneven distribution of energy from the sun is why we have weather while different rates in the redistribution of heat energy is what gives rise to climate. The diagram below shows how this happens. The way the radiant energy is distributed as it reaches Earth and as it flows back out to space is called the **energy budget**.



ACTIVITY:
WEATHER WATCHING

Try studying your weather for a week. Take note of the weather and daily temperature at the same time every morning using a thermometer, your phone, or local weather reports. Compute the mean average of the temperature readings, then refer to the climate calendar in the *Philippine Climate Almanac* and compare your recorded temperature average against the average temperature for the month.

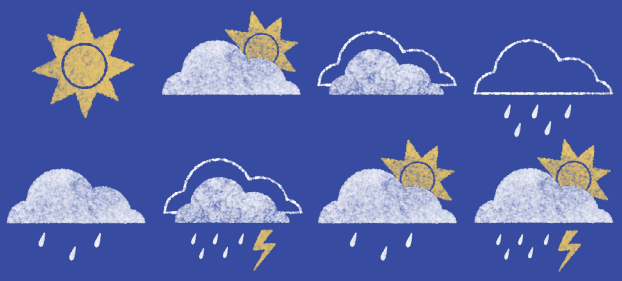
When it comes to climate, you of course have not been able to observe the weather over a period of thirty years. However, you can discuss the current state of weather with older relatives. Ask them to compare their observations of the weather now from what they remember over the past thirty years. Have they observed any change?

You can also collect data on extreme weather events over the past thirty years, searching for news stories on storms, flooding, and drought. Also make note of periods of climate variability and of the El Niño and La Niña years.

Chart the years of these events. Do you observe more extreme events in recent years?

Month:					Time of observation:				
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Average	Average for the month*
Weather									
Temperature									

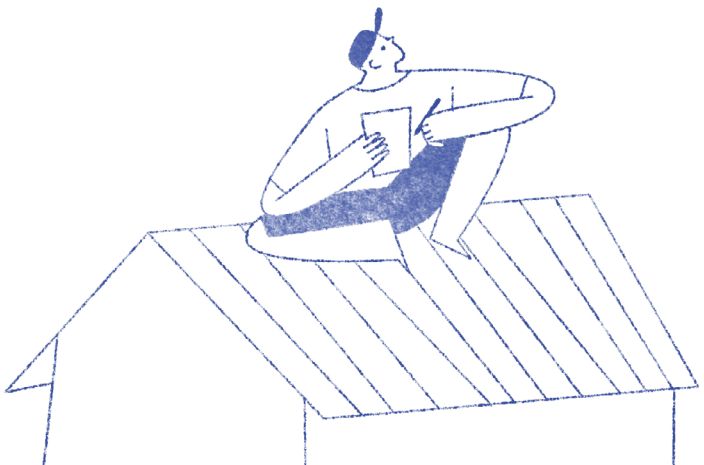
*from the PH Climate Almanac



Philippine Climate Almanac Calendar bit.ly/3qeoZTH

PAGASA bit.ly/3JxjWUN

AccuWeather bit.ly/3O73ldK



THE DIFFERENCE BETWEEN WEATHER AND CLIMATE

Remember that weather refers to short-term conditions of the atmosphere in a particular area. On the other hand, climate refers to the average observed conditions at a much longer period—30 years, as determined by the World Meteorological Organization.

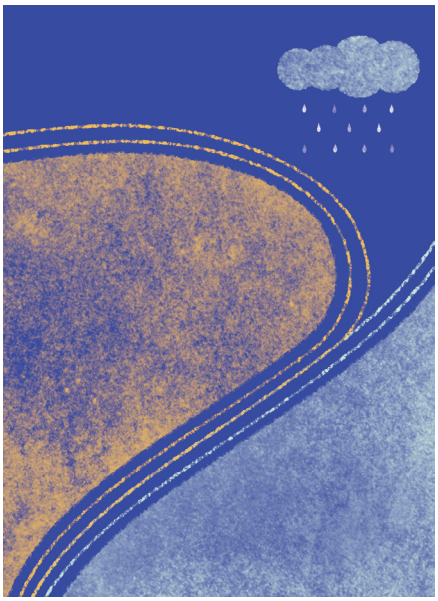
A scientist who studies the weather, as you probably know, is a **meteorologist**. On the other hand, the study of climate is distinct from this and requires its own specialization. We call these people **climatologists**.

Sunshine, rain, and wind are the main phenomena that constitute local weather. You experience one or more of these everyday. We expect more rain and some storms during the rainy season. You may also hear more specific terms for various types of wind, rain, and other weather events in weather reports.

WEATHER SYSTEMS AFFECTING THE PHILIPPINES

Air mass

A large body of air in the atmosphere that has a fairly consistent temperature, humidity, and pressure. If the air mass is unstable, it can produce a storm.



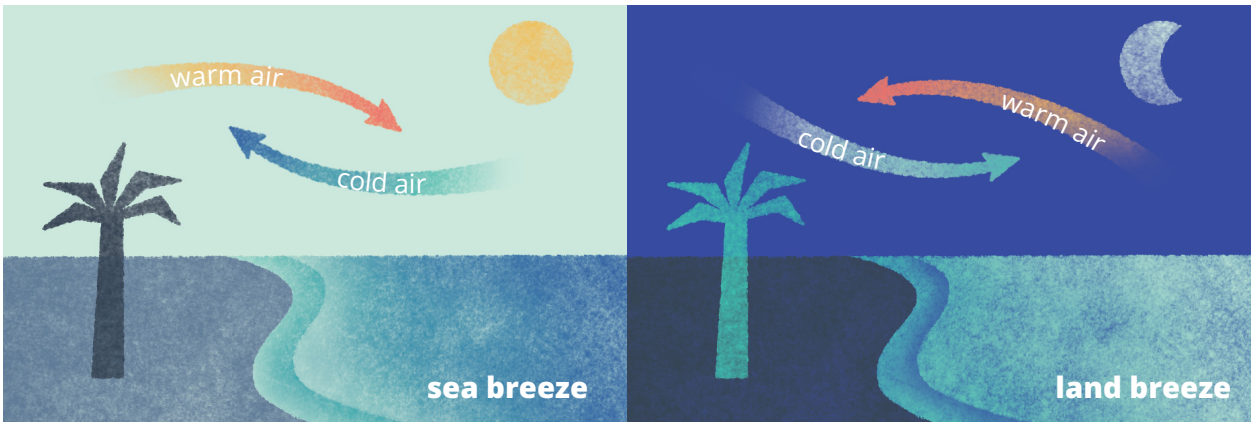
Thunderstorms

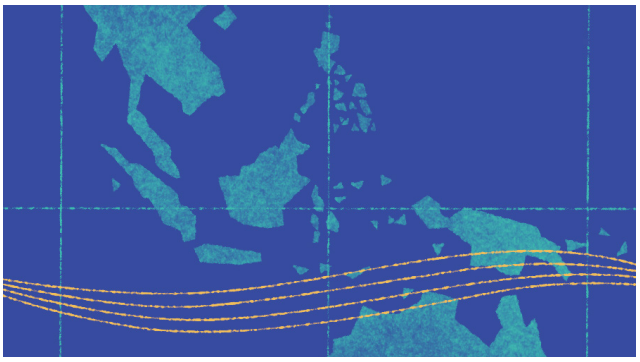
This type of weather disturbance is accompanied by thunder and lightning along with wind and rain. Thunderstorms produce sudden changes in pressure, temperature, and wind.

Thunderstorms may be caused by cyclones and result from cumulonimbus clouds. They normally produce rain showers and, occasionally, hail.

Sea breeze and land breeze

Local wind systems that occur near the coastline. They arise due to differential heating or the disparity of temperature of air over water and land. A **land breeze** is wind moving from land to water while the **sea breeze** is a breeze blowing from water to land. Land breeze occurs during the night or early morning while sea breeze occurs during the day.



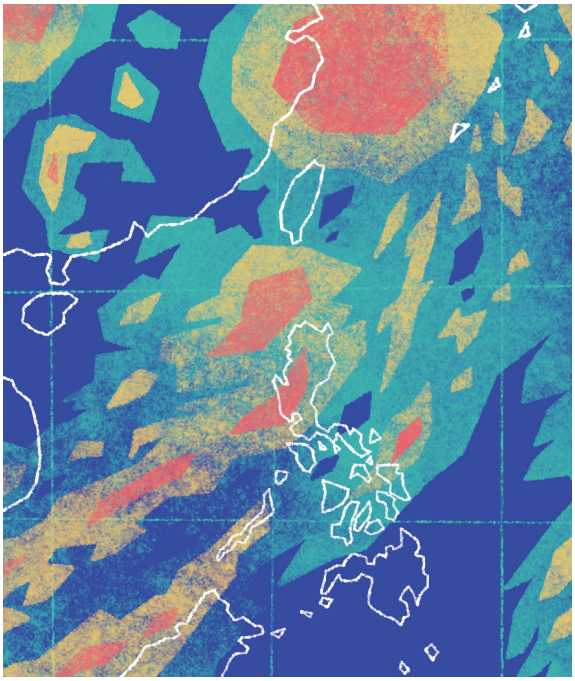


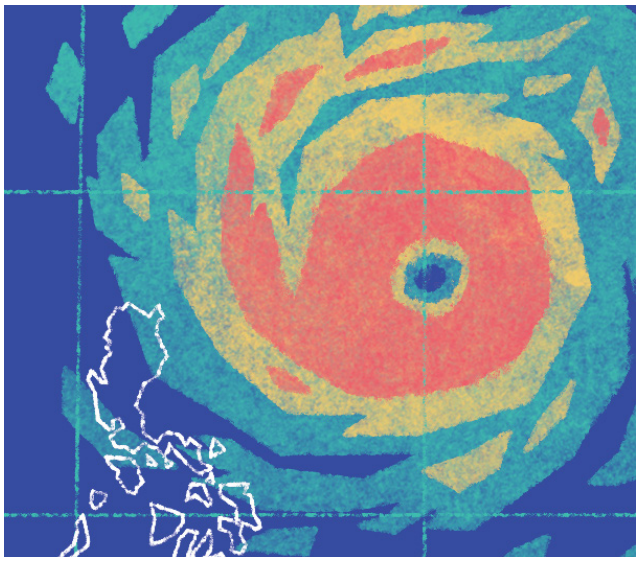
Intertropical Convergence Zone (ITCZ)

A low-pressure belt located near the equator where trade winds converge or meet. It moves northwards (reaching north of the Philippines) around August to September, and moves back southward before December. This primarily influences rainfall in the country.

Monsoons (Southwest and Northeast)

A monsoon is a consistent wind pattern generated by a large weather system that lasts for months and affects large areas. There are two monsoon seasons in the country: Southwest Monsoon (*Habagat*) and Northeast Monsoon (*Amihan*). Habagat usually means wet conditions in the western sections of the country from June to September. It usually brings significant amounts of rainfall that triggers flooding and landslides, and is sometimes further enhanced by the presence of tropical cyclones in Philippine Area of Responsibility (PAR). Amihan features a cool and dry breeze with prolonged periods of successive cloudless days. It affects the eastern sections of the country from November to February.





Tropical Cyclones (TCs)

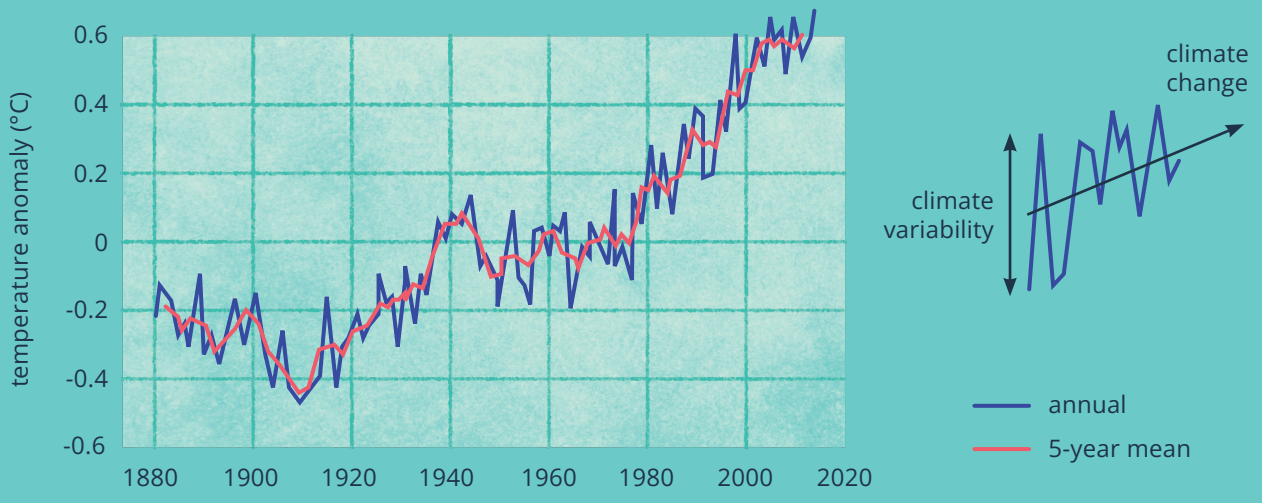
Tropical Cyclone is the general term for a cyclone that originates over the tropical oceans. TCs are low pressure systems in which winds spin inward in a circularly symmetric spiral, bringing with it intense rain and winds. Starting March 2022, TCs are categorized further based on wind intensity: **Tropical Depression (TD)** up to 61 kph, **Tropical Storm (TS)** 62-88 kph, **Severe Tropical Storm (STS)** 89-117kph, **Typhoon (TY)** 118-184kph, and **Super Typhoon (STY)** 185kph or higher.

Climate Variabilities *are regular fluctuations in climate (temperature and precipitation). These are natural processes that affect the atmosphere in shorter-term periods, such as over a year or two or a decade or more.*

The variabilities you are probably most familiar with are **El Niño** *and* **La Niña** *or the* **El Niño-Southern Oscillation (ENSO)**. *ENSO is not a weather system, but a mode of climate variability that affects the Philippines despite originating from the coast of South America and California. In fact, it has a global impact on weather.*

ENSO comes from the warming of the tropical Pacific Ocean on the eastern side of the dateline. This causes an increase in rainfall in South America starting around Christmas time, hence the name which refers to the Christ Child. The winds blowing from east to west (trade winds) grow weaker and the amount of cold, deep ocean water that rises to the surface is reduced and ocean currents are altered.

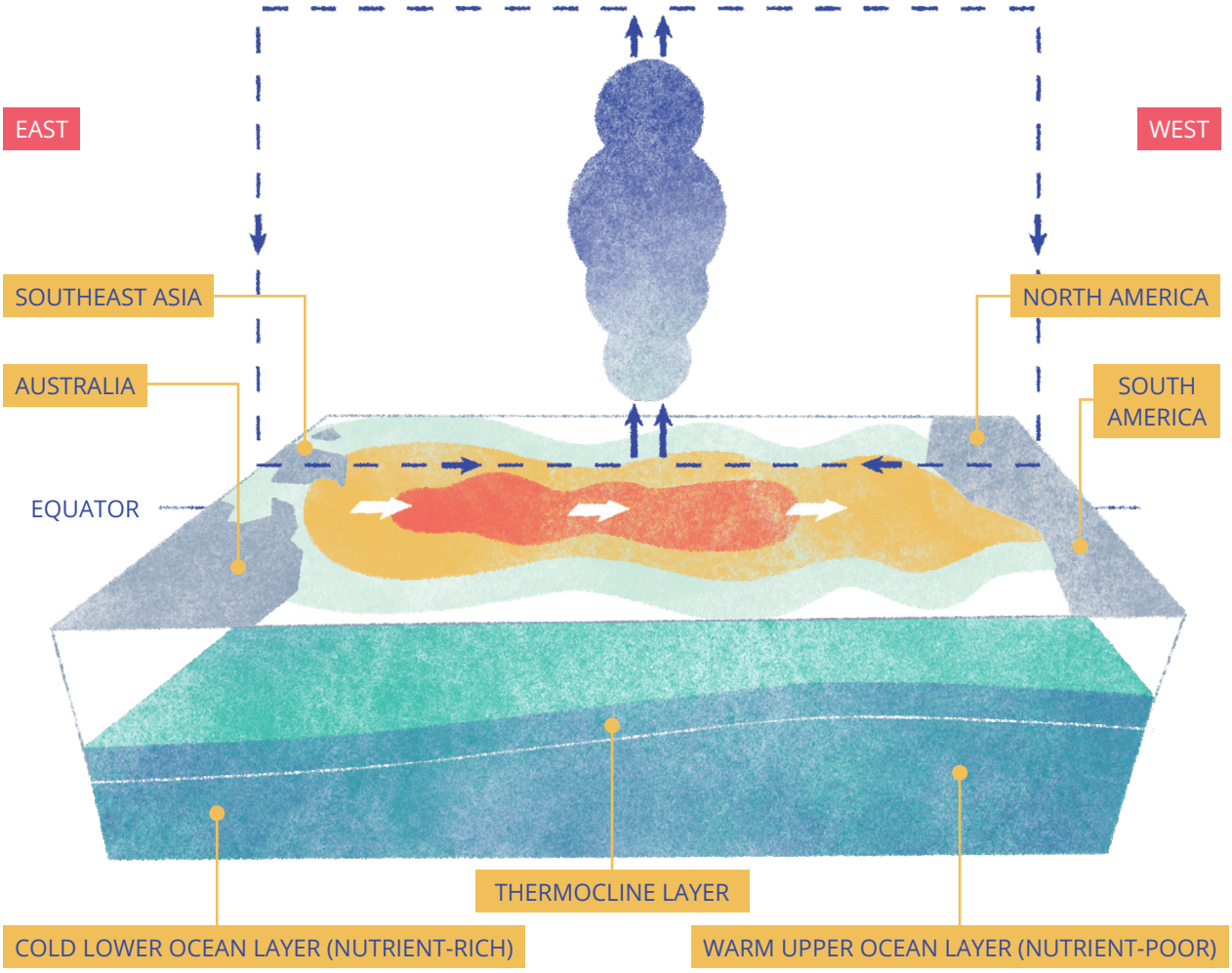
Change in Air Temperature Since 1880



Without the trade winds, there is no more upwelling. What do you think will happen to the marine ecosystem without this?

Weak trade winds lead to the warming of sea surface temperature. When the trade winds weaken, the warm water (red blob, normally on the west side) spreads eastward. A warmer ocean surface deepens the **thermocline**, the transition layer between warmer, mixed surface water and cooler deep water below, pushing the blue lower ocean layer deeper.

EL NIÑO CONDITIONS



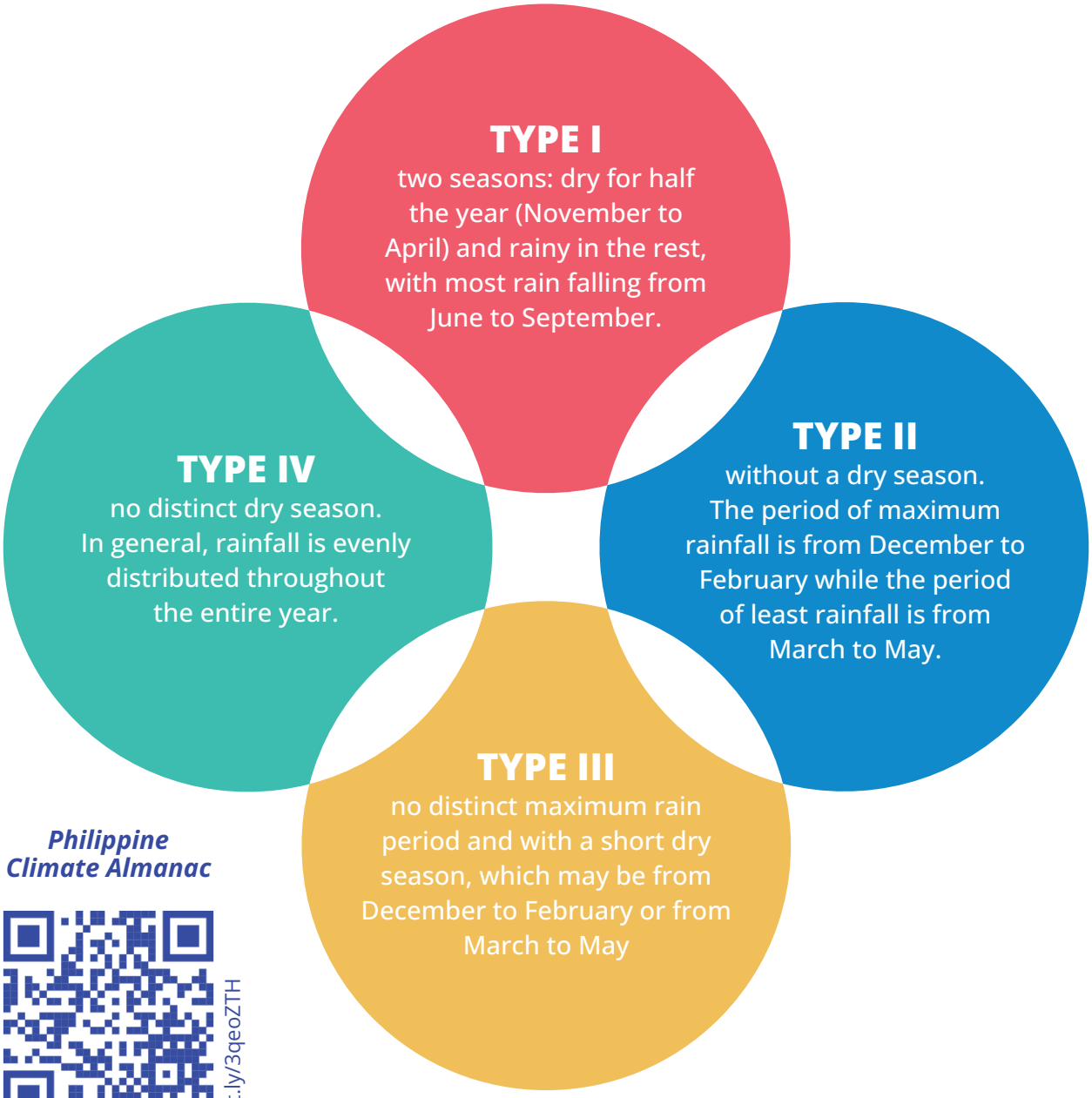
La Niña is the cold phase of ENSO, which brings wetter conditions to the country. Altogether, ENSO is the most important source of inter-annual variability of rainfall in the Philippines. It also affects our tropical cyclone activity and sea level patterns.

Aside from ENSO there are other climate variabilities such as the **Pacific Decadal Oscillation (PDO)**, which is characterized by patterns of sea surface temperature changes over the North Pacific. It has warm and cold phases that last for decades. Another is the **Madden-Julian Oscillation (MJO)**, which influences the intra-seasonal variations in rainfall over the Philippines.

THE CLIMATE OF THE PHILIPPINES

While weather can change from hour-to-hour or day-to-day, climate is the long-term pattern of weather in a particular area. Global climate is determined by numerous global factors that remain consistent. Most of these have to do with the nature of Earth itself, such as its shape, rotation, and the tilt of its axis of rotation, its elliptical orbit, its distance from the sun, and the unevenly distributed land on its surface.

As for the Philippines, its climate is largely determined by its location near the equator and its geographical features including mountains and islands. The country is characterized by four types of climate based on the distribution of rainfall throughout the year.



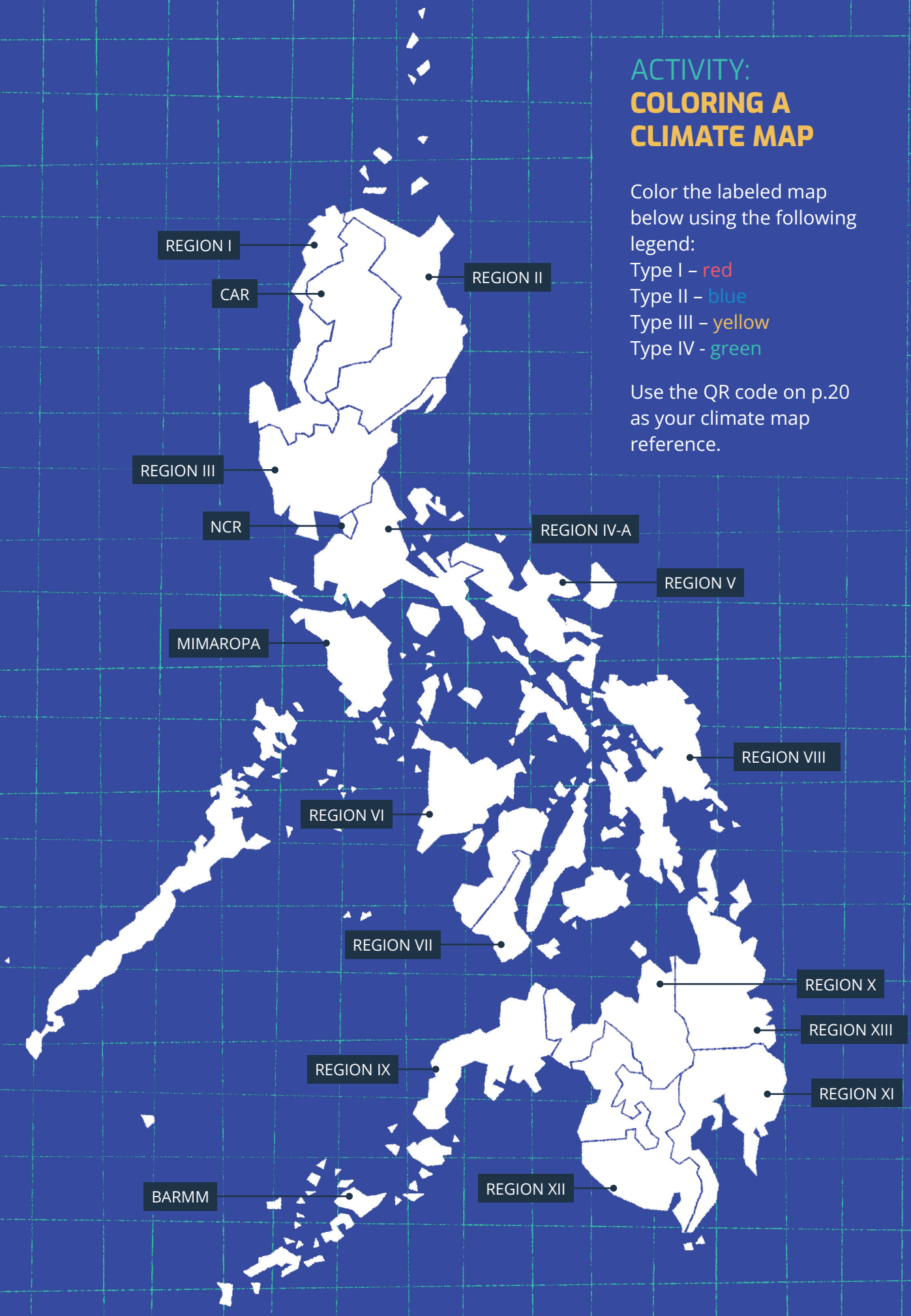
Philippine Climate Almanac

bit.ly/3qeoZTH

ACTIVITY:
COLORING A CLIMATE MAP

Color the labeled map below using the following legend:
Type I – red
Type II – blue
Type III – yellow
Type IV - green

Use the QR code on p.20 as your climate map reference.



What kind of climate have you observed in your area? Refer to the map in the previous activity to confirm your type of climate. Using the map, find and mark where you are located. Under what climate type does your area fall?

Using the QR code below, look at the map showing the "observed" temperature and rainfall. Compare with the projected climate. Does your area have increased or reduced heat? How about rainfall?

Philippine projected and observed climate maps

bit.ly/3fcZb3S

DATE:

REGION:

CLIMATE TYPE:

TEMPERATURE:

RAINFALL:

The Beginnings of Climate Science

Nobel Prize-winning chemist Svante Arrhenius (1859–1927) was the first to observe the increasing carbon dioxide levels of the atmosphere and theorize its effects. He is considered the father of climate science. Living in chilly Sweden, however, he considered the warming effect to be positive rather than negative. It took many more years to realize the problems the rise in temperature could create. Locally, meteorologist Leoncio Amadore is considered the Father of Philippine Climate Science, studying the climate change vulnerability of the Philippines and neighboring countries.

CHANGES IN THE AIR

Climate consists of weather patterns that have been observed over many years. It is surprising then, to realize that climate change has also been developing over many years, since around the time Arrhenius lived and worked. What significant changes in the world could have caused the change in temperature that he observed?

If you are familiar with world history, you may remember the **Industrial Revolution** occurred within Arrhenius' lifespan. This was an era when factory production became widespread, along with vehicular transportation. All these were powered by burning coal. Gases and pollutants from these activities

ACTIVITY:
REPLICATING THE ARRHENIUS EXPERIMENT

This simple experiment will show how Arrhenius' observation led him to make the connection between carbon dioxide and the warming of the Earth.

You will need:

- two thermometers
- a clear glass jar/bottle big enough to hold one of the thermometers.

Do this on a sunny day.

1. Turn both thermometers on and put one inside the jar. Cover it.
2. Lay the jar in direct sunlight on its side, with the other thermometer beside it, but not touching it. Make sure that the sun is shining directly on both thermometers.
3. Check the temperature after two minutes. Which one has the higher temperature? How many degrees is the difference?

traveled up to the atmosphere, changing it over time. As industrial activities continue to increase, so have changes to the atmosphere. It has been confirmed that this is connected to global warming. Can you guess how?

THE GREENHOUSE EFFECT

In replicating the Arrhenius experiment activity, the thermometer inside the jar should have a higher temperature because the covered jar makes it impossible for the heated air inside the jar to escape. This is how the greenhouse effect works. Similar to the glass jar in the experiment above, the atmosphere reflects back some of the Sun's heat while the greenhouse gases in it absorb the rest.

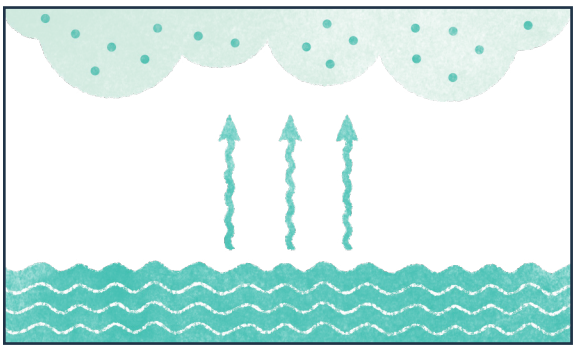
The atmosphere's process of retaining heat allows the Earth to stay at its current temperature. Without the greenhouse gases, it would be about 33 °C colder and most life could not survive.

These gases include water vapor, ozone, nitrous oxide, methane, and carbon dioxide.

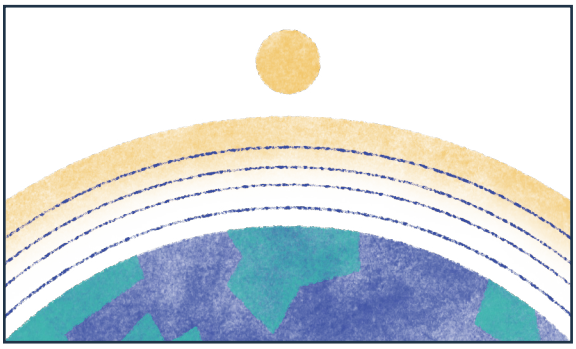
Greenhouse Gases: Good or Bad?

As mentioned earlier, the greenhouse effect is a natural process of the environment and we need most of these greenhouse gases (GHGs) especially those that do not cause harm at all.

Two of these gases are particularly essential to us—water vapor and ozone.



Water vapor (H_2O) is the most abundant of the GHGs. It is always naturally present in the atmosphere due to the water cycle.



Ozone (O_3) is a GHG which helps to protect us from the harmful effects of ultraviolet light. It forms a protective layer in the stratosphere called the ozone layer. However, ozone in the lower troposphere is different. Produced by reactions among pollutants, it is harmful to human (and animal) health.

What is causing changes in climate is an imbalance of gases that enhances the greenhouse effect. A number of the GHGs have tremendously increased from their usual count, and are trapping more heat than usual, leading to the rise in the Earth's temperature. These include several common gases, particularly carbon dioxide.

Carbon dioxide (CO_2) is the greenhouse gas that has increased the most in the last two centuries due to industrialization. Apart from being released by humans and animals when exhaling, carbon dioxide is a by-product of burning wood, gasoline, and other petroleum-based fuels. About 75% of all gas produced by human activities is carbon dioxide, which lingers in the atmosphere for thousands of years.

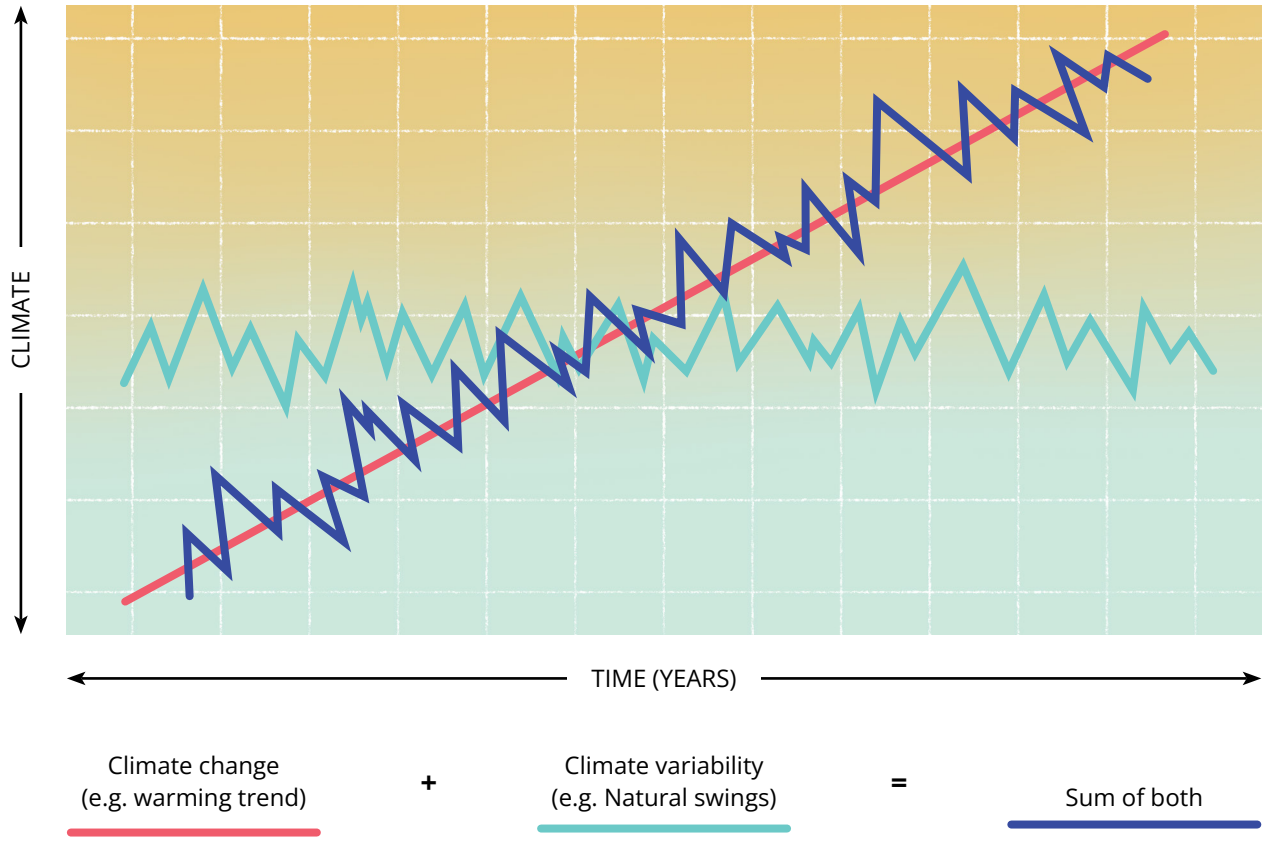
However, it is important to note that plants need carbon dioxide to give us oxygen. Carbon dioxide in itself is not harmful for the planet, but too much of it is.

While human beings are not the only factor causing climate change, studies show that our impact has been increasing in the last two hundred years. With our modern lifestyle, we constantly add carbon dioxide to the air with everyday activities like manufacturing products in factories, using electricity, commuting, burning leaves, and more.

GHGs are essential to maintain a livable temperature, but too much of it is harmful to Earth. The accumulation of these gases in the atmosphere enhances the Greenhouse effect and results in global warming.

The Earth's average temperature has now increased by a little more than one degree Celsius (1 °C). That may not sound like much. Remember though that an increase of one degree over your normal body temperature is a fever that is enough to make you feel uncomfortable. At a temperature one degree above normal can already cause many extreme weather events, negative effects on plants and animals, and corals dying off. You might say that the Earth is sick with a fever.

Aside from temperature, other average weather conditions such as rainfall change as well. There may be extreme rainfall or drought—or both alternately, in just one area. Severe storms and rising sea level are also expected. These can have a great impact on our environment, our health, our food supply, our livelihoods, and our way of life.



The experiment below will show how an increase in temperature makes a difference in the amount of rainfall.

ACTIVITY: RAIN IN A JAR EXPERIMENT

You will need:

- two identical glass jars or bottles
- ceramic saucers
- boiling water
- 6 ice cubes

1. Fill about ⅓ of one jar with room temperature water and the other with the same amount of boiling water.
2. Place a saucer on top of each jar.
3. After three minutes, put three ice cubes in each saucer.

What happens inside each jar?

In the experiment, water quickly evaporates and condenses in the jar with hot water. In the same way, greater heat causes more water from the surface of the earth to evaporate, condense, then turn into rain.

HOW YOU MIGHT AFFECT CLIMATE CHANGE

The amount of carbon dioxide we emit as a result of the activities we do, whether directly or indirectly, is called our **carbon footprint**.

There are formulas you can use to estimate how much carbon you are producing. A simple way is to use this online carbon calculator:

Online Carbon Footprint Calculator

bit.ly/3tfm0fr

Note that this is just a very general estimate. It does not even cover the electronic devices you use or take into consideration how many people there are in your household. It does, however, give you an idea of how much carbon you generate.

Calculate your carbon output and compare with your classmates'. Then think about ways you can lower it. You will find more ways throughout this book.

At sixteen, Marinel Ubaldo was already starting to observe the effects of climate change on her small seaside community. The catch of her father, a fisherman, was much less than it used to be. The heat outdoors was unbearable as early as seven in the morning. Already, as a youth leader with Plan International, she was concerned enough to try to educate others about climate change.

Then her village was devastated by Typhoon Yolanda. Seeing the suffering and damage it caused fueled her determination to do something about climate change. She spoke at the United Nations Climate Change Conference. Along with other disaster survivors, Philippine organizations, and Greenpeace, she submitted a complaint against companies contributing to climate change. She went to the university and continued to teach others about climate change, leading others in protests and actions related to climate change. She also served as a community witness for the investigation of the Philippines's Commission on Human Rights on whether corporations are violating human rights with practices that lead to climate change. Speaking about her efforts, Marinel says: "I do feel they've heard me. The challenge is how to make them act. I don't need them to be touched by my story and I don't need their pity. I need them to take action. I refuse to accept that we are just victims."

Like Marinel, refuse to accept that we are just victims. Learn what you can do to help mitigate and adapt to climate change.

WHAT YOU CAN DO ABOUT CLIMATE CHANGE: FROM MITIGATION TO ADAPTATION

Knowing about climate change and how human activity or the burning of fossil fuels have contributed to it, we should be concerned about mitigation or taking action to reduce impacts. **Mitigation** refers to actions that can reduce or prevent greenhouse gas emissions and sources of these, such as developing and deploying new technologies, using renewable energies like wind and solar, or making older equipment more energy efficient. It also means creating or enhancing **sinks**, or means to prevent greenhouse gases from escaping into the atmosphere, such as planting trees in order to absorb more carbon dioxide.

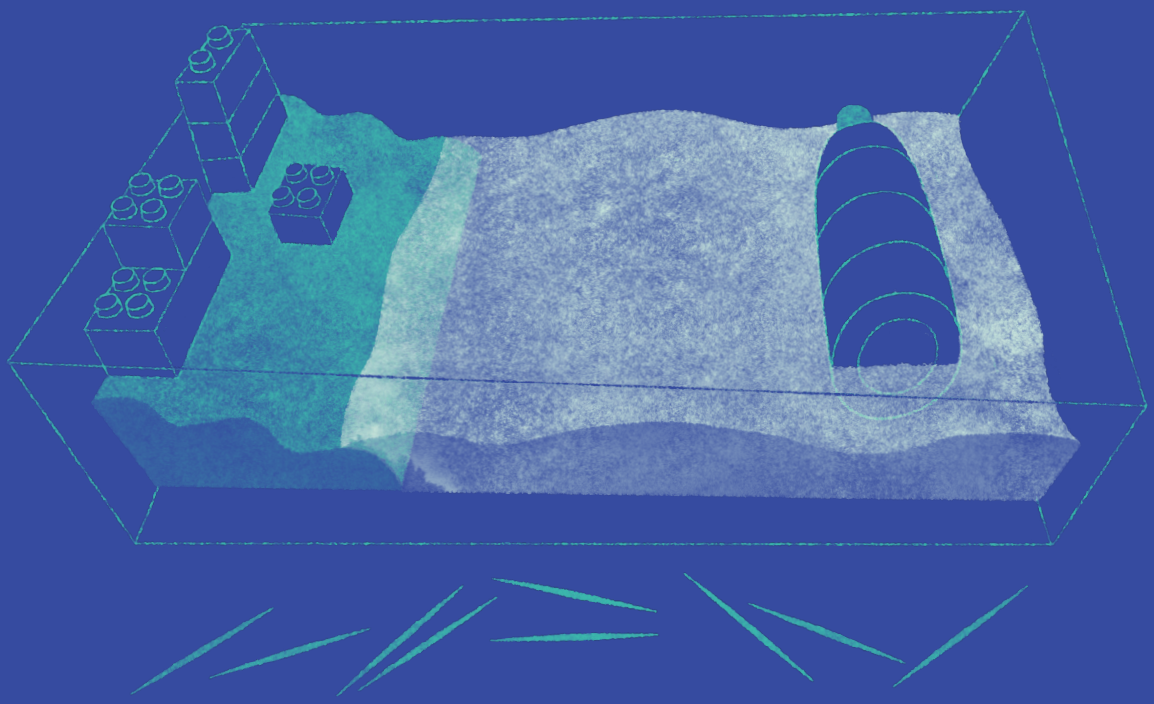
Can you think of other ways to mitigate climate change?

While there is growing awareness of the effects of global warming and many countries, including the Philippines, have pledged to help reduce or mitigate it, we will still be suffering from its current effects. Knowing this, what can we do?

We need to adapt or adjust to the impacts of climate change. **Climate change adaptation** means taking actions that will help us handle the effects of climate change and reduce its impact. It can also mean exploring and taking advantage of opportunities. Periods of extreme rain, for instance, would give us a chance to collect plenty of rainwater that can be used during a drought.

One impact of climate change is flooding, which is a major concern in riverside and coastal communities. In the activity that follows, you will consider some methods of adapting to flooding.

ACTIVITY:
CREATING A FLOOD BARRIER



You will need:

- the model you made in the melting ice experiment, refilled with water
- empty water bottle
- a pack of toothpicks or fallen stick branches, flower stems, or plants

1. Study your current model. What do you think can be done to prevent the waves from reaching the houses?
2. Try making a barrier by sticking toothpicks up in the clay along the waterline.
3. Roll the bottle to make waves. How successful is your barrier? What else do you think you could do to keep water from reaching the houses and buildings? Try it on your model. Compare your methods and results with each of your classmates'.

The means used in adapting to climate change depend on the area. In some areas, mangroves are planted to reduce the effects of waves, much like the toothpicks in your model above. In others, barriers are constructed to prevent flooding. Passageways may also be made to divert water. Still, in other areas, relocation may be the best option.

In the chapter that follows, you will get to learn about the impacts of climate change and think of more methods of adapting to it.

KEYWORDS

climate
the average weather conditions at a particular place over long periods of time

climate change
extreme changes in weather patterns that cause serious consequences to the planet

climate change adaptation
taking actions that will help reduce the effects of climate change and even exploring and taking advantage of opportunities

climate map
a graphical representation or overview of the distribution of climate in a given area

El Niño
the "warm phase" of the ENSO cycle which results in reduced rainfall in the Philippines

ENSO
El Niño-Southern Oscillation. A recurring climate pattern involving changes in the water temperature in the central and eastern tropical Pacific Ocean, which affects the Philippine weather

greenhouse gases (GHGs)
a blanket of gas that warms the atmosphere and makes the Earth a livable planet

greenhouse effect
a process that occurs when the Sun's heat and other greenhouse gasses are trapped in the Earth's atmosphere, keeping our planet warmer than it would be without them

La Niña
the "cool phase" of the ENSO cycle which brings more rains in the Philippines

Mitigation
actions that can reduce or prevent greenhouse gas emissions and sources of these

Spheres
(including lithosphere, biosphere, cryosphere) the various Earth's systems

Temperature
the measured amount of heat in a place or a body

trade winds
prevailing east-to-west winds that flow in the Earth's equatorial region

Typhoon
a tropical cyclone with wind intensity of 121–220 kph

upwelling
a process in which deep, cold, water rises toward the surface of the open ocean or along the coastlines

ultraviolet light
a type of electromagnetic radiation that has shorter wavelengths than visible light. Too much exposure to UV radiation can damage a living tissue.

Weather
short-term conditions of the atmosphere in a particular area

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CHAPTER 2

ADAPTATION IN THE AGE OF CLIMATE CHANGE

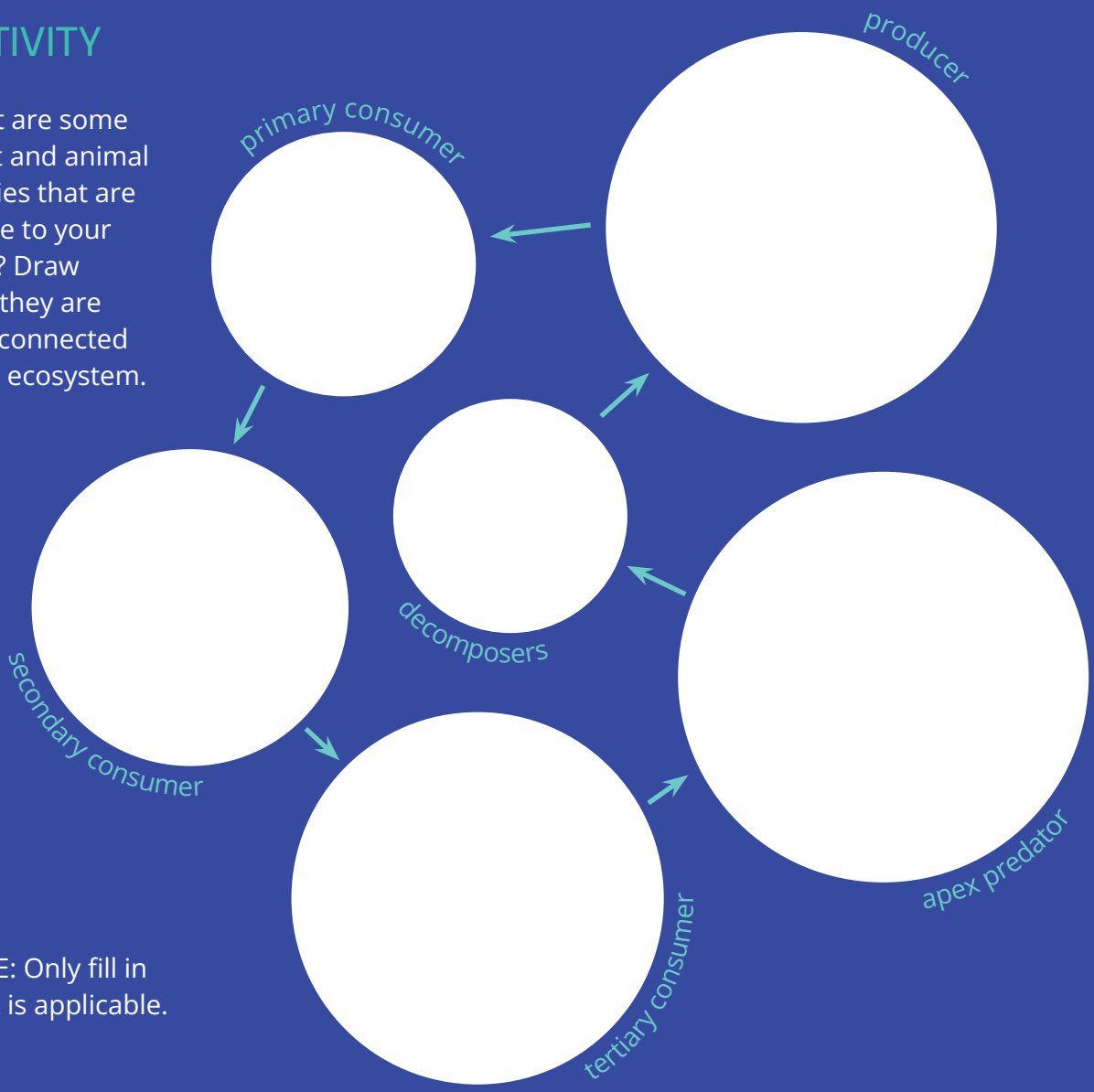
Knowing the time it takes to counteract the effects of climate change, many of which are permanent, it is necessary for us to adapt. Every organism has to adapt or adjust to the conditions it lives in. This would include climate, terrain, and the presence of other organisms. Adaptation has always been necessary for species survival.

It takes time for species to adapt. When people travel to a place with a much colder temperature, they end up wearing thick layers while local people go around in much less clothing (and probably give the visitors curious looks). On the other hand, people who live in a generally cool climate are more likely to suffer from heatstroke when there is an unexpected heat wave than people accustomed to hot weather. Our bodies adapt to the climate and temperature we have lived with for most of our lives and have difficulty handling temperatures outside of our usual range. The same goes for plants and animals. Native species have over time adapted perfectly to their environment's conditions but may be upset by sudden changes.

Adaptation over a long period of time allows living creatures to live in harmony with their environment, including other organisms. Different species develop systems of survival with the creatures around them.

ACTIVITY

What are some plant and animal species that are native to your area? Draw how they are interconnected in an ecosystem.



NOTE: Only fill in what is applicable.

Which of the species provide food for others? How?

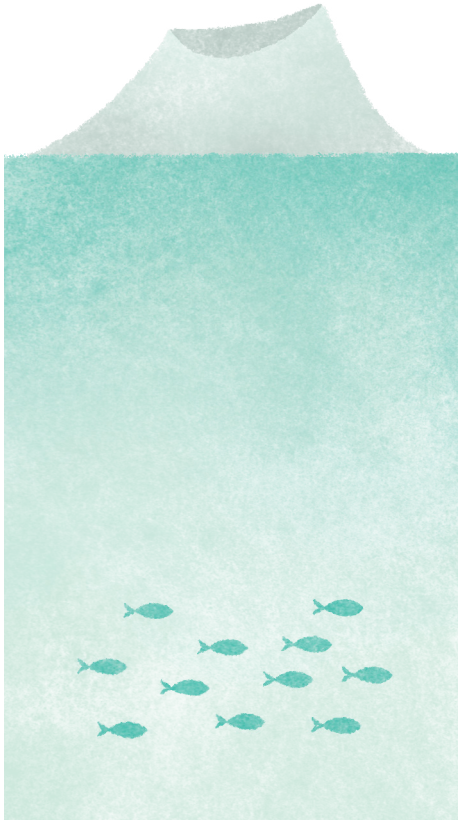
How does the consumption of certain plants or animals help the environment?

Having observed how certain species are interconnected, consider what would happen if each one of these species becomes endangered or extinct. Then compare your model of an ecosystem with others.

TYPES OF ADAPTATION

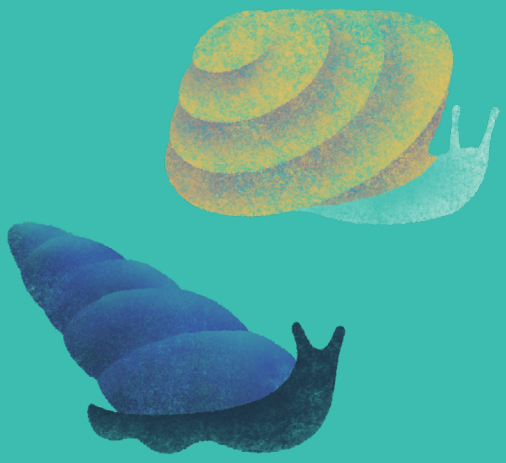
There are two types of adaptation: **behavioral** and **biological** adaptation. Behavioral adaptation is the development of behaviors that aid the species in adapting to its environment. Some examples include species like penguins huddling together for warmth when the weather gets colder. House geckos or *butiki* lived in trees before there were houses but they have adapted to the urban environment so much that they prefer sheltering inside buildings. Another behavioral adaptation is the regular migration of birds from colder areas to warmer ones during winter, a behavior which has been affected by climate change. Changing temperatures have caused birds to change their migration patterns or even to choose not to migrate at all. This can cause more competition for food in certain areas or disrupt the breeding of young in an environment with temperatures too low for them to survive.

In biological adaptation, there are changes in the organism's body that develop over time to help it survive its environment. It evolves to become better suited to its environment through the process of **natural selection**.



Vines, for instance, are plants that have adapted to lush tropical forests by growing on and over trees to get more sunlight. *Tawilis* is believed to be a marine species of sardine that was able to adapt to Taal Lake after eruptions separated the freshwater body from the bay it was once connected to.

This type of adaptation may be seen in human beings as well as animals and plants. The sea nomads of the southern Philippines, the Sama Dilaut (Bajau) who are known for their excellent diving skills, have unusually large spleens just as seals do. This provides them with more oxygenated red blood cells while they are holding their breath.



Biological Adaptation: Evolution and Climate Change

If you are familiar with the theory of evolution, you may wonder why we need to help endangered species adapt. Shouldn't they be able to evolve to handle climate change and its consequences? Survival of the fittest, right?

However, evolution is a process that normally takes many years. Recent studies of the bones, teeth, and DNA of woolly mammoths or ancient elephants suggest that it took hundreds of thousands of years for the mammoth to evolve so that it could survive in extreme cold and eat only grass. And we know that this creature wasn't able to survive the later warming climate.

The species that are able to evolve faster are usually smaller ones like fish, insects, and snails. Various fish species have been found to grow either larger or smaller in warmer waters, mosquitoes in temperate climates have changed their hibernation season (and flowering plants their blooming seasons), and snails in the warmer cities in the Netherlands have grown lighter-colored shells that absorb less heat.

As helpful as evolution might be to the species itself, can you see what problems it might cause in general?

You may notice the animals that evolve easily are often pests. After all, they are smaller, reproduce more, and have a shorter lifespan. So many more generations of them can grow and change more quickly. You have probably observed this with mosquitoes, which increase in population with more rainfall.

The survival of one species could be at the expense of others. There will be an imbalance if just a few species are able to increase their numbers.

Also, nearly all of these reported evolutions are in countries situated in temperate zones. There may just be more studies in those places, but there may also be another reason for this. An article from National Geographic suggests:

> *There's also a widespread but still poorly tested hypothesis that tropical species may have a harder time evolving than temperate species do. Having evolved in a region with less climate variability over both the years and the millennia, tropical species may harbor a less diverse set of genes related to heat tolerance and similar traits. "The tropics are hot, but they are not particularly variable," Hoffmann says. "It is not like they are being challenged all the time."*

Snails are able to lighten the shade of their shells to cope with higher temperatures. Lighter colors reflect heat while darker colors absorb it. Lighter-colored shells allow them to balance their body temperatures despite the heat.

What would happen if snails are able to adapt to the heat in a local farming community? And, meanwhile, their natural predators, such as ducks, are not able to adapt to greater temperatures as quickly? On a sheet of paper, draw a diagram showing the possible causes and effects.

CLIMATE CHANGE IMPACTS ON A SYSTEMS SCALE

Climate change does not only affect individual species. Its impacts can cause widespread changes among numerous species and disrupt a whole system. For example, devastating weather events such as intense typhoons pose threats to the population of tarsiers, along with the trees they live in, such as when they were greatly reduced by Super Typhoon Yolanda in 2013 and now are still struggling to regenerate. Stronger rains and flooding may wash away the eggs of reptiles and amphibians that nest on land and may also increase fungal infections in these. Amphibians and reptiles in Southeast Asia, due to climate change, are expected to lose their ability to adapt within fifty years.

Plants that feed many species may grow less, resulting in animals having to compete with other animals in a smaller area. *Tamaraws*, for instance, are affected not only by the loss of habitat and hunting, but also of their grasslands being taken over by invasive weeds that they do not eat.

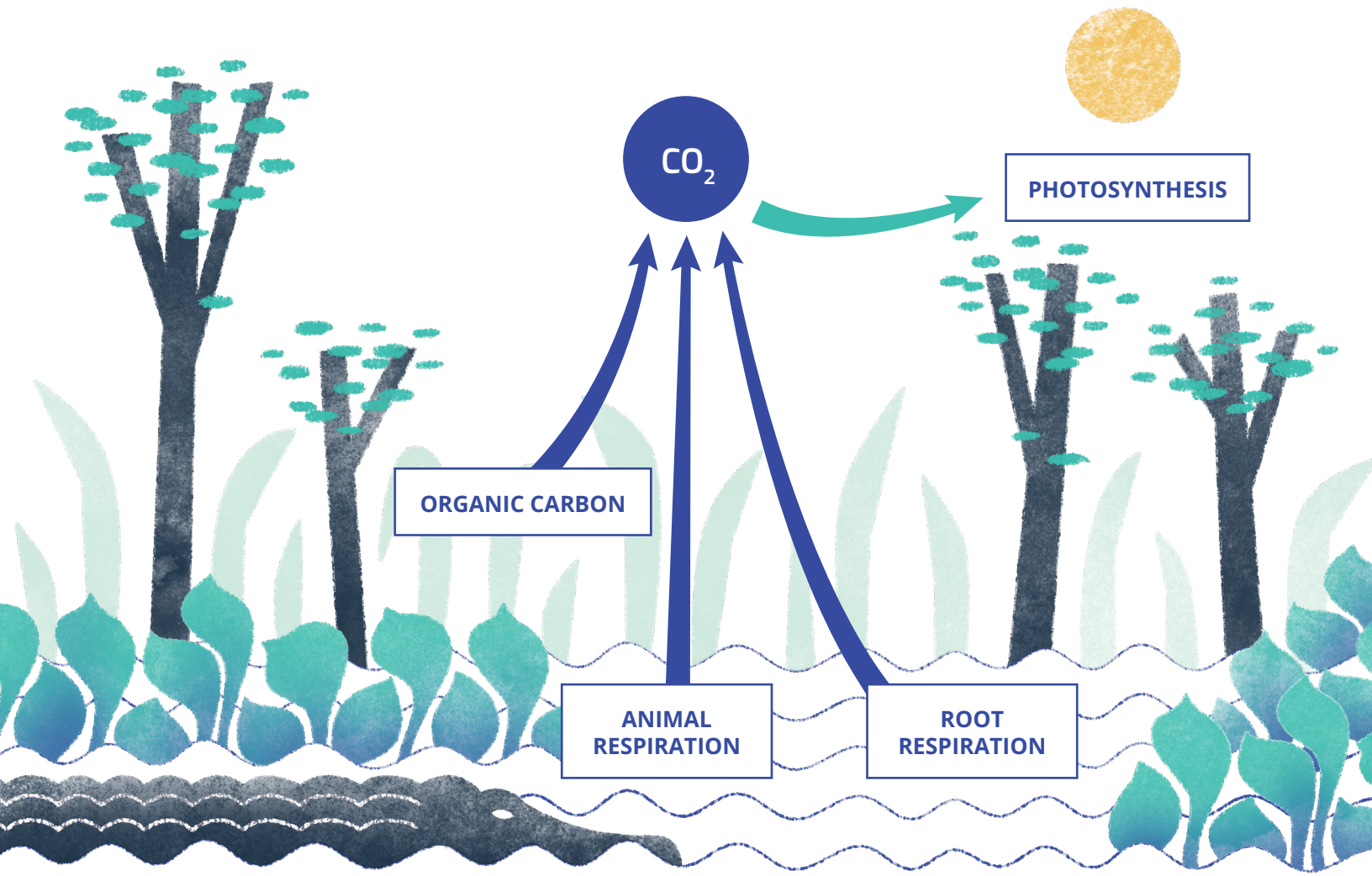
Some creatures become endangered or extinct because of long-term changes they struggle to adapt to. Other organisms may manage to adapt to climate change and its effects, but the way they do this can have consequences as well. For instance, quails are able to regulate their body temperature to cope with higher temperatures. Needing to expend more energy in this, though, means they cannot lay as many eggs. What would the effect of higher temperatures then be on the quail population?

Changing habitats

Some species adapt to changes in the environment and climate by changing their habitat. The conditions they live in or the other species they need to support their existence may no longer be present, so they need to move to another place. This reduces biodiversity in the area.

Forest area is steadily being reduced by a combination of human activities and climate change. This has caused many endangered animals, including the Visayan warty pig, to lose their habitat. Because these animals eat root crops and fruits, they have adapted to habitat loss by moving to the lowlands and foraging crops. Of course, this makes them more vulnerable to being hunted by humans for their meat. Fortunately, the Department of Environment and Natural Resources, Silliman University, and San Diego Zoo have teamed up to breed the pigs in captivity, to be released into a nature preserve. While this saves the species, it does not solve the problem of loss of biodiversity in their former habitat. In fact, biodiversity would be reduced even more in the forests where the pigs were taken from.

Another example of such an affected area is the Agusan Marsh, a 100,000-acre wetland ecosystem, suffering from drought in recent years. Lack of water has devastating effects on the many species that live there, including fish and almost 200 species of birds, as well as other animals. Wetlands are not only a source of food, they protect us from storms and floods by blocking storm surges and mitigating the strength



of wind. They are incredibly productive and diverse ecosystems.

Wetlands in our country are also where migratory birds from colder countries spend their winters. Some of these species, finding that the wetlands have dried up or been drained for human use, adapt by staying in rice fields instead. What consequences could result from this?

Living and nonliving systems

Not only are living things able to adapt, they interact with and affect nonliving systems. Plants, in particular, interact with the soil and they can enrich it with nutrients and microorganisms. You know that plants take in CO_2 from the air. With the help of sunlight, they convert this into food in the form of carbohydrates. They actually release this through their roots to feed organisms in the soil, which then convert this into CO_2, resulting in a **carbon cycle**.

Soil plays a valuable role not only in supporting the life of plants but also in acting as a **carbon sink**, holding in carbon that would otherwise be released into the air as CO_2. Plants are needed for it to perform its role as a carbon sink, especially forests.

Climate change can disrupt carbon sinks and create a cycle of degeneration. Stronger and more frequent rains cause more soil to erode, displacing it and the organic carbon it contains. Deforestation results in the loss of trees that absorb CO_2, which may lead to more CO_2 being released into the atmosphere.

ACTIVITY

The interactions of living and non-living organisms with the soil can influence the climate. The diagram below illustrates how different human and non-human activities affect the interaction of carbon to the soil and produce potential greenhouse gas. Fill in the blanks in the diagram with the letters of the given phrases that corresponds to each interaction and explain your observations.

A. Auto and factory emission
B. Plant respiration
C. Animal respiration
D. Photosynthesis
E. CO_2 in the atmoshere
F. Organic carbon
G. Fossil and fossil fuels
H. Dead organisms and waste products

HUMAN ADAPTATION AND MALADAPTATION

There are many ways in which humans have adapted behaviorally to their environment and climate. Usually, our focus when adapting to a situation is simply to survive. And so we just deal with it in a way that gives us an immediate benefit and keeps us from harm.

How would you adapt to the following effects of climate change? Write down the first answer that comes to your mind.

EFFECTS OF CLIMATE CHANGE	YOUR ADAPTIVE SOLUTIONS
extreme heat	
water shortage	
flooding	
increase in respiratory diseases	
increasing numbers of pests	

Compare your answers with the following common solutions:

1. Use air conditioning.
2. Dig more wells.
3. Build a flood barrier.
4. Use antibiotics.
5. Use pesticides.

These are popular solutions to these problems that unfortunately also contribute to the problem or create a new climate-related problem. Air conditioners, even the more environmentally-friendly ones, add greenhouse gases to the atmosphere. Deep wells cause more water to be taken out of the ground, which can cause the level of the land to go down and increase flooding. Building a flood barrier may be a temporary solution if it causes the ground level to sink while the floodwaters progressively get higher. Using antibiotics following the wrong dosage or for the wrong reasons can lead to antibiotic resistance, and do more harm than good. Pesticides kill helpful as well as harmful insects.

Sometimes we don't consider the long-term consequences of the actions we do to adapt. Poor adaptation strategies that cause more harm than good are called **maladaptive**.

It takes care and research to come up with good solutions to problems. Grasping for a quick fix could lead to greater consequences, such as when a barangay captain thought of attempting to reduce the mosquito population in his community by introducing numerous cane toads, non-native amphibians that prey on many creatures besides mosquitoes, including native frogs.

Philippine indigenous peoples have many traditional practices that ensure the renewal of their resources. The Ifugaos, Bontoks, and Tingguians of the Cordillera region depend on the forest for wood for shelter and firewood and also clear parts of it for farming, so they immediately plant native trees to replace those they cut and let forest cover regrow on certain fields after harvest. This is an example of a good, sustainable adaptation practice.

ACTIVITY

List down the most common climate hazards where you live. Which is your community most at risk of in the rainy season? In the dry season?

List down the common ways that help you adapt to these top climate hazards. Assess whether any of your answers are forms of maladaptation. Come up with better alternatives for the maladaptations.

Where you live:

Season you are most at risk:

Common hazards:

Solutions:

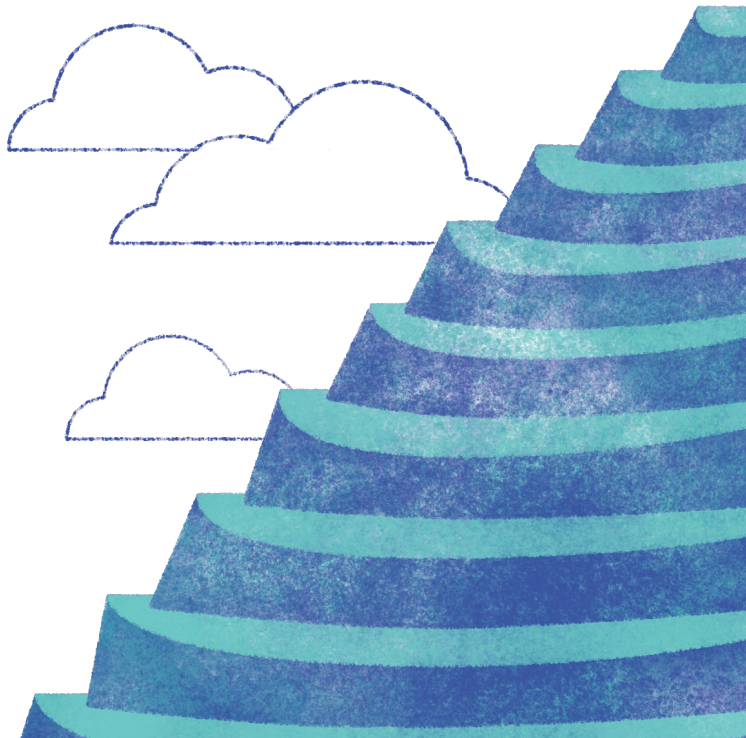
LIVING WITH OUR ENVIRONMENT: SUSTAINABILITY

"Sustainable development is to make the world a better place for everyone now, without destroying the possibilities for the next generations."

—Arindam Basu

What does **sustainability** mean? As the quote above suggests, it is about concern for all those living in the world, for natural ecosystems as well as human society. It means avoiding waste by using only what the system can provide while making sure we preserve and renew resources for the future. Given how much of the Earth's resources we have used, this is an important concern.

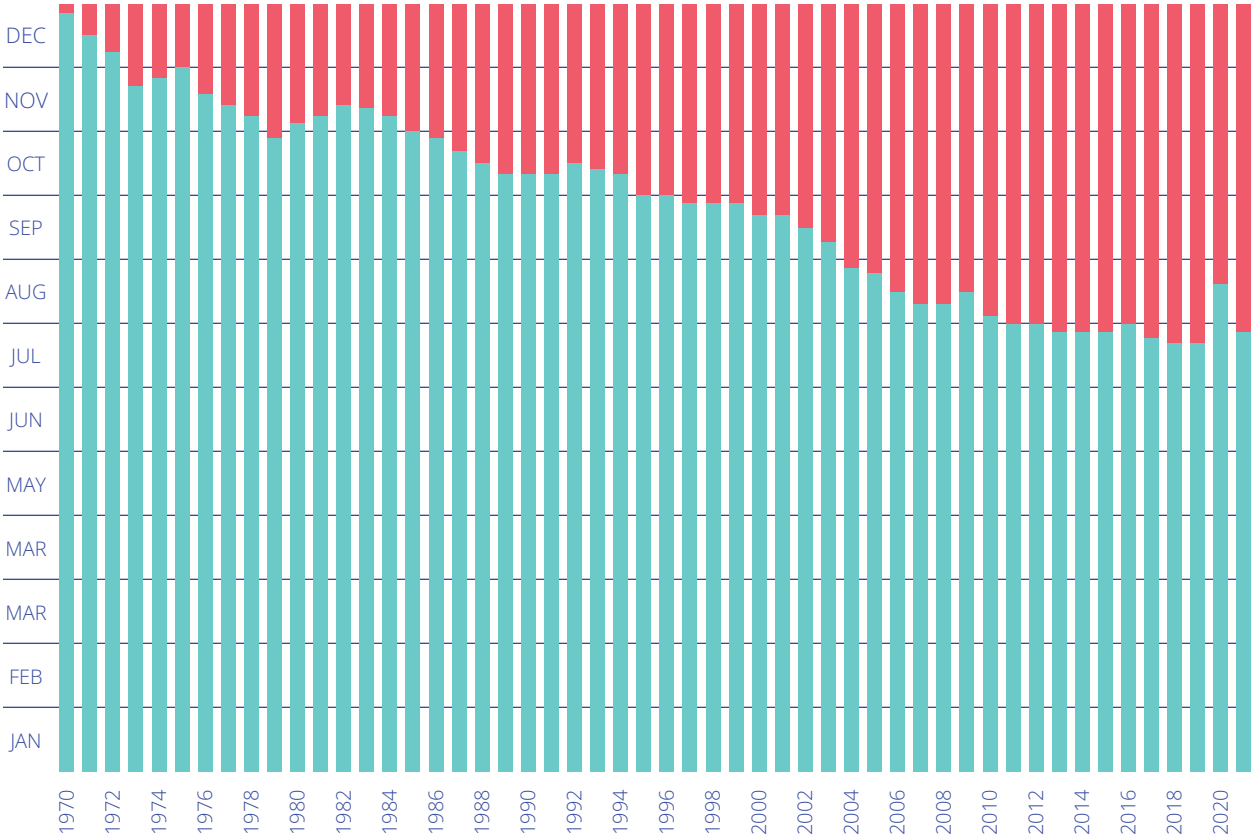
The adaptive practices of the indigenous peoples mentioned earlier are sustainable because they respect the limits of the resources and restore the resources as they are used. It is better to maintain the state of the environment than to wait until we have significantly depleted natural resources before trying to replace them.

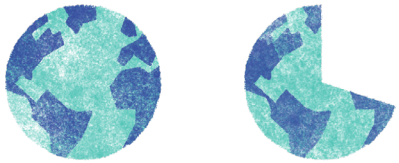


EARTH OVERSHOOT DAY

If you play or watch basketball, you know that to overshoot means to miss the basket by going past it, but what does Earth Overshoot mean? Earth Overshoot Day is the date in a year when the human population's demand for resources and benefits provided by the Earth goes beyond (overshoots) what can regenerate in that year. In this case, the goal is to use only the amount of resources that we can replace, but the tendency is for most of us to use more without replacing them.

Study the graph showing all the Earth Overshoot Days since the 1970s. What pattern do you notice? How do you feel about this?





We are living as if we have 1.7 Earths

ACTIVITY:
CONSUMING ONLY WHAT WE NEED

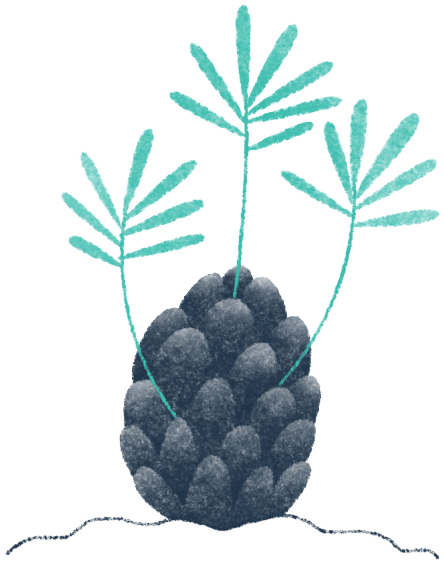
Growing, manufacturing, and transporting foods highly demand energy. In fact, half of Earth's biocapacity is used to feed our population. A University of Oxford study showed that eliminating all meat and dairy could reduce one person's carbon footprint by 73%. Meat and dairy products annually produce about 14.5% of GHGs, which is equal to all transportation emissions in a year! But even if we go plant-based, we still contribute to Earth Overshoot when we over consume. That's why it's important to plan our meals to reduce our food waste and prevent possible food shortages. Another way to prevent food loss is to adapt agroecological and regenerative farming or farming practices that do not erode the soil and other resources.

As a class, devise a dietary plan that promotes proper food consumption. Remember that it should be healthy, sustainable, and affordable for all.

MAINTAINING A REGENERATIVE CYCLE

We need to make sure every part of the system and subsystem thrives. In order to do this, we should strive to use resources wisely and do more than just replace what we use, such as trees that are cut. Since there is already degradation of the natural environment, we need to go a step further and try to regenerate the resources or restore them to the level they were in the past. Just like the Ifugaos, who have long had a tradition of planting and nurturing two tree seedlings to replace a single tree that they cut.

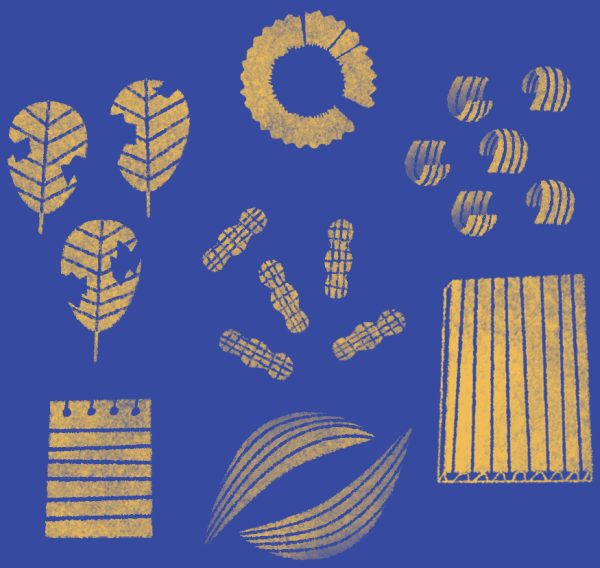
A simple way to not just renew but improve the soil is to compost or collect food waste and other biodegradable trash and turn it into fertilizer through a natural process of degradation. This will enrich the soil with nitrates and reduce the amount of methane that is released by trash when it degrades in landfills. And it will enable healthier plants to grow.



ACTIVITY:
COMPOSTING

Making compost will turn biodegradable waste into a natural fertilizer, which you can use for your garden. The biodegradable waste collected for compost is broken down by microorganisms, worms, and insects in the soil until it becomes nitrate (NO_3) and/or ammonium (NH_4) that can be used by plants. The release of nitrogen takes time, with decomposition speeding up when the soil grows warmer, unlike when using commercial fertilizers, which make nitrogen available at lower temperatures and excessively, much of it ending up in our water supply and the ocean.

If you don't have a patch of ground to make a compost heap on, you may use a large container such as a pail. Make sure to have a fairly equal mix of green materials, which provide nitrogen and protein, and brown materials, which provide carbon and carbohydrates. It should not be smelly; if it is, add more browns.



Green materials:

- fruit and vegetable peels and scraps (cooked or uncooked)
- fresh leaves, weeds, and plant clippings
- crushed eggshells and mussel shells
- used teabags
- coffee grounds and filters

Brown materials:

- pencil shavings and sawdust
- unlaminated paper and cardboard, paper bags
- dead leaves
- dry cornhusks
- nutshells

It helps to turn over the material on the edges of the pile every two weeks. After three months, it can be incorporated into soil as fertilizer. Add worms if you can find them.

ORGANISMS AND ECOSYSTEMS AROUND YOU

One indicator of a healthy environment is the presence of amphibians: frogs and toads. Although some species, such as the cane toad, are considered invasive pests, the presence of these animals indicates an environment with sufficient clean water and vegetation. They also keep the insect population in check.

For one week, see if you can find frogs and toads in your neighborhood. Take photos if you can and note if you hear their sounds.

You may use these guide questions for your observations: Is there clean water where you found the frogs and toads? Is there vegetation? How diverse is it?

If you didn't see any frogs and toads in your area, list the possible reasons for their absence.

Compare your notes with your classmates'.

Discuss why frogs and toads thrive in some areas but not in others. Factors that threaten amphibians include the following:

- a dry environment
- pollutants and pesticides
- lack of vegetation for them to shelter under

What factors present in your environment could affect the amphibian population? Has climate change contributed to this? What does the absence of amphibians mean? Do you think it's important to have amphibians in your area? Why or why not?

Use another sheet of paper for your observations.

DAY	NOTES
1	
2	
3	
4	

DAY	NOTES
5	
6	
7	

THE VALUE OF BIODIVERSITY

The presence of one species is not enough, of course, to ensure the health of an ecosystem. We need a network of species and ecosystems.

Plants and animals native to an area have developed an ecosystem to support each other. The more of these species found living together in a proper balance, the healthier the environment will be. This is called **biodiversity**.

Different species have different abilities, behavior, and nutrition needs which give each of them a unique role in the ecosystem. At the very least, they each form a part of a web of relationships for food and supply of resources. Many creatures are small, barely noticeable, until we experience the impact of their absence.

Insects are a primary example. They are a source of food for many animals, help decompose dead plants and animals, and keep the pest population down. While some insects themselves are pests, many other beneficial insects feed on them, which helps control their numbers naturally. Most importantly, insects pollinate plants. More than a third of the crops we plant produce food with the help of pollinators.

Lately, there is concern about the plummeting population of pollinators like birds, bees, bats, and butterflies globally, due to liberal use of pesticides. The absence of such pollinators can lead in turn to loss of some plant species that depend on them to reproduce. The loss of any species could have consequences for many others, which would in turn reduce other species populations, especially those that rely on a particular species for food or shelter. This is why we need to maintain biodiversity.

ACTIVITY

What is the most biodiverse area near you? Choose a species found there to research on. Find out its role in the ecosystem and how it is affected by climate change. Discuss what would happen if the population of this species is reduced in its habitat.

SPECIES:

LOCATION:

ROLE IN THE ECOSYSTEM:

FOOD:

KNOWN PREDATOR:

The ecosystem constantly changes to maintain biodiversity so it will have the right balance of species, habitats, and ecosystems to sustain it. Climate change contributes to upsetting this balance.

ADAPTATION AROUND US

As you have seen in the previous sections, biodiversity, sustainability, and adaptation are important for our Earth to thrive.

Looking around you, you may have observed the ways individuals and communities are trying to adapt to climate change. Very often, people opt for technology or infrastructure for adaptive solutions. This could involve artificial cooling systems like refrigeration and air conditioning. It may mean constructing dams and seawalls or raising bridges. The solution could also be chemical, like pesticides and repellent lotions to deal with mosquitoes, fertilizers to boost the growth of plants struggling to adapt to climate change, or protective paints for buildings.

Nature-based solutions are also available, like new methods of organic farming and simply adding more trees and greenery. These are more sustainable than those that rely on the creation of products, which could sometimes be maladaptive.

How we adapt to the effects of climate change will depend on the particular environment we live in. People who live in the city have different concerns from those who live in rural areas. Those who live along coasts have their own unique concerns. In the following chapters, you will learn how people need to adapt in some of the more common types of environments around you.

KEYWORDS

behavioral adaptation
the development of behaviors that aid the species in adapting to its environment

biological adaptation
the development of the organism's body over time to help it survive its environment

biodiversity
the diversity of life in a particular habitat or ecosystem

carbon sink
plants, soil, the ocean, or anything that absorbs large amounts of carbon dioxide from the air

compost
a mixture of decayed organic matter used as fertilizer

consumer
a category in the food chain that refers to any organism that obtains food by feeding on another organism or any organic matter

decomposer
an organism that feeds on and breaks down dead organic material

ecosystem
a system composed of living organisms (biotic factors) and the physical environment (abiotic factors) in a particular area functioning together as a unit

evolution
the biological change that occurs in organisms over time leading to the appearance of new forms

Earth Overshoot Day
the date in a year when the human population's demand for resources and benefits provided by the planet goes beyond what can regenerate in that year

habitat
a place where organisms live or thrive; also known as natural environment, natural territory, or natural home

maladaptation
poor or inadequate adaptation

maladaptive
poor adaptation strategies that cause more harm than good

predator
an organism that obtains food by killing other organisms

producer
a category in the food chain that refers to any organisms that make their own food

species
a group of organisms that belong to the same genetic heritage and can reproduce with one another and produce fertile offspring

sustainability
ability of biological systems to remain diverse, healthy, and productive over time

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CHAPTER 3

LIFE ALONG THE COASTS

The ocean: so vast it goes on beyond what our eyes can see. It teems with thousands of species, many of which we rely on for food and other necessities. It supports our existence in many ways that we aren't aware of.

Many Filipinos live near the ocean; others are frequent visitors. Whether you see the ocean often or live far away, you must be aware of the role this valuable natural resource plays and how we can help to preserve it. In this chapter, you will learn about how climate change has affected the ocean and reflect on ways we can mitigate as well as adapt to its effects.

SURVEYING THE PHILIPPINE SEAS

In our archipelagic nation, the ocean is very much a part of our lives. Many Filipinos rely on the ocean for their livelihood, especially through fishing, aquaculture, and tourism. For communities that rely on these industries, maintaining the quality of the water and the richness and biodiversity of life in it is essential for their economic survival and growth.

Our territory actually supports many more species of marine life forms than land—thousands of them. Of these species, we rely on over 700 for food, making marine resources essential to food security for us. Seafood is a major protein source for us, and a more climate-friendly one compared to animals raised for their meat.

Our corals themselves are biodiverse, particularly in Tubbataha Reef, which was declared a World Heritage Site in 1992. The coral reefs along our coasts are not just breathtaking heritage sites and tourist attractions, they support our wealth of marine life. The Philippines is found in a region known as the Coral Triangle, so named since it is highly populated with corals and is thus the world center of marine biodiversity. The Philippines is at the apex of this center, with various biodiverse habitats such as seagrass beds and mangrove forests as well as coral reefs.

Many of these marine species have become threatened, even endangered, due to various factors, among them climate change. Thus climate change has a serious impact on life in the ocean, which has direct consequences for us, the people who depend on it for food and livelihood, as well as a ripple effect on marine ecosystems and the environment.

So far, about 3.1 million hectares of Philippine ocean territory have been declared marine protected areas. Verde Island Passage, a strait between Luzon and Mindoro well-populated with giant corals, young sea turtles, and schools of fish, is considered the Global Center of Marine Biodiversity.

tilapia

galunggong

bangus

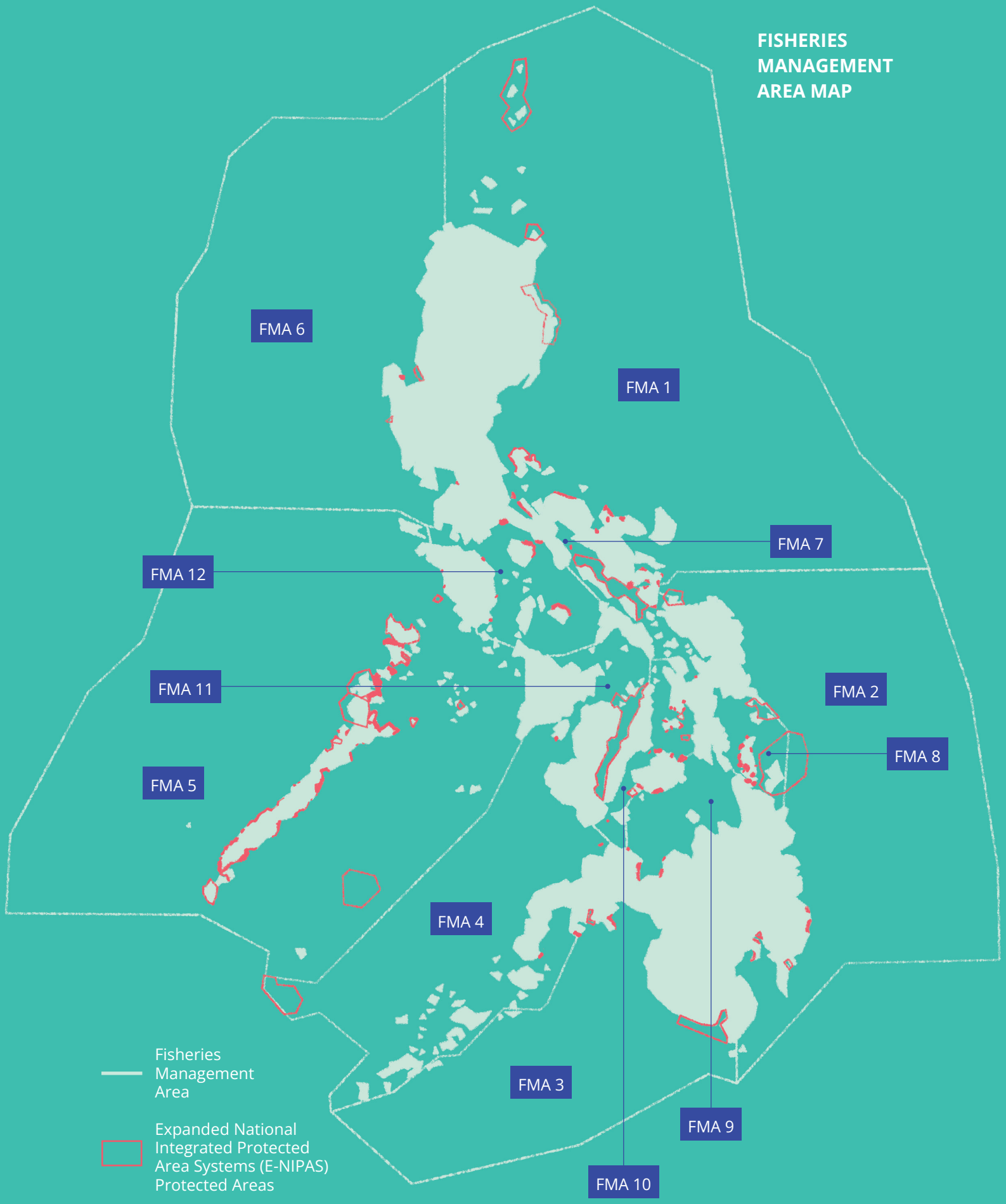
lapulapu

dalagang bukid

Tubbataha Reef

bit.ly/3rqeahp

FISHERIES MANAGEMENT AREA MAP



ACTIVITY:
STUDYING CLIMATE IMPACTS ON MARINE SPECIES

What marine species in the Philippines are familiar to you? Which ones would you miss if they disappeared from our waters?

Choose a local marine species and learn the following about it:

1. Where does it live?
2. What does it need for food and shelter?
3. Is it endangered or threatened? If not, what are possible threats to it?
4. How could climate change affect this species?
5. What other species could be affected by the extinction of this species?

Here are some sites you can refer to:

Marine Wildlife Watch of the Philippines

mwwphilippines.org

FishBase

tinyurl.com/385ap9bu

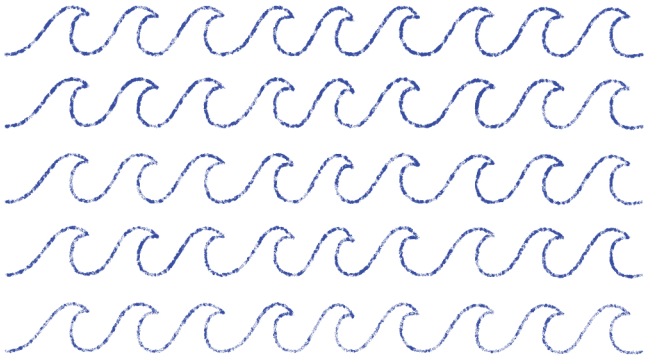
Butanding or whale shark (Scientific name: Rhincodon typus) is considered as the world's largest fish and can be found in all tropical oceans of the world. A Butanding can be identified by the unique spot patterns on its body.

THE OCEAN-CLIMATE CONNECTION

Perhaps the most important environmental purpose that cool blue expanse of water serves is to keep the planet warm. That's right, warm. The cool, blue ocean actually serves as a heat storage. Both land and water absorb the heat radiated by the sun but given that it covers 70% of the Earth's surface, the ocean naturally stores more.

Because water has a high heat capacity, it releases the heat slowly over months, even years. As the seawater evaporates, the air grows warmer and more humid and precipitates. The rain and storms are circulated by the trade winds to various areas. As the tropical areas around the equator are especially warm, there is more heat absorption and thus rain there. This includes the Philippines, of course.

Ocean currents caused by winds, variations in heat and salinity levels, and tides also have effects on the weather. The circulation of warm water toward the Arctic and Antarctic and the cold water towards the equator helps to regulate global temperatures. It evens things out, ensuring livable temperature levels throughout most of the world.



ACTIVITY:
OBSERVING THE FLOW OF CURRENTS

You will need:

- food coloring or ink (preferably blue)
- water
- an ice cube tray
- a large clear rectangular container

1. Freeze water mixed with a drop of food coloring in an ice cube tray overnight.
2. The next day, half-fill the container with water. Place a colored ice cube on each end of the container.
3. Observe what happens as the ice melts.
    a. Where does the colored water go?
    b. What does this show about the relationship between cold and warm ocean water and ocean currents?

THE OCEAN AS A HEAT SINK

With its ability to absorb warmth, the ocean also helps slow the rise in the Earth's temperature by serving as a heat sink, absorbing excess heat from the sun and distributing it.

The ocean is the largest solar energy collector on Earth. Due to its high heat capacity and depth, it generally takes time for the ocean's temperature to warm. It can absorb around four times more solar radiation than air before its temperature rises by one degree. In addition, it distributes the heat it receives through the global ocean circulation.

However, at the rate of global warming, the ocean is beginning to absorb heat more than it releases. At the moment, it is said that about 90% of the excess heat caused by global warming has been absorbed by the ocean. While it is able to mitigate it to a degree, as climate change escalates there will continue to be an increase in the temperature of the ocean along with the rest of the Earth.

ACTIVITY:
CAN YOU BOIL WATER IN A PAPER CUP?

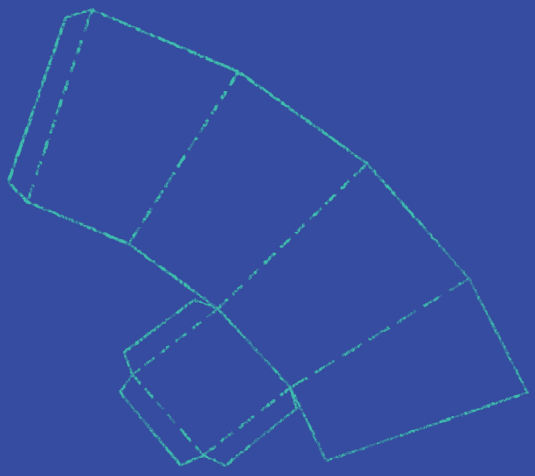
Do this activity with adult supervision to learn about water's capacity to absorb heat.

You will need:

- a sturdy paper cup (if you don't have one, enlarge and fold the container pattern below from thin cardboard)
- tongs
- a candle in a candle holder
- matches or lighter

1. Predict what would happen if you held an empty paper cup over a candle flame. Explain your answer.
2. Now fill the cup with water.
3. Light the candle then hold the paper cup just above the flame using the tongs.
4. Observe what happens to the cup.
5. Wait for the water to bubble then remove from the flame.

This experiment shows how water is able to draw heat away through convection. The heat is drawn away from the paper and distributed through the water in this way. On a much larger scale, heat is dispersed through the ocean which is why it takes much time to build up.



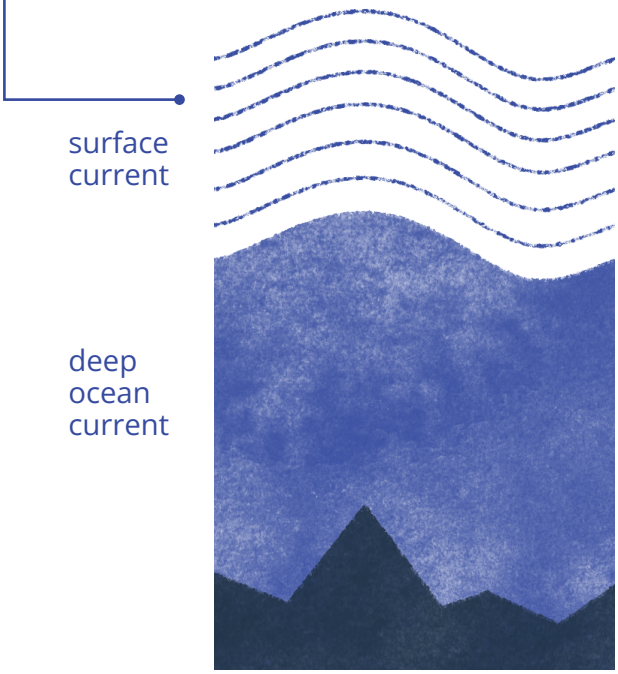
FACTORS AFFECTING OCEAN CURRENTS

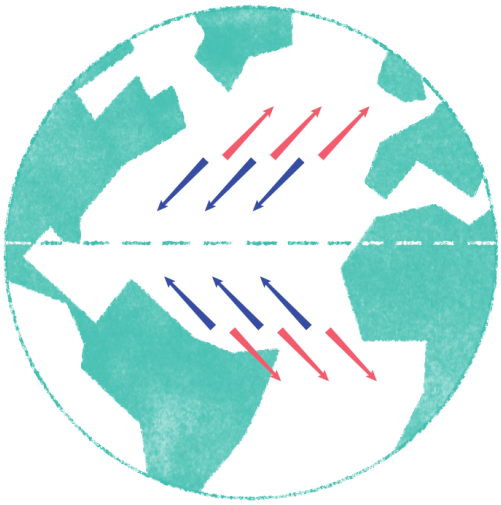
CLIMATE IMPACTS ON WIND PATTERNS AND OCEAN CURRENTS:

Both wind and ocean currents, including the Global Conveyer Belt, are means of distributing heat throughout the globe.

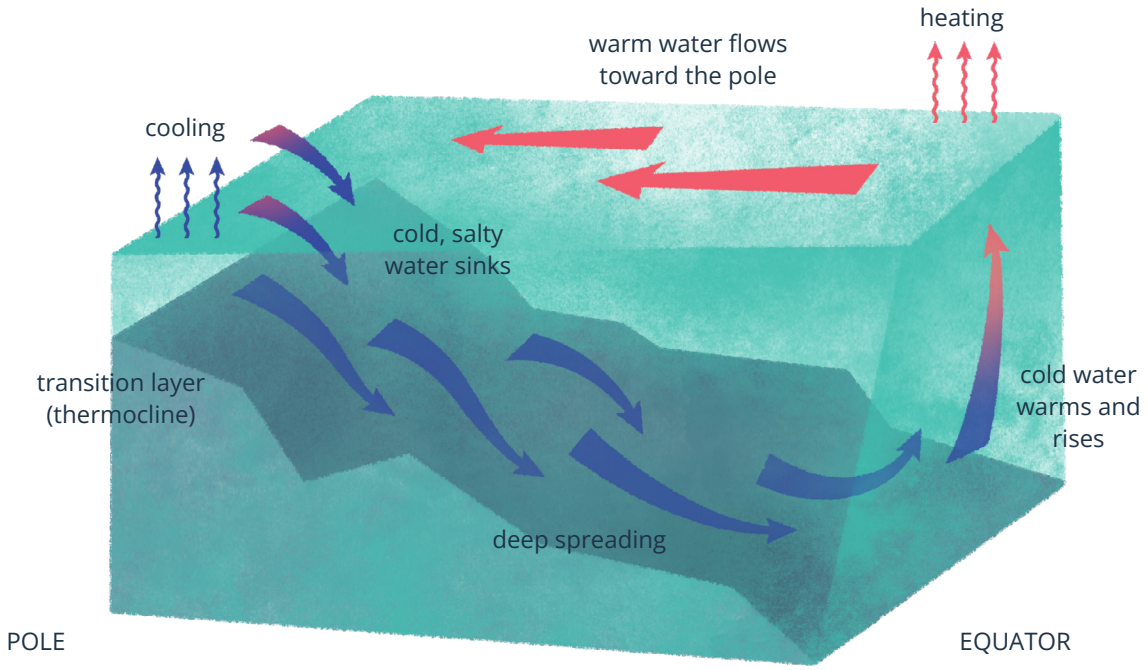
With a warming planet, changes in the dynamics of both wind and ocean currents may be expected.

The westerlies, the wind system typically blowing from the west across the middle latitudes, were found to be migrating poleward over the last several decades. Near-surface wind speeds over landmasses decreased since the 1980s, but have recovered and have been growing faster since about 2010. Research suggests that these changes were due to the changing climate, but scientists have yet to confirm this.

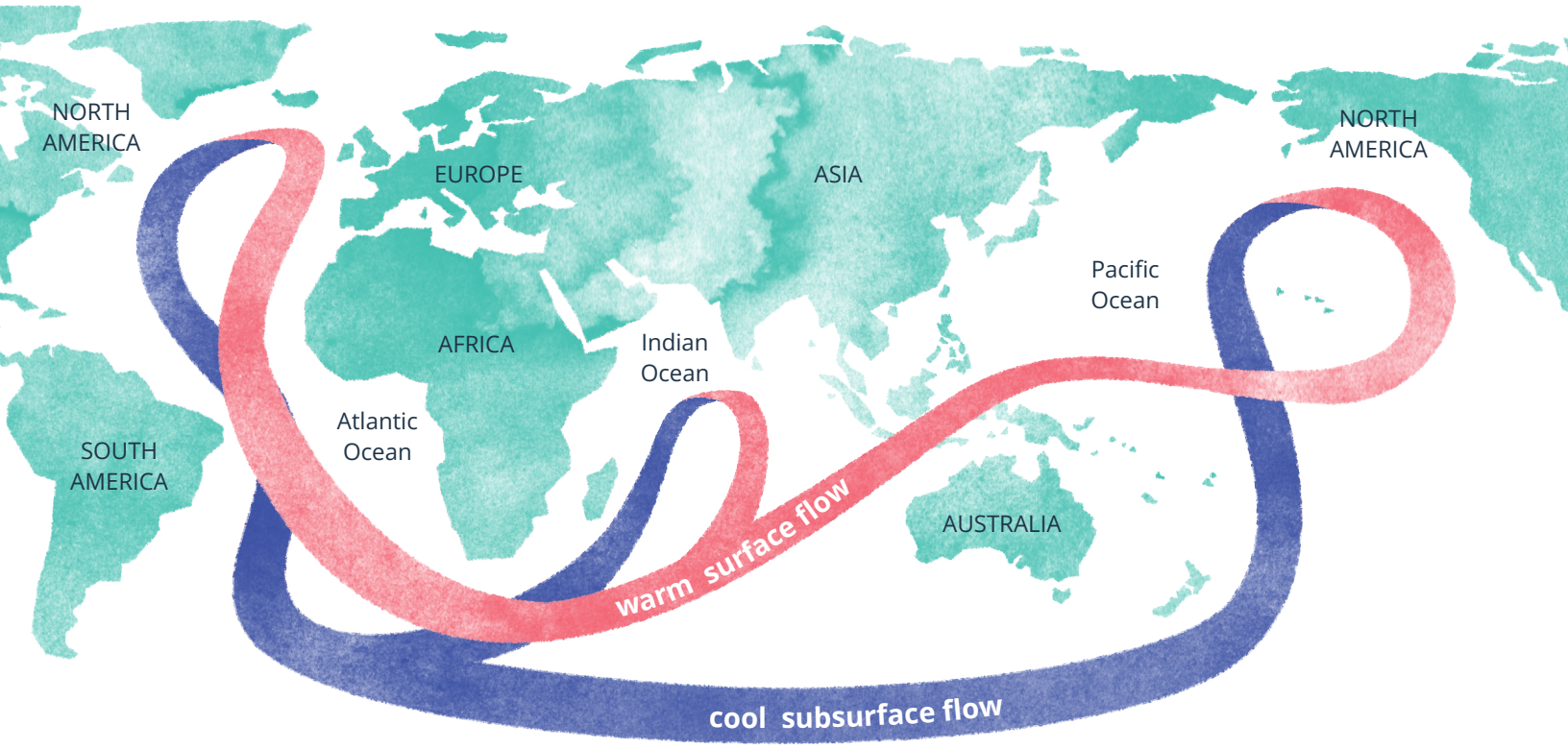




One major factor that drives the ocean current is water density. When water at the poles becomes warmer than normal, it becomes lighter and is less likely to sink deeper. In addition, the melting ice sheets and snow cover add fresh water into the salty ocean, further decreasing the water density. This results in the weakening of the ocean currents.



THE GLOBAL CONVEYOR BELT



THE OCEAN AS A CARBON SINK

Covering most of the Earth's surface, the ocean acts as the largest carbon sink, absorbing about 25% of all the emissions produced since the Industrial Age. You may wonder how ocean water is able to take in carbon. It is actually the wealth of plant life in the water that makes it the largest carbon sink. It is rich in seaweeds and seagrass, of course, but most marine vegetation actually cannot be seen by the naked eye. Microscopic marine algae or phytoplankton, along with bacteria in the ocean, absorb as much carbon as all the plant life on land.

The amount of carbon the ocean needs to absorb has become excessive, though, and is altering the ocean's chemistry. This change in the ocean's chemistry negatively impacts many forms of marine life.

ACTIVITY: SELLING SEAWEED

Learn more about local seaweed and its uses. Then create a vlog that promotes seaweed and/or seaweed farming, highlighting the climate effects of seaweed.

Can We Save The Sea With Seaweed?

You may be surprised to learn that farming seaweed is actually one of the most important industries in the Philippines: We are one of the world's top producers of seaweed! Not only is seaweed used for food, beauty products, and medicines, it can help mitigate climate effects. Aside from absorbing carbon, seaweed helps reduce methane emissions when used in cattle feed to reduce the release of this gas by cows. Being a high-protein source, it has potential to help us reduce our meat consumption. Widespread cultivation of seaweed along coastlines reduces the strength of waves. As many marine creatures rely on it for shelter, farming seaweed contributes to biodiversity.

Unfortunately, the growth of seaweed is also affected by climate change. There is less growth when there are warmer surface temperatures and brighter sunlight. Warmer temperatures also cause some diseases in seaweed whereas violent storms may wash them away. We need to increase its growth greatly in order for it to reduce climate impacts. Luckily, seaweed grows at a rate of about 60 cm a day, much faster than trees in a forest.

More Aids to Carbon Absorption

Wind and temperature help the ocean trap carbon. As the wind blows on the surface of the water, carbon dioxide gets trapped there. The difference between the amount of carbon in the air and in the water makes a difference! As larger proportions of carbon are released into the air, the ocean water absorbs more.

As the water cools, it sinks deeper and the carbon sinks along with it. The deep waters and ocean sediments hold in some of the carbon. Strong winds can bring some of this carbon-rich water to the surface, and this would mean less carbon from the air can be absorbed. This can be illustrated with a simple activity.

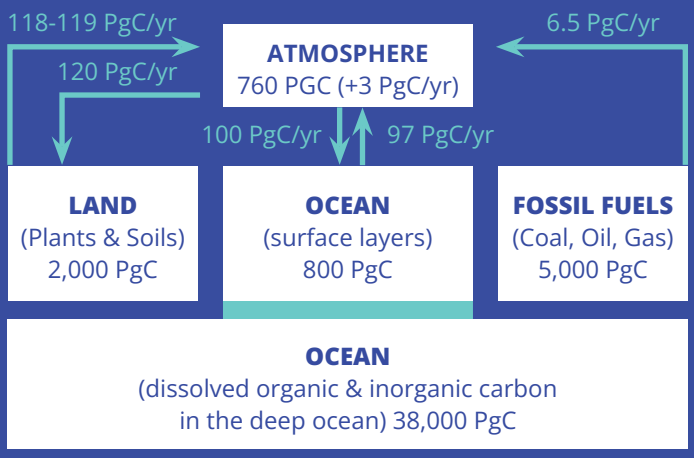
ACTIVITY

You will need:

- two measuring cups with gradations
- a dry sponge

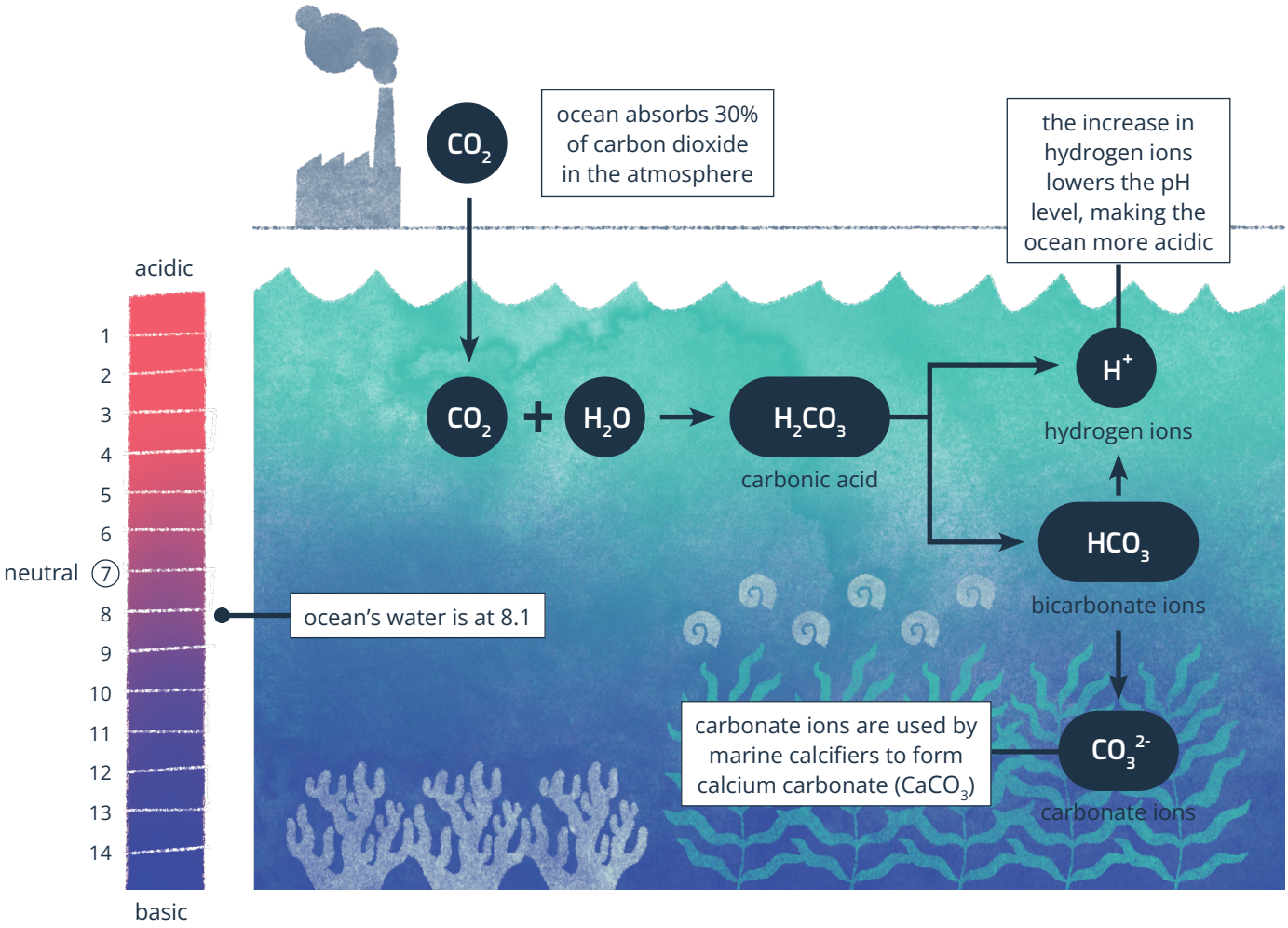
1. Fill each cup with one cup of water.
2. Drop the sponge in one cup of water and let it get completely soaked.
3. Take out the sponge and let the excess water drip back into the cup without squeezing it.
4. Now drop the soaked sponge in the other measuring cup.
5. Take out the sponge and again let the excess water drip into the cup without squeezing it. Then compare the levels of water. Which has a lower level? Why?

The cup that you put the dry sponge into should have a lower level of water. In this activity, water represents carbon dioxide and the sponge the ocean water. As with the sponge, the ocean water has a limited capacity to absorb. Once that limit is reached, it cannot absorb more carbon dioxide.



PgC means 'petagrams of carbon.'
1 PgC is equal to 1 Gigatonne of carbon.

The ocean plays a vital dominant role in the Earth's carbon cycle. The total amount of carbon in the ocean is about 50 times greater than the amount in the atmosphere, and is exchanged with the atmosphere on a time-scale of several hundred years.



CLIMATE CHANGE CHANGES SEAS

As large, powerful, and unchanging as it appears, the ocean has nevertheless been affected by climate change over the past century. With the rise of global temperature and increase in carbon emissions, the ocean has been undergoing changes that affect its function. These changes in turn have negative effects on marine life, including forms that we rely on for food. Some of the changes in the ocean can also further contribute to the hazards brought about by climate change.

Ocean Acidification

As more CO_2 is introduced into the ocean, it grows more acidic. This acid can eat away at calcium carbonate, which is a chemical component found in seawater and many marine creatures, including corals and shellfish. Coral skeletons are made of this material as are the shells of mussels, clams, and oysters. Ocean acidification impedes the formation of skeletons in corals and plankton. Exposure to acidic water over a prolonged period can make corals and shellfish more brittle and vulnerable. Acidification also reduces the ocean's CO_2 storage capacity.

Pteropods are small gastropods that makes the base of the oceanic food chain. They also have shells that are very sensitive to the increasing acidification of the ocean. This results in the decrease in their population, which can then cause a ripple effect on the whole of ocean's ecosystem.

ACTIVITY:
OBSERVING OCEAN ACIDIFICATION'S EFFECT ON SHELLS

In this experiment, you will be able to see how an acidic solution affects shells.

You will need:

- both halves of a mussel (*tahong*) shell, empty and clean
- ⅓ cup of water with 1 teaspoon of salt
- 2 tablespoons of vinegar
- two sauce containers or small jars with covers
- a measuring spoon (1tablespoon)
- a marking pen
- a stainless steel fork

1. Pour the vinegar in one container and stir in 2 tablespoons saltwater. Pour the rest of the water in the other container.
2. Label which container is plain saltwater and which has vinegar.
3. Separate the shell and place one half in each container. Label if necessary (if the vinegar has a distinct color, this may not be necessary).
4. Cover the containers and set aside for six hours.
5. Open containers and observe. Look at the liquid in each container and note changes. Have the shells changed? Note any changes in color. Test the hardness of the shell in vinegar by scratching it with the fork. Then do the same with the shell in saltwater. Write down your observations in the table below.
6. Return each shell to its container then leave overnight. Again, note any changes and test with the fork.

	Shell in Vinegar	**Shell in Saltwater**
After 6 hours	Appearance:	Appearance:
	Hardness:	Hardness:
After one night	Appearance:	Appearance:
	Hardness:	Hardness:

What do your observations show about the effect of acid on shells? What does this imply about acidification on shells of marine creatures?

Climate Effects on Corals: Heat Stress and Bleaching

The warm tropical waters in the Coral Triangle are able to support a great diversity of corals in extensive reefs. Coral reefs provide many benefits to marine life as spawning grounds and shelter for many creatures. They provide benefits to humans as well and are greatly appreciated for their beauty. The coral reefs of the Philippines attract many tourists because of their varied colors and the wealth of sea life that live in them.

Have you ever seen corals in real life? Did they look like what you see in the picture?

Coral bleaching in Calatagan, Batangas captured on July 6, 2020 by Jessie Fronda Delos Reyes

The corals look dull and faded because of the bleaching which occurs when corals are stressed. Stressors that affect corals include prolonged exposure to increased/high sea temperatures and violent storms. Stress on corals causes them to expel their symbiotic algae and turn white. As the corals lose the algae they feed on, they weaken, their growth lags and they become prone to diseases, even death. Some species of corals may die out due to bleaching events, to the detriment of the fish and other marine life that depend on them for food and shelter.

Aside from its contribution to tourism and providing shelter for marine life, healthy corals can also protect humans from some of the effects of climate change. Coral reef structures can act as a natural barrier for strong waves brought by violent storms, which consequently protects the shoreline and coastal communities from flooding, erosion, damage to property, or loss of lives.

There are efforts to protect corals from other stressors such as damage from boats and illegal fishing methods (e.g. use of explosives and chemicals), but research is still being done on how to help them adapt to greater heat. To help in the collection of data, a citizen science app has been launched to encourage divers to share pictures that show the state of the reefs they see. This was created by the volunteer group Philippine Coral Bleaching Watch (PCBW), which includes concerned divers and scientists. The organization forwards the data on the area to research agencies to check if the bleaching is due to the temperature or to other causes. Since 2018, over 500 reports have been sent by over a hundred divers to aid research on corals.

ACTIVITY:
PROMOTING CITIZEN SCIENCE TO SAVE THE CORALS

How can you use social media to help bring attention to areas with bleaching and threats to corals? Create a social media post that will link to the PCBW citizen science mobile app and website. Be sure to explain the importance of corals and explain how citizen science can help save them. You can use non-copyrighted images and link to articles.

tinyurl.com/2p83wded

The Dangers of Deoxygenation

Rising ocean temperatures combined with pollution has caused deoxygenation of seawater. This reduces the amount of oxygen marine organisms can absorb from the water. The issue of deoxygenation is especially a concern for us since it tends to occur more in tropical regions. The warmer the water is, the less gas it is able to absorb.

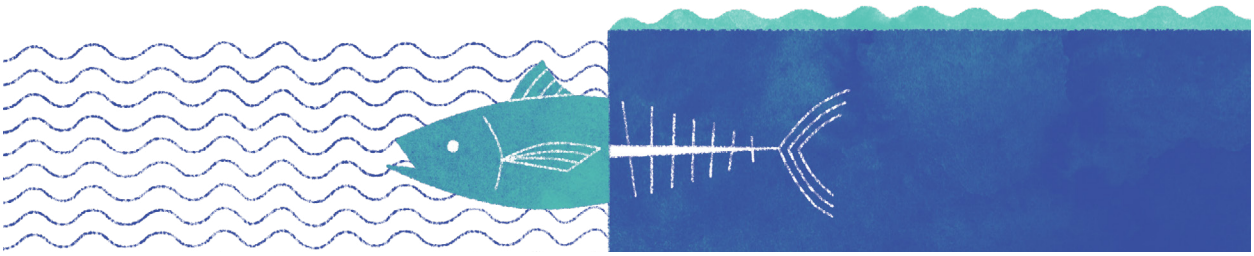
We cannot simply rely on the ocean to absorb all the excess heat. As marine waters grow warmer, they can hold less oxygen. In hot, tropical areas, the amount of oxygen lost can reach as much as 40%!

Apart from holding less oxygen, warmer ocean water is more buoyant than cooler waters. This means it tends to remain on the surface and the oxygen absorbed by the surface waters is not carried down to the cooler depths of the ocean. Also, the organisms in warmer waters develop a greater need for oxygen and so there is less to share among other marine life, even as creatures from below swim higher in search of more oxygen.

Large species with high metabolic rates, like tuna, sharks, and swordfish, are especially vulnerable to its effects. Many creatures also require more oxygen when dealing with higher temperatures. As they are starved for oxygen, such marine species are forced to leave traditional fishing grounds and crowd into smaller and smaller areas of oxygen-rich surface waters. Fish have also been found to grow less fertile as well as a result of deoxygenation, a problem which seems to persist in their offspring. This could mean a continuing decline in the population of many marine organisms.

There are few species that are able to adapt to lower oxygen levels in seawater. These include jellyfish, some kinds of squid, and algae. There can be an imbalance when there is an extreme growth in the population of these species. Nutrients from excess chemical fertilizers washed into the ocean from the land further increase the growth of algae. Such algal blooms mean the oxygen in the water is reduced even more as it is consumed by decomposing algae that has died. Certain types of algae produce toxins that can affect marine species, which then could poison the people who consume them. At times they give the water a reddish color, in what is called red tide.

Deoxygenation of the deeper ocean waters produces carbon dioxide as well as other greenhouse gases like nitrous oxide and methane. These gases may travel to the surface then to the atmosphere, contributing further to the greenhouse effect.



Species Moving and Changing with Climate Change

About half of the Earth's species have migrated due to climate change. Lack of oxygen and changing temperatures are driving many marine species to move to different territories. The marine creatures among these move at a rate of about 6.44 km a year, four times faster than the land species do. As much as 80% of marine species migrate and change their feeding and breeding patterns due to climate change. Some have migrated over 600 km from their original territory.

While some people benefit from finding new species in their territories, there are still more consequences. When a certain species migrates, the species that rely on it for food will either follow or starve.

For species that don't migrate, there may be other changes in them as they struggle to adapt to new challenges. They may burn energy faster and need to eat more, which could have an impact on the food web. They may become less fertile and spawn less.

The bodies of cold-blooded marine creatures like reptiles and fish tend to be more affected by changing temperatures. Sea turtles, especially endangered ones, are threatened by increasing temperatures and rising sea levels which disrupt their nesting sites.

Poisonous or venomous creatures like lionfish, sea snakes, crown-of-thorns starfish, and various species of jellyfish may seek out cooler waters, expanding their range. Jellyfish in particular can swarm in large numbers, leading to avoidance of beaches, at times even their closure.

Sea Level Rise

As the sea level continues to rise, the risk will become even greater. The water level in flooding will grow progressively higher, especially when accompanied by land subsidence and beach erosion.

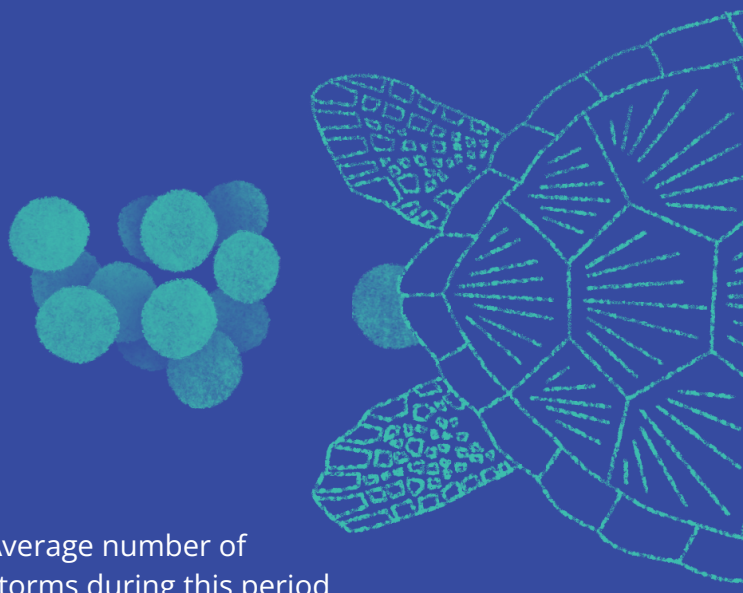
The sea encroaches on more and more land as it rises. Sea turtles, which return to the same shore to lay their eggs each year, may find their regular nesting places underwater or within reach of a tide that will wash their eggs away. Shoreline reduction can cause a problem for people who live along the coast. In some cases, whole residential areas and even islands have become submerged.

ACTIVITY:
CREATING AN INFOGRAPHIC

Create an infographic showing how global warming leads to ocean acidification and deoxygenation and how these affect different types of marine life.

ACTIVITY:

A SEA TURTLE'S NESTING SITE



Many sea turtle species are already endangered, and rising temperatures only make their populations more vulnerable. Hotter beaches lead to less egg production and eggs end up producing only females if they incubate at temperatures 31 degrees and above, which may make it difficult for future generations to find mates.

Are you familiar with different sea turtles in the Philippines? Look them up online and choose the most interesting for you. Then find out where their nesting site is and gather the following data:

Turtle species and description

Egg-laying period

Length of incubation of eggs

Highest temperature during egg-laying and incubation period

Average number of storms during this period

Sea level

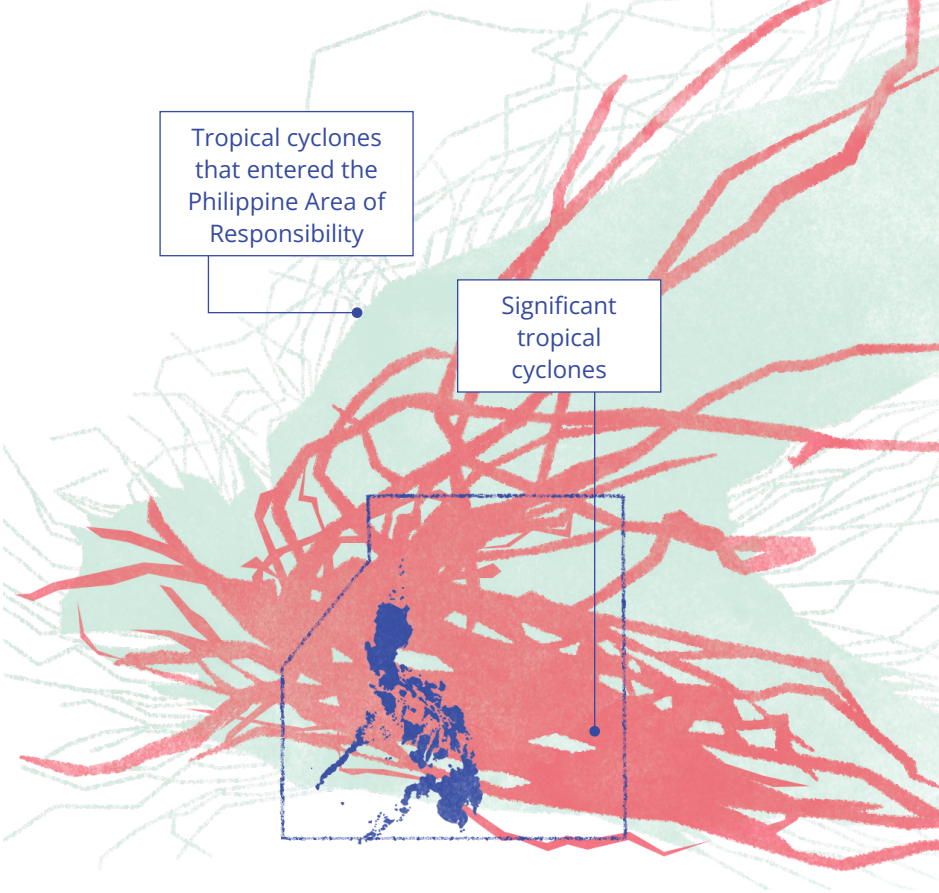
State of the beaches and efforts being made to protect turtles and their nesting sites here

Based on this data, assess how safe and conducive your sea turtle's nesting site is now.

You can get basic facts on Philippine sea turtle species at: *https://mwwphilippines.org/learn-more-about-turtles/*

bit.ly/35YICHY

Intensifying tropical cyclones



In 2021, Visayas and Mindanao were struck by Typhoon Odette, one of the strongest storms in the world that year and the sixth to reach Category 5 though it had only been predicted to be a Category 3. The storm intensified unusually fast, exceeding all predictions. While it did not reach close to the casualty rate of Yolanda, the storm caused widespread destruction, especially since people were unprepared for its intensity as it made landfall nine times.

This type of scenario may grow more common with climate change. In the past decades, tropical cyclones were observed to be growing more powerful. As ocean surface warms with climate change, more energy is available to fuel these storms, amplifying their destructive power. The number of tropical cyclones forming per year, however, may decrease or just remain the same. But a larger proportion of more intense storms have been observed and are projected to increase. In addition, the rainfall associated with tropical storms are also expected to increase. A growing consensus among researchers attributes these changes to climate change.

Surge of Storm Surges

Similar to a tsunami in size and potential devastation, a storm surge is the sudden rise of the sea in areas with low atmospheric pressure and/or strong winds. Such conditions are generally caused by typhoons. The height of the storm surge goes beyond that of a normal tide. The most extreme example of this in the Philippines is the storm surge caused by Typhoon Yolanda in 2013. The devastation it caused is shown in the first episode of *Mga Kwento ng Klima*.

While storm surges have always been a possible hazard following a typhoon or other extreme weather event, climate change can make the possibility more frequent. Ocean warming has also led to the development of stronger tropical cyclones. More frequent and intense rainstorms along with land subsidence and a higher sea level mean higher floods in the event of a storm surge.

ACTIVITY:
EFFECTIVELY COMMUNICATING HAZARDS

One of the reasons for the high number of casualties from Typhoon Yolanda in 2013 was that many people did not evacuate early enough. While evacuation centers may have been insufficient and some flattened by the waves anyway, many people who lived close to the coast would have been less vulnerable on higher ground.

Weather forecasts had mentioned the possibility of storm surge, but a number of survivors admitted afterward that the term was unfamiliar to them. They did not feel the urgency to evacuate until flooding had already begun.

While the calamity has made this type of hazard more familiar, it is still necessary to clearly communicate risks and corresponding safety measures without instilling panic.

Write a short warning of hazards that may accompany a typhoon that gives the necessary information in familiar words, but without causing panic. You may also use a local language commonly used in your area for your announcement. Find out relevant local terms about weather and climate that you can use.

EMBRACING THE OCEAN AS A SOLUTION TO CLIMATE CHANGE

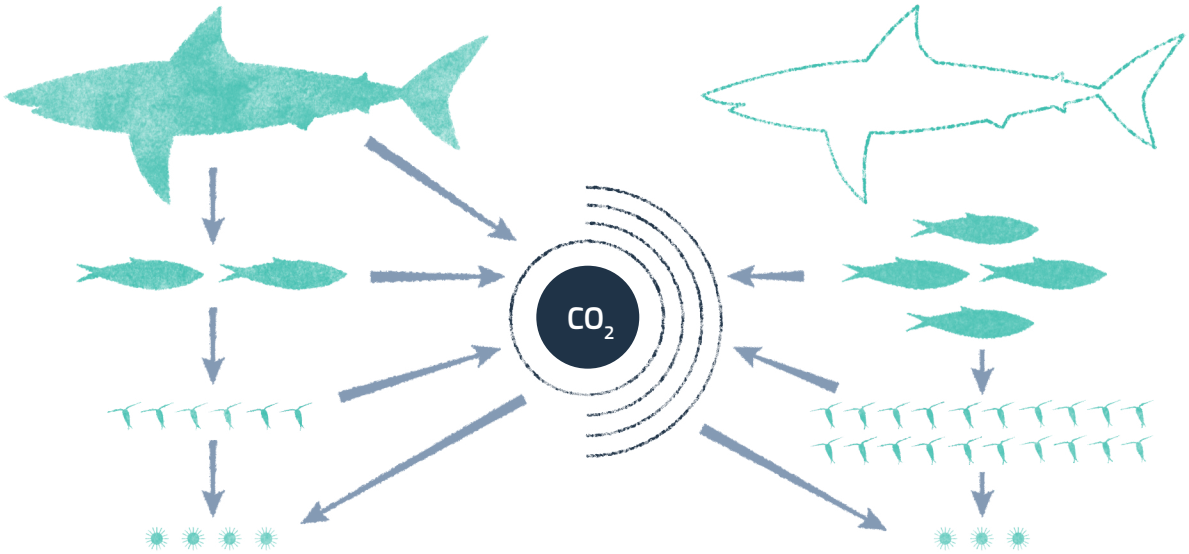
The ocean itself can be harnessed as a solution to the problem of global warming with its plant life being recognized as being highly effective at capturing carbon. The phytoplankton which populate the ocean in vast numbers is able to both process carbon and produce oxygen. Seagrass beds and mangrove forests have been found more effective than even rainforests in capturing carbon.

Other forms of marine life can also be harnessed to help reduce the effects of storms. Aquaculture can be effectively utilized to provide solutions to climate impacts and hazards. This includes the cultivation not just of seaweed but of certain marine creatures.

Sustainable Fishing

Fishing is an important source of food and means of livelihood in the Philippines. It is also affected by climate change since intense rain events prevent fishermen from going out to sea and the seafood population is reduced by damage to coral reefs and ocean acidification.

Overfishing can further contribute to the reduction of the seafood population, reducing biodiversity. Most of the fish in demand for food are larger ones, which are predators of many smaller fish. If the natural balance of the fish population is maintained, the population of smaller fish is reduced by the larger ones, reducing the number of fish that produce carbon dioxide. Unethical fishing methods, such as the use of explosives and poison, also damage coral reefs.



However, fishing itself can be part of the solution to the problem of climate change if done properly. Fish is a major protein food source with far less emissions than raising livestock for meat: 1,000–5,000 g of carbon per kilo of fish caught vs. 50,000–850,000 g for red meat (This applies mainly to pork and beef as less emissions result from poultries). Yet globally, only 17% of animal protein consumed is seafood.

Being able to fish or to raise fish closer to shore reduces the carbon footprint from boat engines. Accompanied by reducing fish spoilage by learning methods of drying and preserving fish and other seafood, emissions can be reduced by fishermen as they go about their livelihood. Especially if they practice sustainable fishing, or use fishing practices that assure there will always be enough fish in the ocean. This means preserving fish habitats like mangrove forests and coral reefs and saving threatened species. Overfished species must be given time to restore their population. Nets used in fishing must have large enough holes to allow young fish to escape. Certain types of hooks are chosen so that when sea turtles or sharks bite, they can be unhooked without injury, allowing more of these large marine animals to survive to keep the population of smaller fish small.

Among the most sustainable fishing methods are line and spear fishing, aquaculture with properly managed fish pens, and permitting fishing only in certain seasons. The Tagbanua people use spears and only hunt for specific fish species at certain times of the year, allowing fish to maintain a healthy stock. Having a closed fishing season allows more fish to spawn and grow, which ultimately benefits the fishermen. They can be given alternate sources of livelihood during the closed season, such as giving boat tours or selling preserved seafood. Fishermen are happy to comply with the restrictions when they see how these lead to a much larger catch. Increasing breeding grounds for fish such as mangrove stands and coral reefs will help ensure there will continue to be a good catch.

Mangrove Maintenance and Reforestation

Mangroves are trees that grow along coasts and serve as carbon sinks as well as provide a habitat for many creatures. They are able to absorb large amounts of carbon, maintaining three to four times more in their soil than tropical forests on land.

Mangrove forests have been found to save communities from severe effects of storms. The small town of General MacArthur in Eastern Samar had no human casualties from the storm surge from Typhoon Yolanda, though many of their buildings and homes were badly damaged. There was little damage to the market area by the bay across the mangrove stands. There were sixty-four killed in a neighboring town but MacArthur, whose mangroves are officially protected, managed to save its whole population of about 14,000.

Mangroves serve as a buffer to storms, as you have learned in previous activities. Unfortunately, as much as 80% of mangrove forest in the Philippines has been lost. Following Typhoon Yolanda, scientists recommended rehabilitation of up to 200 hectares of mangrove forest and starting new growth of these a hundred meters from the coastline instead of just forty meters. However, it is taking some time to meet these goals.

There need to be more efforts to plant more of these trees in the appropriate locations. Sufficient space should be allotted to the mangroves, which means structures must be built some distance from them. The trees need to be allowed to grow and spread and not be cut down.

Find out if there is a mangrove reforestation project near you or in a coastal area that has been badly affected by a typhoon. See if you can contribute or participate in such an effort.

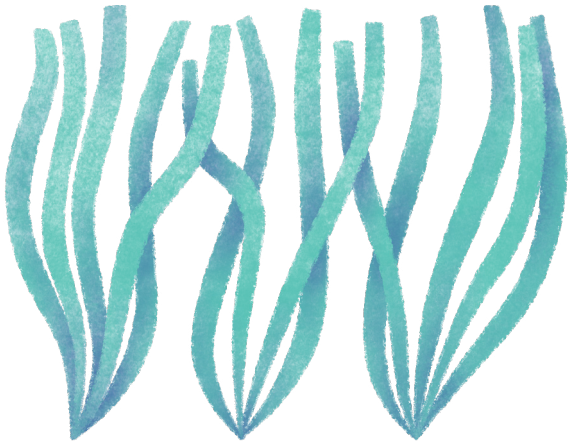
Can't find an ongoing mangrove reforestation project? Why not start one? With your class, you can come up with a project to raise funds for mangrove reforestation in a vulnerable area such as Tacloban.

> "...when healthy, mangrove forests, saltwater marshlands and seagrass meadows are extremely effective at storing atmospheric carbon, thereby mitigating climate change."
> —UNEP/IUCN 2009

Sustaining Seagrass

Like mangroves, seagrass beds also provide shelter and food to many marine creatures. They grow easily in shallow tropical waters. Both small creatures like shrimps and sea urchins as well as large ones like the endangered sea turtles and dugongs are dependent on seagrass beds. As much as 95% of the dugong's diet consists of seagrass!

A healthy seagrass ecosystem is a major contributor to high biodiversity and rich seafood resources. Seagrass also has a high carbon-absorbing capacity, with the seagrass beds of the world absorbing 166 grams of carbon per square meter in a year. Southeast Asia is the center of global seagrass growth.

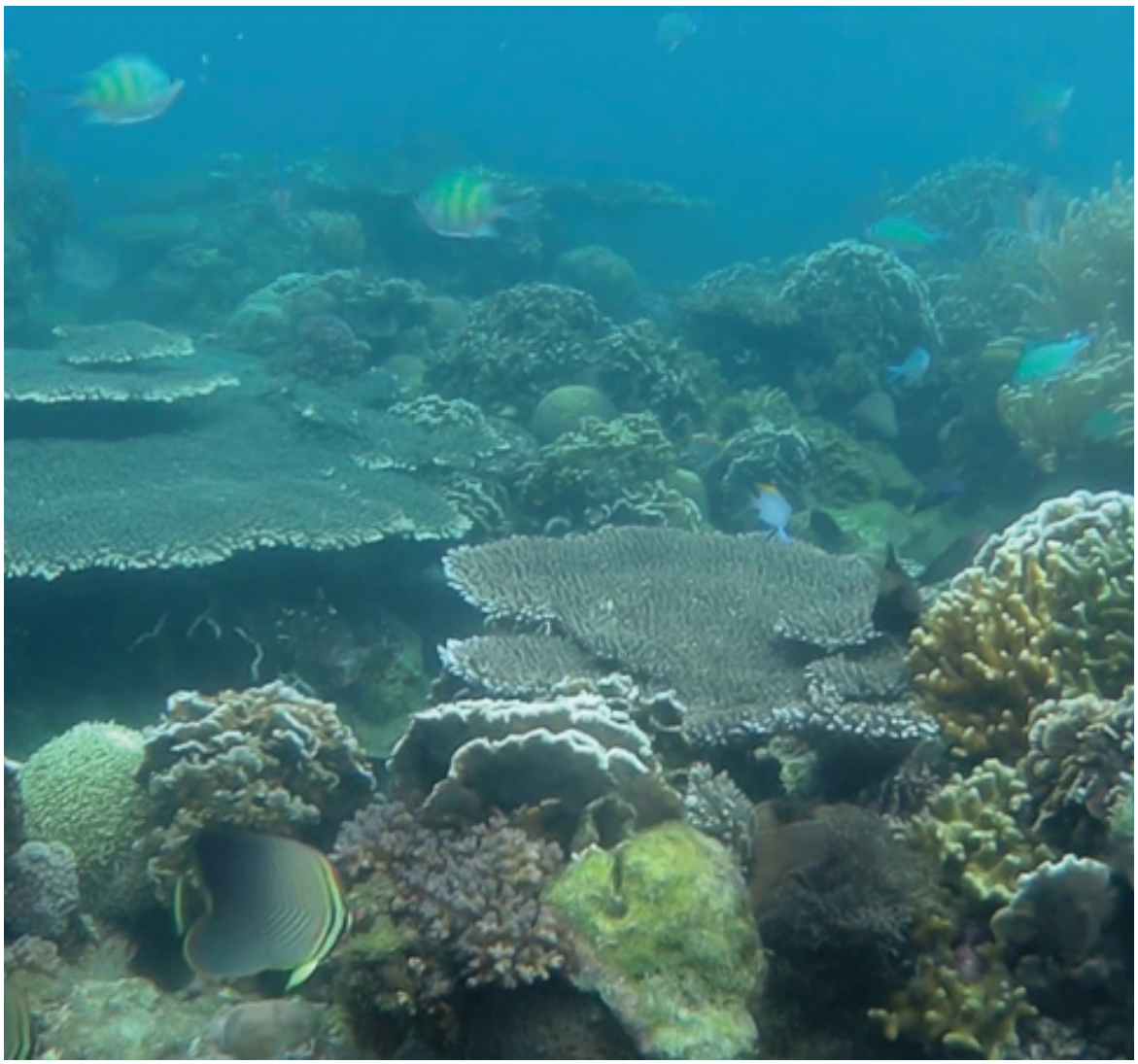


The Need for Marine Protected Areas

To maintain the growth of marine resources, certain areas of the ocean with a wealth of these are designated as Marine Protected Areas (MPAs). In these areas, healthy ecosystems can be maintained. They help in climate change adaptation and the mitigation of its effects. They could include mangrove stands, wetlands, barrier islands, and coral reefs that dampen the effects of storms, for instance. Marine creatures are better able to adapt to climate change in such areas, since they allow them free movement to go to safer areas and get the resources they need.

Right now, sadly only 6.35% of the ocean is protected. Furthermore, just around 1.89% of the ocean consists of exclusively **no-take MPAs** where all activities that take resources from the area, such as fishing, mining, or oil-drilling, are prohibited.

The designated MPAs usually are not sufficiently guarded and maintained. There is usually a lack of people to manage the areas due to low funding. Protection of these areas needs to be given higher priority by the government.



A portion of the coral reef in Brgy. Butong Taal Batangas Philippines. Photo by C2e architect

ACTIVITY

With a group, prepare a report on an MPA of your choice. Answer the following questions:

1. What are the special features and species found here? Provide illustrations of these.
2. How does this MPA contribute to climate change adaptation and/or mitigation of its effects? What are the threats to this area?
3. What are your recommendations for maintaining and enhancing this area?

After you present your report to your class, your teacher can help you to send it to the proper authorities.

Energy From the Sea: The Wave of the Future?

As much as we fear the force of the waves when there is a risk of storm surge, it has its benefits, and not only for surfers. Waves are consistently produced in coastal areas. Even in the absence of wind, there will be motion in the sea during tides. The movement from waves and tides produces energy that can be harnessed as renewable sources. This can be done with different devices.

Wave and tidal energy are still fairly new technologies with some advantages that still need to be addressed. First, is that marine life could be affected by changes in the tidal currents and even injured by the turbines. Second is the cost: tidal turbines are much more costly to build than wind turbines. They can recoup their cost though by producing more energy and more consistently, as the tide always occurs regularly. Third, the energy plants and the areas they serve will need to be near a coast.

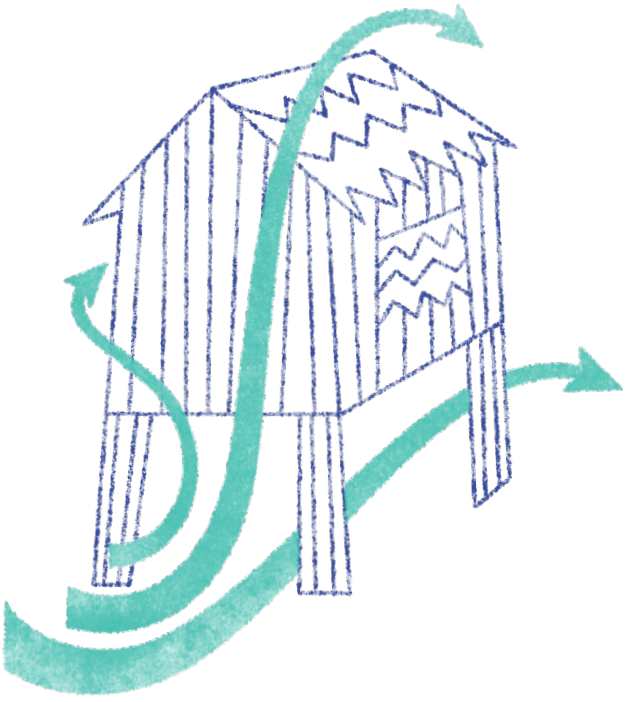
Tidal energy plants' impact on marine life can be reduced by the construction of a tidal lagoon, an artificial body of water that will only fill up when the tide comes in. Larger sea creatures would not be able to get into the lagoon and the small ones that do could hide from predators there and multiply, increasing fish supply. While tidal and wave energy is not suitable for every environment, for an archipelago like the Philippines, it has potential as a renewable energy option.

Given how much coastline the Philippines has, it has for some years been suggested for our country as a source of renewable energy. The World Bank estimates that the wave energy potential of the Philippines amounts to about 33 kilowatts per meter per year (kw/m/year) on the Pacific coast and 35 kw/m/year on the West Philippine Coast. Currently, tidal and wave energy plants have been set up in Zambales, Sorsogon, Norther Samar, and Surigao del Norte.

Learn more about the tidal and wave energy plants in the Philippines. What methods do they use? Have they been successful in providing electricity? If they have, what conditions of their location made them successful?

ADAPTIVE COASTAL DEVELOPMENT

In earlier times, people needed to settle near bodies of water to have a source of food as well as drinking water. As a result, many Philippine cities are built along riverbanks or coasts. Unfortunately, the Philippines is expected to experience three times the sea level rise than the rest of the world will. To make things worse, intense urbanization is happening with faulty urban planning and the lack of proper sewage, drainage, and waste management.



The coast is the location of seven of the country's most vulnerable cities to a one-meter sea level rise: Manila, Taguig, Caloocan, Davao, Butuan, Malabon, and Iloilo. Coastal communities of as many as nineteen municipalities around Manila Bay could be flooded with this one-meter rise—an area of about 5,555 hectares! Therefore, it is urgent that we accept the rise of the sea level and the flooding it causes as part of our lives and adapt.

Residents of coastal areas have to be aware of hazards like storm surge and flooding, and realize that the water level is likely to get higher in the future.

Moving further inland and to higher places is a good idea, but may not be possible for many. So changes have to be made in the design of coastal homes, buildings, towns, and cities.

Architects of Cebu offered some solutions after typhoon Yolanda devastated their area. First, there are lessons we can learn from traditional homes. The Ivatans of windy Batanes make stone houses with solid walls on the windy side and situate their windows on the side that receives less wind. Houses can also be built on stilts as they were traditionally. They advised that the safest type of home for a coastal area is a one-story square-shaped unit that stands alone, so wind can blow between the buildings. Rectangular houses should be built parallel to the usual direction of the wind.

Roofs should not be made high-pitched and slanting. Octagonal or dome roofs would reduce the force of the wind.

ACTIVITY:
COMMUNITY HAZARD PROTECTION

If your community is vulnerable to storm surge, do you think it is protected enough? You may look back at previous storms to consider the effectiveness of current measures. Even if you don't live along the coast, your area may still be susceptible to flooding brought about by stronger storms due to climate change and land subsidence.

If you don't live near a vulnerable coastal area, which areas do you know of fall in this category? You may have heard about areas that experienced storm surge in the news. Choose such an area to work on.

Which of the solutions given above do you think would be most effective for your chosen area? Check a map of your area to find out where these could be situated. Learn where there are existing natural buffers like mangrove stands, wetlands, and reefs which could be rehabilitated. There may also be flood mitigation measures built in your area. Mark out where these protective measures are on a map. Then, using a different color, mark out places where an additional means of protection could be located. Explain what type of protective measure this is and how it would be effective. Make sure to focus more on natural solutions that preserve the environment.

Why Can't We Just Keep The Sea Out With A Wall?

It might seem like an obvious solution just to build a wall to keep the water out or break the force of the waves so the water won't travel as far. Seawalls have been used to attempt to combat storm surge, but can cause the sea floor to get more eroded.

Simply widening the beach or creating dunes with sand, a process called beach nourishment, can reduce the force of the waves on houses and buildings further inland. It can be combined with a seawall, serving to reduce the force of the waves before they reach the wall, making it more effective. However, it does not protect against high water.

Given how much vulnerable coastline the Philippine has, employing such projects as solutions is costly and labor-intensive. These all require maintenance, too. Beach nourishment in particular requires regular restoration of the sand carried away, though it still costs less than building and repairing a seawall. Because the sea level keeps rising, a seawall might not be high enough to be effective in the future and will have to be raised. And any construction project that requires machinery and transport produces carbon emissions. Natural beach habitats are disturbed and destroyed to build such walls. It is better instead to grow mangroves that will keep growing and shelter marine life.

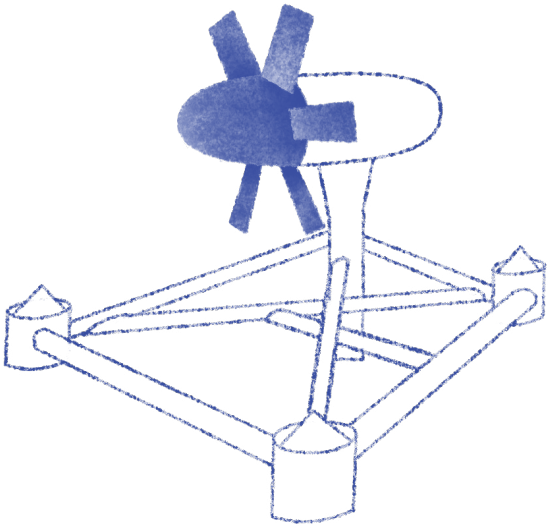
Concrete roof decks are best (and may be a means of evacuating residents if the house is flooded).

Storm shutters and strong tempered glass are a good idea for windows. Regular glass with a safety film (which can also be tinted to reduce heat) is a less expensive alternative.

These design elements can also be used for buildings, even placing them on stilts. The space beneath can be utilized for parking, reducing the need to dig up and pave lots just for that purpose. More pavement also contributes to flooding as it replaces the soil and vegetation that can absorb excess water.

APPRECIATION FOR THE OCEAN

The ocean provides us with a wealth of resources, including ways of combating climate change and its effects. We need to make the most of these resources and further enrich them. It is possible for the ocean to provide us with food, energy, recreation, and health products while effectively performing its role as a carbon sink and helping maintain the Earth's temperature at a livable level. We need to care for the ocean!



ACTIVITY:
ENVISIONING AN IDEAL COASTAL AREA

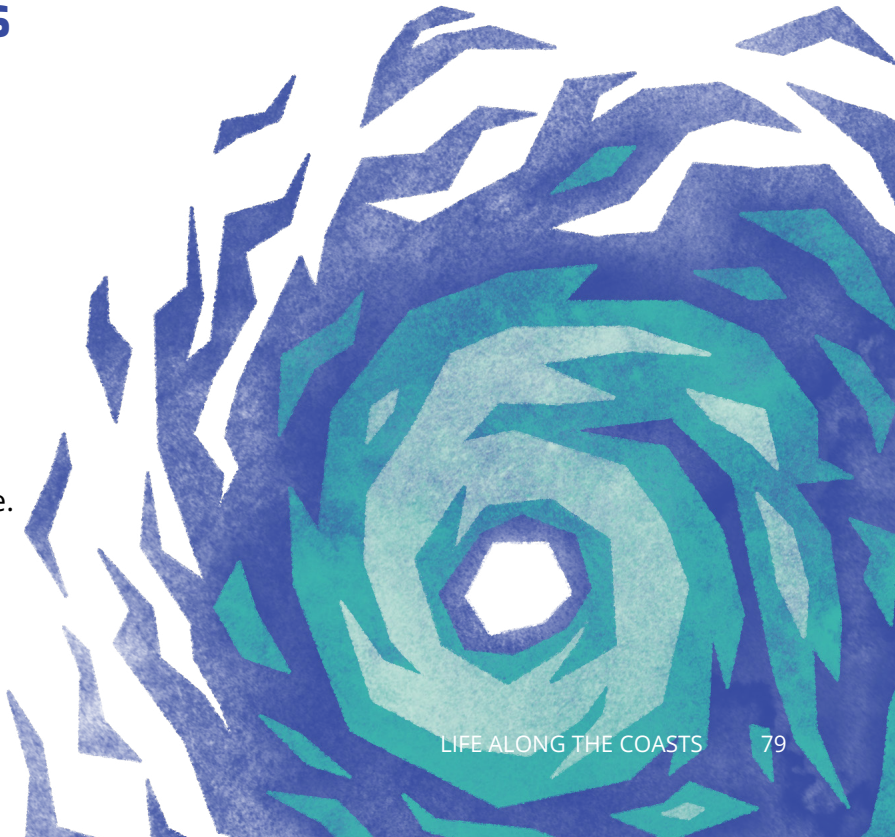
What places by the sea have you most recently visited? What did you notice about the houses and buildings of the communities there? Did they seem well-adapted to their coastal location? Did you see any mangrove forests and healthy coral reefs?

Create a model of a healthy coastal community. Be able to explain how each of the features helps in protecting the residents in adapting to the challenges caused by climate change. You can build on the model for the melting ice experiment, and add items by creatively repurposing paper, cardboard, and plastic trash or other objects. You can also use natural found objects like twigs, shells, and pebbles. Present your finished model and explain how the community is able to mitigate and adapt to climate effects and how it properly uses resources from the sea.

As much as we associate coasts with sandy beaches, remember this image isn't true for all coastal areas. There are rocky shores and even dense, cemented urban areas by some shores. In the next chapter, we will study the particular concerns of urban areas, whether by the sea or inland.

OCEANIC CLIMATE IMPACTS EXTEND BEYOND THE SHORES

You don't have to live near a coast to be affected by the ocean. Tropical cyclones originate above the ocean and winds and rains travel inland. We are affected by the availability of products that originate from the ocean even if we live far from the sea. Since the ocean covers the globe, its impact is worldwide. Knowing the role it plays in mitigating climate change, we need to exert more effort to preserve and rehabilitate it.



KEYWORDS

beach nourishment
the process of widening the beach or creating dunes with sand to reduce the force of the waves on houses and other nearby buildings

coastline
a line that acts as boundary between the land and the ocean or the lake

corals
marine invertebrates that form reefs, providing food and habitat to about 25% of the planet's fishes

coral bleaching
happens when corals are stressed which can cause them to expel their symbiotic algae and turn white

deoxygenation
the reduction of oxygen that can be absorbed by marine organisms from the water

fishing
the act of catching fish

food security
according to the United Nations' Committee on World Food Security, it means that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food

global warming
the gradual heating of the Earth's surface, oceans, and atmosphere

heat sink
an environment, like the ocean, that absorbs excess heat from the sun and distributes it

heat stress
when corals are stressed due to increase in temperature that disrupts the symbiotic relationship between the corals and the algae that inhabit in them

ocean acidification
the decrease of potential hydrogen (pH) in the ocean over a long period of time caused by an uptake of carbon dioxide (CO_2) in the atmosphere

ocean currents
the continuous, predictable, directional movement of seawater caused by gravity, wind, and water density

ocean surface
the top surface layer of the ocean that is also called the epipelagic zone

mangroves
a group of trees or shrubs that live in the coastal intertidal zone

marine species
plants, animals, and other organisms that live in the sea water

micro-fragmentation
breaking the corals into smaller pieces to stimulate tissue growth, allowing corals to grow into clones at 25–50 times more than the normal growth

reefs
a ridge of natural or artificial material lying at or near the surface of the ocean that protects the coastline and promotes marine life

seaweed
common name for countless species of marine plants and algae

shoreline reduction
shrinking of shores due to rising sea levels or erosion from storms

storm surge
the sudden and abnormal rise of seawater level during a storm

tidal energy
a renewable source of energy produced by the natural rise and fall of ocean tides and currents

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PARTNER ORGANIZATION

Save Philippine Seas
Because our seas save us.

Save Philippine Seas (SPS) aims to conserve and protect coastal and marine resources by educating, engaging, and empowering "seatizens" towards collective action and behavior change. Its projects and campaigns focus on shark conservation, waste management, and environmental education. SPS began as an online advocacy in May 2011 and became a non-profit organization in February 2013.

Website: www.savephilippineseas.org
Instagram: www.instagram.com/savephseas
Facebook: www.facebook.com/savephilippineseas


PANADERIA

CHAPTER 4

LIFE IN URBAN AREAS

Urban areas not only serve as centers of education and culture, but also provide livelihood to our growing population. However, with climate change, areas that are crowded due to a dense population and many buildings are especially vulnerable to certain climate hazards like storm surges and floods. As discussed in the previous chapter, storm surges are a particular concern since, due to its archipelagic nature and being in the path of tropical cyclones, the Philippines is one of the countries most vulnerable to this hazard.

With sea level rise, aggravated by poor drainage systems and land subsidence due to groundwater extraction, many of the country's communities have been growing more and more flood-prone, and dense populations cause more difficulties in evacuation and rehabilitation. Such problems are typical in large urban areas.

In this chapter, you will study the hazards in urban areas around you. If you live in one, find a map and data on the population size and density of your area. If you don't, do this research on the urban center closest to you.

Population: What Makes and Breaks A City

*The **National Statistical Coordination Board** (NSCB) classifies an area as urban if it has a population density of at least 4,000. About half of the Philippine population now resides in what are considered urban areas (47.4% as of 2020).*

While not all urban areas are cities, all cities are considered urban. Cities are generally associated with large numbers of people, which requires constant growth and expansion. Cities as such become hubs of education, finance and commerce, services, and culture to serve their large and diverse population. As they grow, they attract even more people. Density will always be a central feature of cities and urban areas. Given this, we see that most of the direct climate change impacts in the urban centers are on people and communities.

Urban populations are also large consumers of rural resources. Being dependent on agriculture / farming communities for food, they are also affected by climate impacts on these communities. The same goes for fresh water supply that generally comes from outside city limits, given that the urban population consumes massive amounts of water.

CLIMATE CHANGE IMPACTS ON URBAN AREAS

While climate change has global consequences, people in highly urbanized cities experience particular effects that are worsened by climate change. If you live in or have been to a city, you may have observed some of these. Can you guess what some of them are? Read on and see which of your hypotheses are correct.

Feeling the Heat

Cities tend to get very hot owing to their blocks of pavement and close-together buildings. Concrete absorbs and retains more heat, resulting in the phenomenon of **urban heat**. When a city has a much higher temperature than the rural areas around it, it is called an **urban heat island**. Some places have always been hotter due to their geographical location and with climate change, temperatures can escalate to unbearable heights. This can be dangerous to the health of young children, the elderly, and those with serious medical conditions, especially heart problems.

According to PAGASA's climate projections, "hot temperatures will continue to become more frequent in the future." In 2021, Dagupan City reached a record 53 °C heat index, near the upper limit of the 41–54 °C range for the danger level. Over a dozen urban areas reached these danger levels in 2021. People are likely to experience heat cramps or heat exhaustion at such levels, and heat stroke may occur in those who are active.

Worries over Water Supply

Our country is rich in water resources, but areas with a large population struggle to get enough clean water, particularly in the dry season. Extreme heat contributes to this, as water supply becomes reduced when the weather is hot and dry.

The problem is further compounded in cities because of pollution. The available supply of water is likely to be contaminated by industrial pollutants and waste. This contaminated water can cause diseases: about 31% of illnesses over a five-year period have been found to be water-borne.

Land Subsidence and How It Contributes To Flooding

Land subsidence is the sinking of the ground to a lower level. There are both natural and human causes of this. One natural cause is that the sediments deposited by rivers naturally grow more compact over time.

Human activities like land reclamation and building flood barriers also cause the land to sink. One of the major causes of land subsidence is believed to be the increasing pumping of groundwater from below to serve the needs of our steadily growing population, especially in dense urban areas. There has been a ban on digging new wells in Metro Manila since 2004, but illegal ones are still being dug. With climate change, drought in the dry season reduces water supply and so there are desperate efforts to seek new sources.

In Manila, researchers at the UP Marine Science Institute have found the city's coastal areas are sinking at the rate of nine centimeters a year. This, even more than the rise of the sea level (three millimeters a year), is bound to worsen the problem of flooding in Metro Manila.

ACTIVITY:
MAKING A RAINWATER COLLECTION SYSTEM

Prepare for water shortage in the future by designing a rainwater collection system. The water can be collected for the remaining rainy season and you can start using it when the weather gets dry.

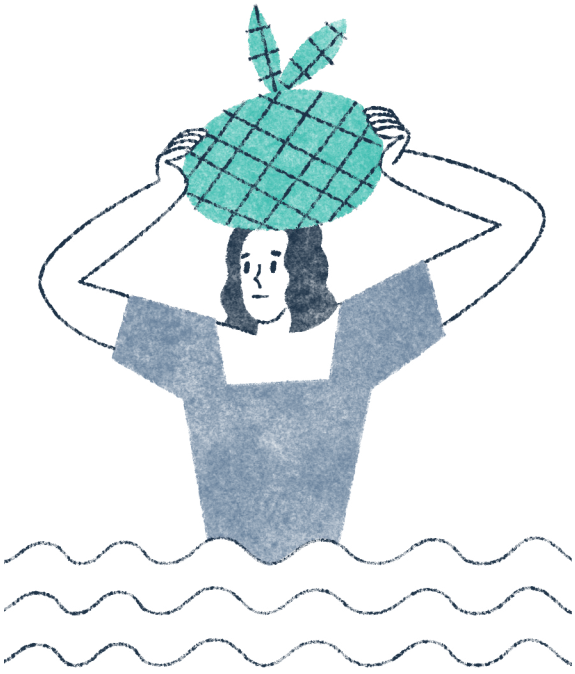
To prevent the danger of mosquitoes breeding in the water, you will need to place screening over the opening. Brainstorm what materials can be reused to create such a system. Sketch your design on a piece of paper, labeling it with the materials you will use to build it. Once your teacher approves your plan, build the rainwater collection system.

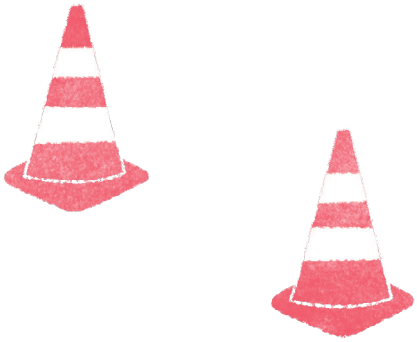
Flooding Fears

In contrast to water scarcity, climate change can also cause flooding in cities with waterways, which tend to happen in areas with poor drainage systems. While little rain causes problems, too much rain is also something that urban dwellers have to deal with every year. This is common in congested cities which have not kept up with their quickly growing population's needs.

This can lead to many risks to health and life. Floods can cause drowning without early evacuation measures. Those who survive wading or swimming through floodwaters, though, are also at risk for serious illnesses like leptospirosis. Young children can get life-threatening diarrheal diseases from floodwaters.

At the very least, flooding can worsen travel and transportation issues in cities, making roads impassable or certain forms of transportation unusable in the flooded areas. People may have to move out of flood-prone areas, adding to the housing problem.





Damage of Infrastructure

Extreme heat and flooding are not only a danger to people's health and safety but can also cause costly damage to urban infrastructure. Houses, buildings, bridges, and other infrastructure may not be able to withstand extreme rainfall, extreme heat, or flooding. Flooded, obstructed or damaged streets can hamper the movement of people, businesses, and goods.

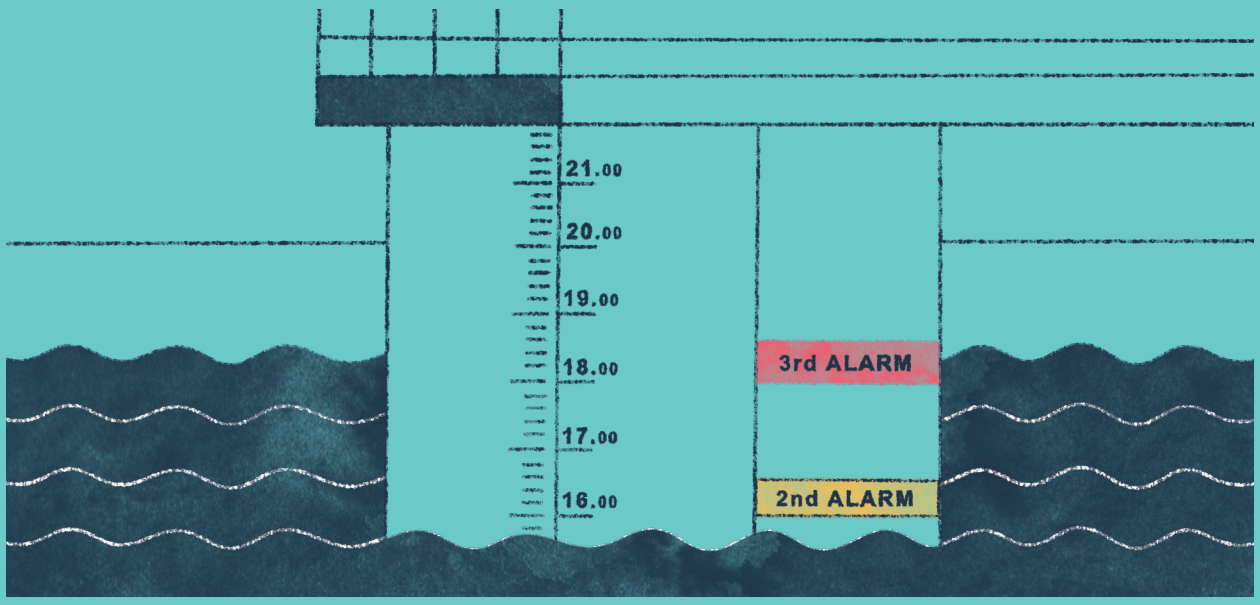
It doesn't take a disaster to damage infrastructure. Does it seem like the streets in the cities are being repaired every year? Vehicles cause a lot of wear and tear on the road, of course, but climate change is also a factor in road damage. Extremes of heat and rain make asphalt and concrete more vulnerable to damage.

ACTIVITY:
MGA KWENTO NG KLIMA VIEWING

Watch the first part of the documentary *Mga Kwento ng Klima* on https://www.omlopezcenter.org/mga-kwento-ng-klima-page/ or scan the QR code below.

Take note of the damage caused by the storm surge and floods in the video. Observe the ways that residents in the areas and their officials have adapted to the possibility of a repeat of the disaster. Compare your area's adaptation and disaster-preparedness measures.

tinyurl.com/5n7azsej



Adaptation Efforts

What does your community do when a storm is coming?

Early warning systems have been instituted over the past decade, especially in disaster-prone areas. The National Disaster Risk Reduction and Management Council (NDRRMC) sends advisories to everyone via text. Your family may have received these messages on your phones when there is an approaching storm. Giving necessary information and advice before the disaster occurs prepares people so they can take the necessary measures. Your own community may take additional measures. Coastal and riverside areas may have flood warning systems. If yours does, make sure you know what to do at each alert level. Communities may also decide to organize to observe and take pictures of nearby bodies of water periodically when there is extreme rain.

Find out also what efforts are being made in your community to prevent flooding if it is vulnerable to this. Are esteros and riverbanks kept clean to allow water to flow freely? Are there reeds in rivers to stabilize the banks as well as clean water and provide shelter for fish?

One way of reducing flood risk, as well as managing water supplies, is collecting rainwater and using it to water plants and clean. This helps reduce the amount of water run-off into your city's waterways.

Just the simple act of avoiding littering helps to reduce the clogging of waterways that contributes to flooding. Public trash cans and the enforcement of the Anti-Littering Law in the area should be present. Because trash in its waterways has been such a problem for Malabon, the city has focused its efforts on trash management and encouraging its citizens to recycle and avoid littering. They have even offered a cash prize for the cleanest barangay. The main cause of people's carelessness in throwing trash, the mayor has observed, is their lack of awareness of how small amounts of litter contribute to flooding. Have you observed this problem in your area as well? Create a video that explains the connection between careless discarding of trash and flooding. Share this on social media to increase awareness.

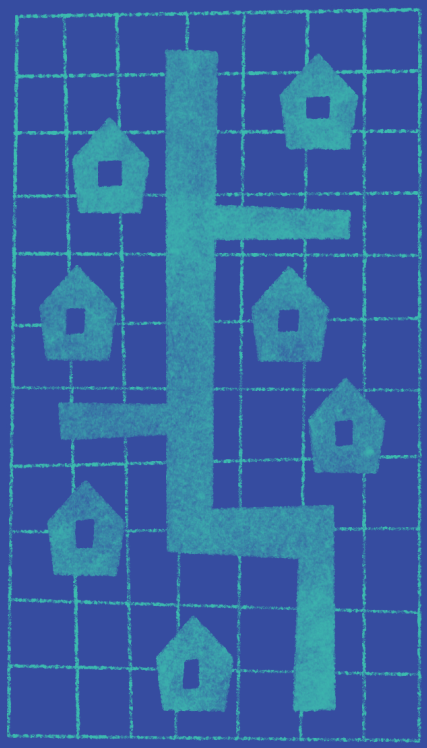
ACTIVITY:

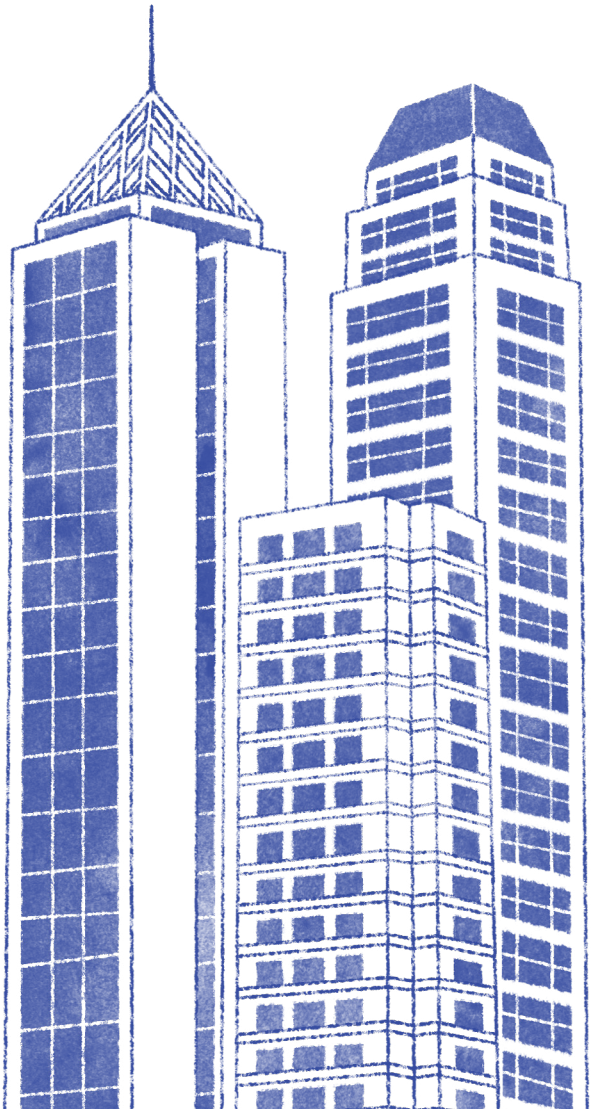
PREPARING A COMMUNITY FOR HAZARDS

What areas of your community are prone to flooding? Check with your LGU if they already have flood maps and if these are updated.

If flooding is not a problem in your community, what disasters may you be prone to? What role might climate change play in these? For instance, heavy rains may make a landslide more likely in a mountainside area.

Discuss your community's current methods in preparing for disasters and what you need. List down what an emergency kit for your family should contain.





GREENING CITIES

Remember how so much infrastructure development can lead to urban heat effect? Well, the conversion of land also results in less green spaces. For the health of the people and the environment, the World Health Organization recommends that every city should have at least nine square meters of green space per person. According to the Green City Index, the Philippines has an overall average of only five square meters of such space per person. In Metro Manila, only 0.03% of the land area is green space.

ACTIVITY:
SEEKING THE GREEN

Look at the map of your urban area. Identify which are open green spaces such as parks and tree-lined streets. Color these green. Find out the land area of each of these spaces (in square meters) and total them. Compute to see how much green space there is per person and what percent of the land area is covered by these green spaces.

It has been observed that the green areas that are most attractive to Filipinos provide entertainment such as playgrounds and activities. Do you observe this in the types of green spaces in your area?

What kind of open space would you convert or enhance as a green space for the city on your map? Remember that these don't have to be conventional parks. In his guidebook for creating green spaces, environmental planner Nathaniel von Eisendel suggested vertical and rooftop gardens as well as parks and waterways as green spaces. Discuss what areas in your community that could be used for this green space and how. Then draw a plan.

Enjoy the Great Outdoors

Have you been to an open green space? How far is it from your residence and how often are you able to go there? What did you observe in its environment? Describe how you felt about being there. Compare your experience with your classmates'.

Studies have shown that spending up to two hours connecting with nature significantly boosts our mental health. Having learned what green spaces can be found in your area, make a commitment to spend at least two hours a week in one of them in good weather. Spend your time there relaxing in tech-free activities like walking, birdwatching, or recreational reading. Write a short reflection on this experience. Note the types of plants and animals you observed and the feelings you experienced.

Can't find a suitable green space? Maybe you can try creating a green corner in your home or request your local officials to create one.

My Green-bathing Experience

What I Saw:

What I Did:

What I Felt:

Something in the Air

People living in urban areas not only have to deal with limited open green spaces. They are also exposed to air pollutants, including ozone and CO_2 emissions, that are far greater in urban areas. These can cause various respiratory conditions. Inhalation of nitrogen dioxide, which comes from nitrogen oxides produced by fossil fuels, leads to development of asthma in children. Some pollutants have also been found to affect the heart. Particulate matter and carbon monoxide from motor vehicle exhaust have both been linked to heart ailments.

Frequent rains can add to these problems. Irritants in the air like pollution and allergy-triggering mold spores, which increase in damp weather, cause additional respiratory problems for those who are suffering from viruses that affect the nose, throat, and lungs.

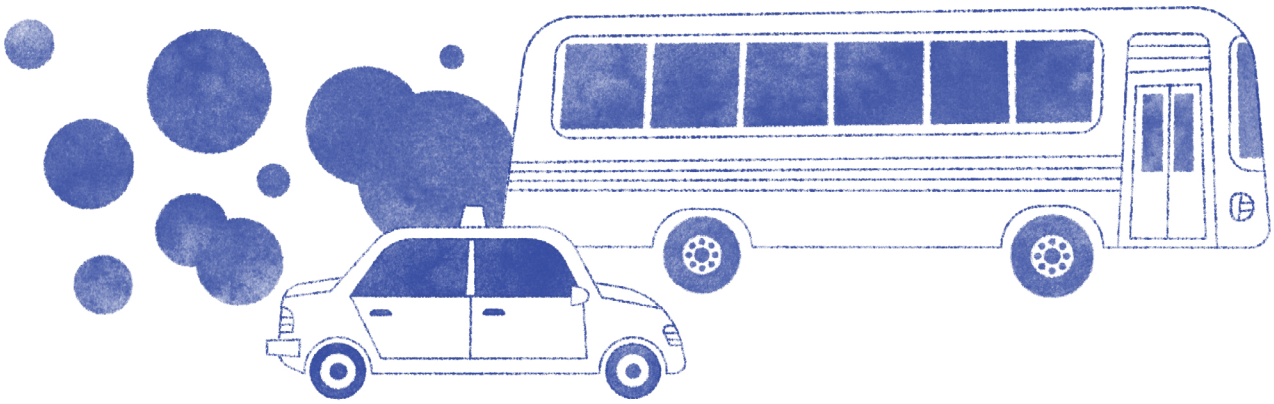
ACTIVITY:
HAZARD WARNING

Create an informative poster that will warn a vulnerable population about one of these health issues caused by climate change. Do more research on the health problem and give practical advice on how to cope with it given climate change. Focus on its effects on your everyday activities, such as walking to school or spending time outdoors.

MITIGATION MOVES THE TROUBLE WITH TRAFFIC

In dense urban areas, much of the pollution that causes health hazards comes from vehicles. After all, large volumes of city traffic are not only inconvenient and time-consuming but produce emissions with high **CO_2 equivalent**, a measure that shows how the effects of other greenhouse gases compare to carbon dioxide. Bad traffic can also lead to mental health issues such as stress and dangerous road rage. Transportation issues must be resolved for our wellbeing, while at the same time mitigating climate change.

Any solution should aim to reduce the number of gasoline-powered vehicles on the road and the time such vehicles spend idling, or running their motors while not moving. Large amounts of GHG are produced by large urban populations given the number of vehicles on their roads that produce these emissions.



Transportation Options

What transportation options exist in your city? Are there ways for transportation in the city to be more efficient? Can you think of a way for this type of transportation to reduce its volume of emissions?

Using public transportation is better for the environment than riding a car, but can be made better by using biodiesel instead of regular diesel. Electric vehicles are considered to contribute less pollution, but they still make use of carbon-producing electricity. Some vehicles, though, generate some of their power with regenerative braking, or brakes that when compressed create energy that the vehicle can store and later use.

While observing the volume of traffic caused by buses and jeepneys, it may seem we have plenty of public transport but the jams the vehicles cause actually show that it is not enough or appropriate to our needs. Public transportation has to be safe, efficient, and convenient for all people to encourage widespread use. This also means the vehicles should provide aids and consideration to the elderly and people with disabilities so they will be encouraged to use them.

People who use cars can organize carpools or ride with others on the same route to reduce fuel emissions. It also reduces traffic on the road.

In terms of reducing emissions, pedal power is one of the best means of transport. Some areas are served

ACTIVITY:
PASSENGER COUNT

The next time you are in an urban area, take note of the first five vehicles that you see around you. How many passengers are in those vehicles? (A rough estimate will do!) From your observation, what do you think is the most energy-efficient mode of transportation in the city?

Fortunately, it doesn't have to stay this way.

There are actually sustainable cities in the world. Canberra, Australia was recognized as the most sustainable city in 2020 with its efficient public transport and use of solar and wind power as well as its many green spaces. Bogota, Colombia has been found to be one of the greenest Latin American cities. Contributing to this is its focus on developing an efficient public bus and train transit system, creating 300 km of bike lanes and more green spaces, restricting car use, and improvement of waste management. Locally, other cities have performed similar initiatives, with Pasig City offering greener transport options and encouraging urban farming.

by pedicabs for short distances. You may also be able to use a bike if your community has safety measures in place for cyclists. Biking has become more popular as it helps save money and reduces time stuck in traffic or waiting for public transportation. There are even bicycles designed for people with disabilities. Although switching to pedal power may be considered adaptation, it still has mitigation co-benefits. Cycling is being encouraged in recent years, with awards being given to cities that are most bike-friendly. There are growing numbers of cities such as Iloilo, Naga, and Mandaue that are making their cities more friendly to cyclists by building interconnected bike lane networks, end-of-trip facilities for bicycles, and programs to promote cycling. As cities provide more properly regulated bike lanes, more people are turning to this cheap as well as clean and healthy form of transportation.

And finally, there's always walking. While it's not the fastest, it's the cheapest way to get around and it prevents the frustration of being stuck in traffic. And, like cycling, it's good exercise. It is usually not popular in the heat of the city and with rain and flooding, but infrastructure can be created to make it safer and more comfortable, like Makati's well-regulated pedestrian lanes and covered elevated walkways and tunnels. Reducing pollution and increasing greenery in the city will also make it healthier and more enjoyable. Well-designed infrastructure encourages walking, especially if it allows people to stay close to areas with plenty of activity, which will help keep them safe, and their comfort and safety is prioritized.

ACTIVITY:
LOBBYING FOR BIKE LANES AND PEDESTRIAN-FRIENDLY INFRASTRUCTURE

Walking and cycling are some of the few ways that you can get around on your own at your age. But does your community support this and make it safe and comfortable for you? Do a survey among your schoolmates who walk and bike to school. How safe do they feel on the route they take? What do they think is needed in order to be safe? For cyclists, also ask how they learned to bike and whether they have places to properly secure their bicycles.

Based on your survey, list down the needs of cyclists and pedestrians. Note which needs they feel are not sufficiently addressed. You can write a letter requesting your barangay officials to make improvements to make it safer for members of your school community to walk or cycle to school. For ideas, you may refer to the link below.

tinyurl.com/5dbsb97y

CLEANING UP THE URBAN ENVIRONMENT

Trash is also produced in large volumes by dense urban populations. It doesn't help that in order to make money, most companies constantly come up with products that are designed and marketed to encourage people to buy them whether they need them or not. This creates a cycle of production and consumption that causes a lot of waste.

It is difficult to manage waste, especially in urban areas since we purchase most of our necessities packaged. But simply reducing the amount of nonbiodegradable waste we produce is helpful. Eliminating or at least greatly reducing plastic waste is an important measure to take. Large amounts of carbon are produced in the process of manufacturing plastic and in recycling it as well. Also, only a small amount of plastic is recycled compared to what is produced: only 18% globally in 2015!

One of the simplest climate-friendly measures to take is to buy less. Avoid buying anything you don't need. Even when buying gifts, consider the needs of the person, maybe even ask what the receiver would like. And when you do buy something, try to choose options that have less packaging. Making sure to avoid generating trash is known as going **zero waste**.

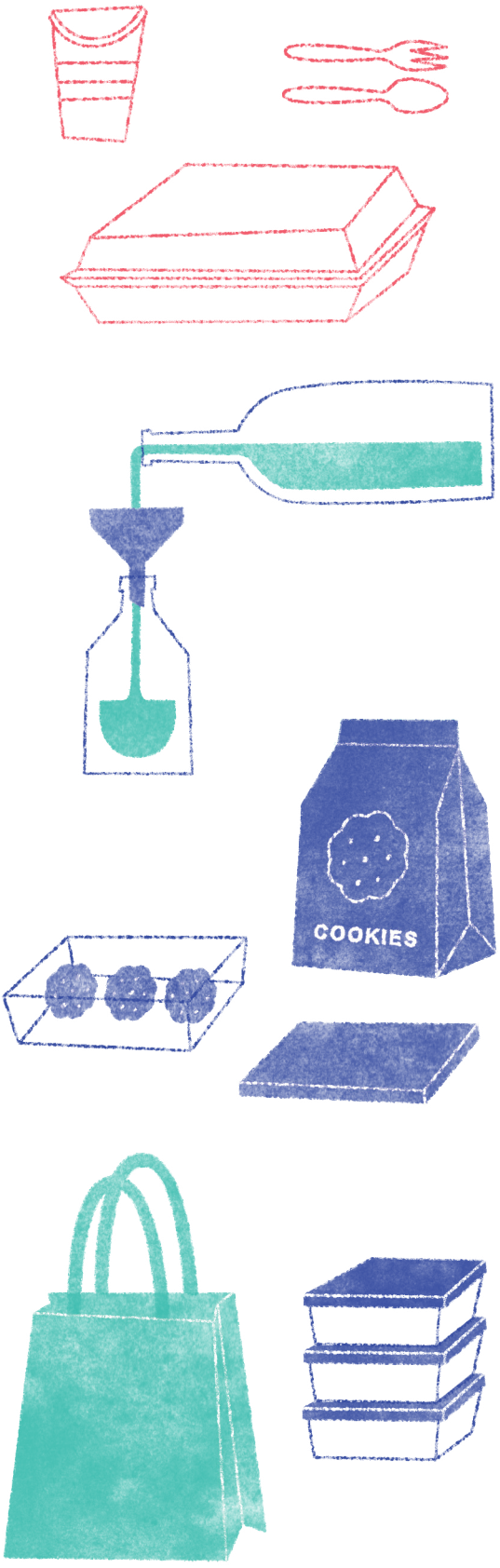
Here are some measures you and your family can take to try to achieve zero waste:

- Buy less food in plastic and styrofoam packaging. The production of these materials produces more unhealthy emissions, which adds to the total carbon footprint of the food choice.

- Look for alternatives for products that you use that have less nonbiodegradable packaging. See if you can find stores that provide refills. Some *sari-sari* stores will fill your own bottles with vinegar, for instance.

- Does your family buy many individually packaged items like Tetrapaks and snack items in a week? Discuss preferences for such things with your family so you can share larger packages instead of buying many small packs. For *baon*, you can simply divide the large pack into reusable containers.

- Bring a reusable bag when shopping and containers for wet products and rice so you don't have to ask for plastic bags. Weekly grocery shopping should be planned well so you don't have to run out to the *sari-sari* for *tingi* packs or make extra trips to buy a few items. If there is a wet market near enough, your family can shop there, bringing your own containers in your *bayong* so that you won't be given plastic bags.



ACTIVITY:
GARBOLOGY

Garbology is learning about people and their lifestyle from their garbage, which is practiced in archaeology but is also helpful in analyzing your family's current habits of consumption and waste. Consider the following:

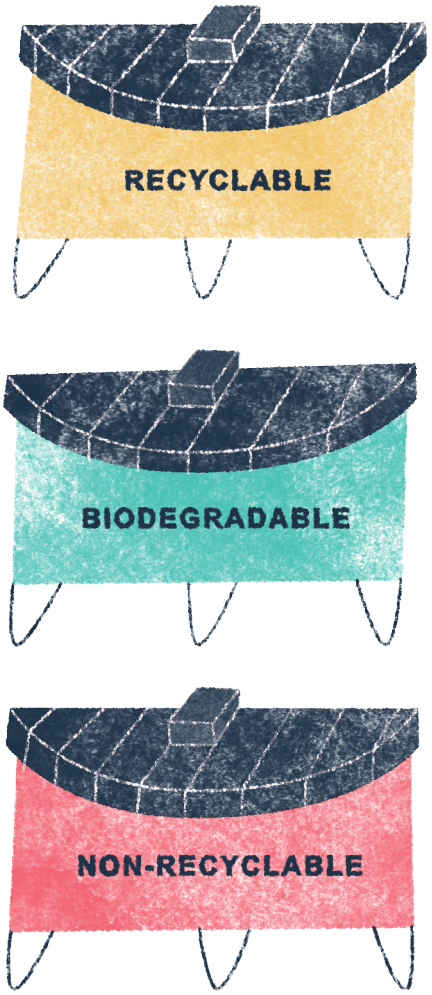
- How many bags of trash are picked up from your home each week?
- What are in these bags?
- How much of it is biodegradable?
- How long will it take to decompose? What will it take to decompose?
- Of the things that produce most waste, which can you do without?

You can also count the items that you have purchased that are packed in single-use plastics that you most probably will discard. How many are they? Plastic packaging is a persistent trash problem because it does not decompose and is often not recyclable. Can you think of alternatives to buying items in small packs and sachets?

Waste Management

Garbage is something we throw away and don't want to think about anymore. But thinking about the trash you generate will help reduce waste.

It's also helpful to segregate or separate recyclable, residual (nonrecyclable and nonbiodegradable), and biodegradable trash, some of which you can add to the compost heap you started in the previous unit. Try to do this before performing the activity that follows, whether your LGU requires it or not.

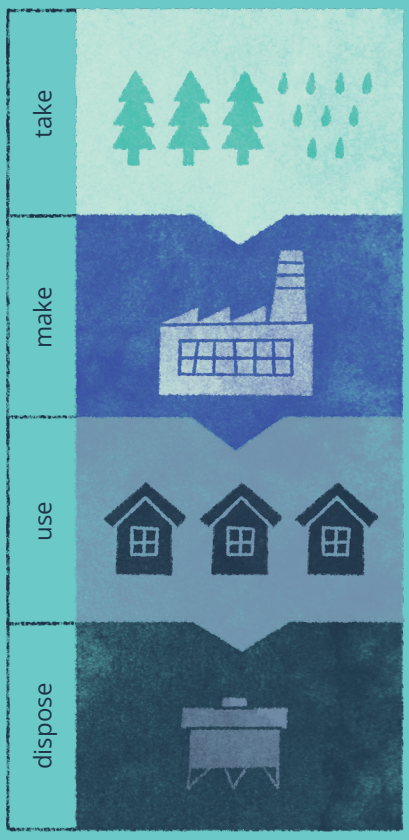


Circular vs. Linear Economy

*Companies encourage more consumption by creating products to simply be used then discarded in what is called a **linear economy**. So many products are sold with no thought as to what should be done with them after they are no longer useful. Many of them are designed to be used for just a short time to encourage more purchases. Unfortunately, this also results in more waste, much of it going to a landfill. This is the problem with a linear economy.*

*We are accustomed to this pattern of production and use, but there is an alternative: a **circular economy**. A circular economy aims to reduce waste. This might mean creating longer-lasting products that are repairable and recyclable. Or they can be converted, like baby bottles that, with a change of cover, become cups for toddlers then water bottles for older children. It can involve choosing the raw materials for products so that there is less waste in the end, like eco-friendly shampoo bars wrapped in paper to replace plastic bottles of shampoo. It could mean replacing goods with services, such as selling subscriptions to a music app instead of CDs. Best of all would be a plan for regeneration at the end of a product's life, like the plantable Bambuhay toothbrushes. These wooden products not only replace nonrecyclable plastic versions but, when no longer usable, would be planted into the ground to fertilize seedlings that are embedded in their packaging. With products like these, Bambuhay was able to eliminate 1,100 tons of discarded plastic which would have produced 6,600 tons of CO2.*

Think of an item that you often purchase only to discard after a while. How could this product be modified for a circular economic model?



LINEAR ECONOMY

CIRCULAR ECONOMY

THE FUTURE OF URBAN AREAS

Now that you have studied the problems of your urban area and possible solutions, you can envision a better future for you and others, a place that will both adapt to climate change and mitigate its effects and be a pleasant and safe place for its inhabitants. Very often, we assume it is necessary to address urban issues with extensive (and expensive) solutions, such as flood barriers, alternative energy-generation plants, and new drainage systems. However, smaller and simpler measures can go a long way. Some cities, for instance, have decided to outfit their bus stops with green roofs, which both cool the environment and reduce carbon. Something as simple as designating no-car/motorcycle zones can reduce pollution in an area.

Given the size of urban areas, it may seem daunting to try to reduce their climate risks and make them more adaptive. Every little action you can do or suggestion you can make to officials can help, however. Many urban areas have been revamped not just with the commitment of their officials but through the efforts of their citizens. Improving urban centers and the efficient use of resources will also benefit farming communities, which provide many of these resources.

ACTIVITY: A TALE OF TWO CITIES

Having learned what urban areas need to be healthier and more sustainable places, what would your dream city be like? On the other hand, if your urban area continues to increase its population, motor vehicles, and infrastructure at the same rate, how will it look in twenty years?

As a class, share your ideas. Then form two groups. The first group will draw an idealized version of your own city or an imaginary city of the future that is green and sustainable. The second group will sketch what a city that maintains the same growth without addressing its climate hazards will look like in twenty years. Compare your illustrations.

As many as the problems urban areas have due to climate change, rural areas also have their own. You will discover these in the next chapter and come up with ways to mitigate them and adapt to them.

KEYWORDS

air pollutants
any concentrated solid particles, liquid droplets, or gases introduced to the environment that can have adverse effects on humans and the ecosystem

Carbon dioxide equivalent
the abbreviated as **CO_2-eq**, is a metric measure used to compare greenhouse gases emissions based on their global-warming potential (GWP)

circular economy
a systems solution approach to production and consumption that seeks to eliminate waste and pollution, circulate products and materials, and regenerate nature

cities
towns of significant size and development

consumption
the act of consuming or using of resources

flood
an overflowing of water that submerges usually dry places

garbology
the study of people and their lifestyle from their garbage

green spaces
a space dedicated or reserved for trees and other plant life for recreational and aesthetic purposes in an urban setting

linear economy
a "take-make-dispose" approach to production and consumption

nitrogen oxide
a family of poisonous and highly reactive gases formed when fuel is burned at high temperatures

pedal power
cycling

public transportation
a system of jeepneys, trains, buses, etc. used by the public

urban areas
places in the city

urban heat
high temperature in the city

water supply
a source, means, or process of supplying water

zero waste
the aim of not generating trash through reducing, reusing, recycling (or upcycling), and composting

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PARTNER ORGANIZATION

The Institute for Climate and Sustainable Cities (ICSC) is an international non-government group advancing fair climate policy and low carbon, climate-resilient development. Based in the Philippines, it is engaged with the wider international climate and energy policy arena, particularly in Asia. It is recognized for its role in helping advance effective global climate action and the Paris climate agreement. ICSC's work on urban transition supports early adoption and integration of climate change considerations—covering issues such as mobility and water—into long-term urban development planning.

The Agam Agenda is a special project of ICSC engaging the public in reimagining climate conversations through stories and art. It provides a dynamic, shape-shifting platform for creative, trans-disciplinary collaboration designed to grow and contribute to fluid networks of climate-aware writers, artists, scientists, youth, and campaigners. Visit whenisnow.org to see one of Agam Agenda's initiatives.

Website: icsc.ngo; agamagenda.com
Facebook: www.facebook.com/icsc.ngo/; www.facebook.com/TheAgamAgenda
Instagram: www.instagram.com/agamagenda
Twitter: twitter.com/icsc_ph; twitter.com/agamagenda
YouTube: www.youtube.com/channel/UCxKqyAwHejwVbSamaHG72qQ

CHAPTER 5
LIFE IN RURAL AREAS

In contrast to messy, congested cities, rural areas seem peaceful and carefree. Yet they suffer even more from the effects of climate change. As you have seen in the previous chapter, urbanization and development, if not kept in check, can put a strain on our natural resources and other ecosystems that support cities and other urban areas.

Many depend on agriculture, fisheries, and other related livelihood as a source of income. Even if you do not farm, you benefit from agriculture. It provides us all with food and other products from animals and plants such as leather, bath and health products, and more. Farming is a concern for all of us, especially since it is greatly affected by climate change, which it unfortunately has also contributed to.

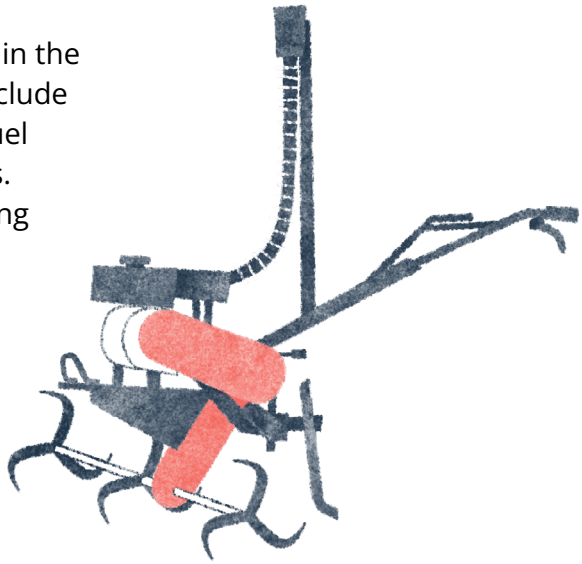
If you belong to a rural community, what types of crops and/or animals are commonly raised there? Study whether these are best suited for your current climate and terrain. Are there other species that would be more suitable?

On the other hand, if you live in an urban area, do you practice or have neighbors who practice urban gardening?

THE CARBON FOOTPRINT OF FARMING

As essential as farming is to life, the large-scale agricultural methods we have been practicing for many years now have major consequences on the environment. Over 40% of land in the Philippines is now devoted to farming. Unfortunately, these agricultural lands (i.e. pineapple and banana plantations in Bukidnon) used to be forestlands which were cleared by cutting down and burning trees for cultivation purposes (*kaingin* system). The vegetation left in these lands is so little, they are no longer effective carbon sinks. They lack biodiversity and often use chemical fertilizers and pesticides.

As much as 29% of greenhouse gases (GHG) produced in the Philippines comes from agricultural activities. These include running farm vehicles and machinery using diesel as fuel and too much use of chemical fertilizers and pesticides. But it begins simply with clearing the land and disturbing the soil, which releases carbon into the air. Other GHG produced by farming is nitrous oxide as a by-product of fertilizers and methane from raising livestock.



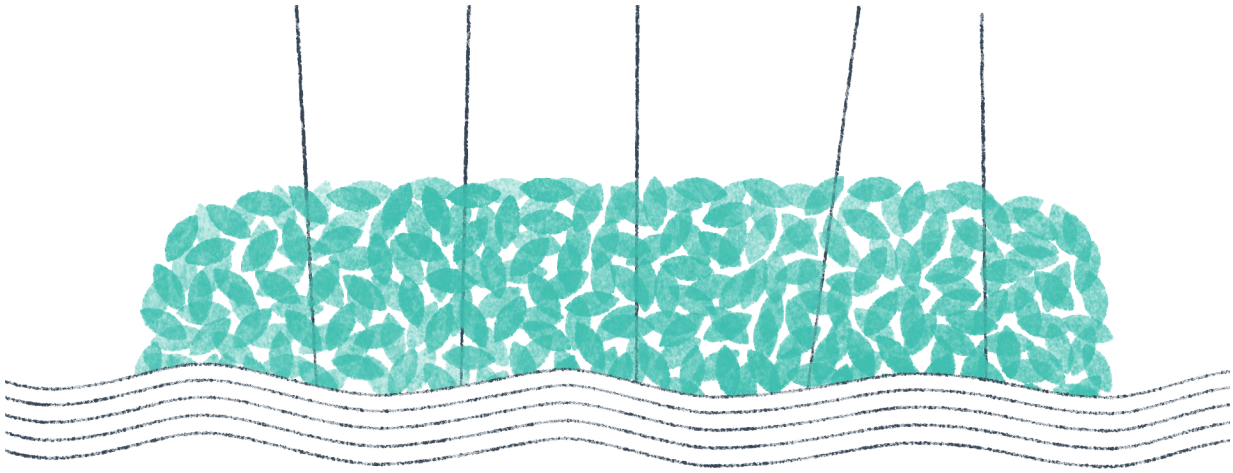
Due to the high GHG emissions from agriculture, reducing this sector's carbon footprint has become an urgent concern.

THE URGENT NEED FOR "TRANSFORMATION": THE CONTEXT OF CLIMATE-SMART AGRICULTURE (CSA)

Sustainable production of major crops like rice, corn, and cassava is greatly affected by extreme weather events that reduce yields and productivity. There is a need to enhance the resiliency of crop production systems through a process of "transformation." This is where Climate-Smart Agriculture (CSA) enters the picture. CSA is a systematic integrated approach for transforming and reorienting agricultural development under the realities of climate change.

According to the definition of the Food and Agriculture Organization (FAO) of the United Nations, CSA involves three pillars. These are: 1) sustainably increasing agricultural productivity (productivity); 2) enhancing resilience to climate change (adaptation); and 3) reducing and/or removing greenhouse gas (GHGs) emissions (mitigation). These three interlinked factors or "pillars" are needed in the transformation process to achieve food security and development in a world made increasingly complex by climate change.

a. **Productivity** – Productivity and income from farming, crops, livestock, and fish need to be sustainably increased. This will provide greater food security and increase in nutritional security. Needless to say, the process of increasing these must be undertaken without causing negative effects on the environment. Some of these sustainable methods include using climate-smart varieties, employing integrated farming systems, and practicing crop diversification.



b. **Adaptation** – It is essential to reduce the risks farmers are being exposed to and, at the same time, increase their resilience and build their capacities to adapt and continue to earn even when they encounter shocks and long-term stresses. It is equally important to improve ecosystem services needed for maintaining farmers' productivity and their ability to adapt to climate changes. This may involve practices or machines that not just speed up planting and harvesting, but also reduce farm labor, allowing farmers to be engaged in other activities. There are also researchers who have looked at floating gardens as an alternative way to grow food even during flooding.

c. **Mitigation** – The last pillar is reducing and/or removing GHG emissions, where possible. This means that we should reduce emissions for each calorie or kilo of food, fiber, and fuel that is produced, avoid further deforestation due to agriculture, and our practices should maximize the potential of trees and soil to act as carbon sinks and absorb carbon dioxide from the atmosphere. Some practices that reduce or remove GHG emissions would be the efficient use or reduction of farm inputs like water and pesticides.

You may watch the following videos online relating to CSA:

1. ***Integrated farming system***

tinyurl.com/22axh6u8

2. ***Floating gardens***

tinyurl.com/yckwmb7b

3. ***Ecological engineering***

bit.ly/3H4Alif

Resources to help you:

tinyurl.com/3duacn6a

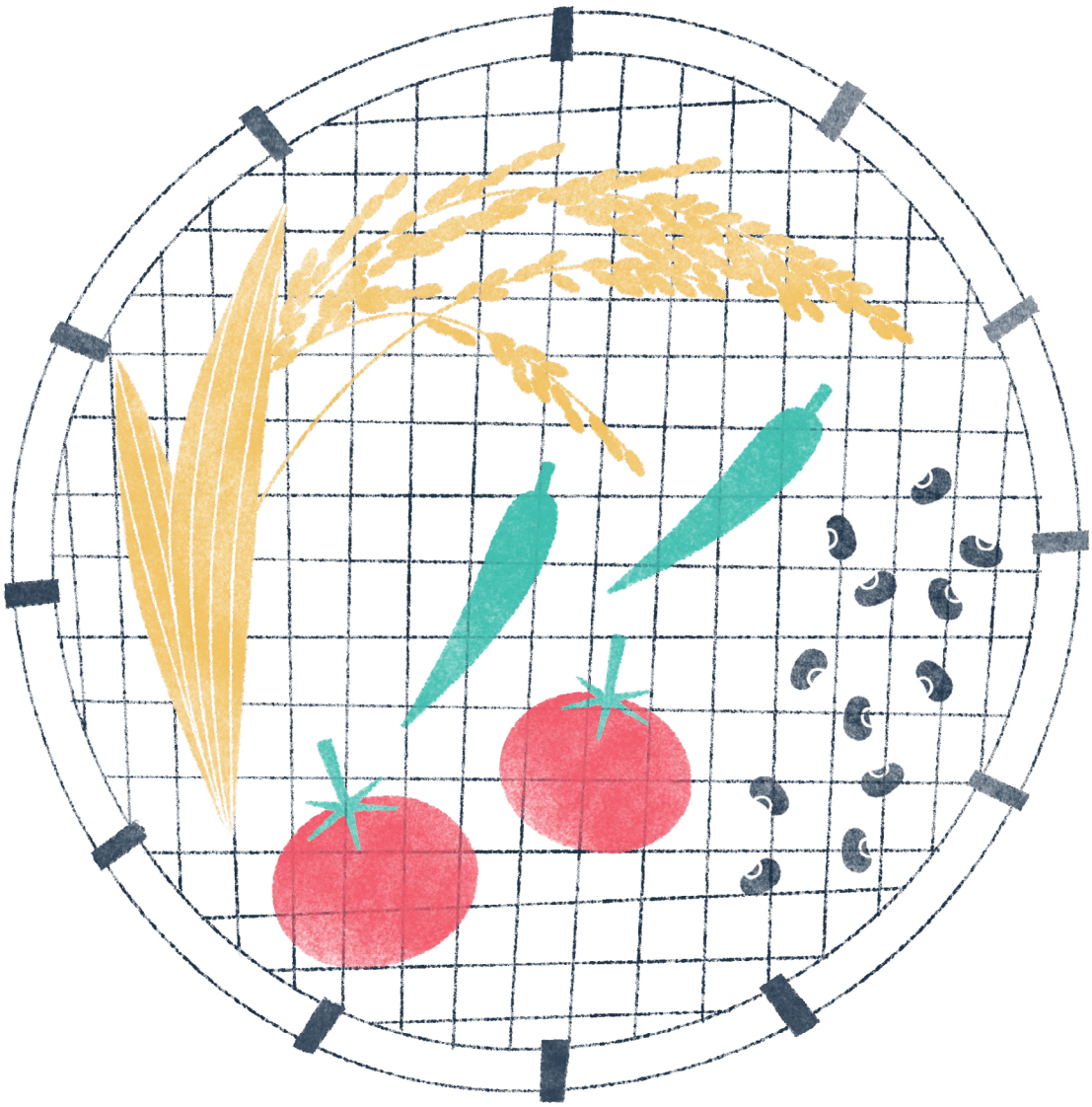
tinyurl.com/2p8rmv5f

tinyurl.com/yc8h3nyw

EFFECTS OF CLIMATE CHANGE ON FARMING

Crops repeatedly subjected to the climatic stresses of extreme heat and rain produce lower yield. Rice, in particular, may have not only lower yield but be of poorer quality. The grain produced becomes chalky and brittle, which results in excessive breakage as the harvest is processed, reducing the amount of good quality grains.

Even heat-loving tomatoes and peppers are extremely sensitive to heat stress. These plants cannot produce fruit in extreme heat. Tomatoes are also sensitive to too much rain. So are many other plants. In fact, most young seedlings easily die when exposed to too much rain. Mungbean or *monggo* may not produce beans and easily die while broccoli and cauliflower heads and coffee cherries are ruined when they get too wet. Farmers may adapt by harvesting early when rain goes on too long or when a storm is predicted. But this produce is often smaller and some may not ripen well, resulting in low quality of produce. Mold may also grow on fruits and vegetables that are stored and shipped when wet. Thus they are either wasted or sold at much lower prices.



ACTIVITY:
INTERVIEW WITH A FARMER

For insight on the challenges of climate change to agriculture and those working in the farming sector, interview a person who raises plants for food, whether a farmer or a gardener. Fill in the chart:

RESOURCE PERSON:

PLANTS GROWN:

LOCATION OF FARM / GARDEN:

PROBLEMS IN RAISING PLANTS IN EXTREME HEAT	SOLUTION/S APPLIED	ARE THERE STILL CONSEQUENCES DESPITE THE SOLUTIONS? IF SO, WHAT?
PROBLEMS IN RAISING PLANTS IN EXTREME RAIN	**SOLUTION/S APPLIED**	**ARE THERE STILL CONSEQUENCES DESPITE THE SOLUTIONS? IF SO, WHAT?**

ADAPTATION: CHANGING WITH THE SEASONS

The weather in each season now diverges more often from the norm. Farmers have long based their practices on the weather they expect in each season, but that practice is hampered by new patterns. When climate varies greatly from the usual, flowering and fruiting schedules change, leading to new, unexpected harvest schedules. This can cause problems for farmers who grow different types of crops because they may not be able to harvest and clear their fields in time to start the next crop. It is therefore important that, in farming, you know the best time to plant a certain crop and understand its climatic requirements.

ACTIVITY:
CROPPING CALENDAR

You will need:

- pen and paper
- crayons
- a laptop/computer (optional)

Procedure:

1. List down at least five crops most commonly grown in your area or those which are most familiar to you.
2. Look for references with regards to the production of such crops, e.g., crop production guides.
3. Devise a cropping calendar with the following details:
   a. Time (period) of planting
   b. Crop management
   c. Time (period) harvesting
4. Use a color-coding scheme to indicate the details in your cropping calendar (see sample below).
5. Cite your references.

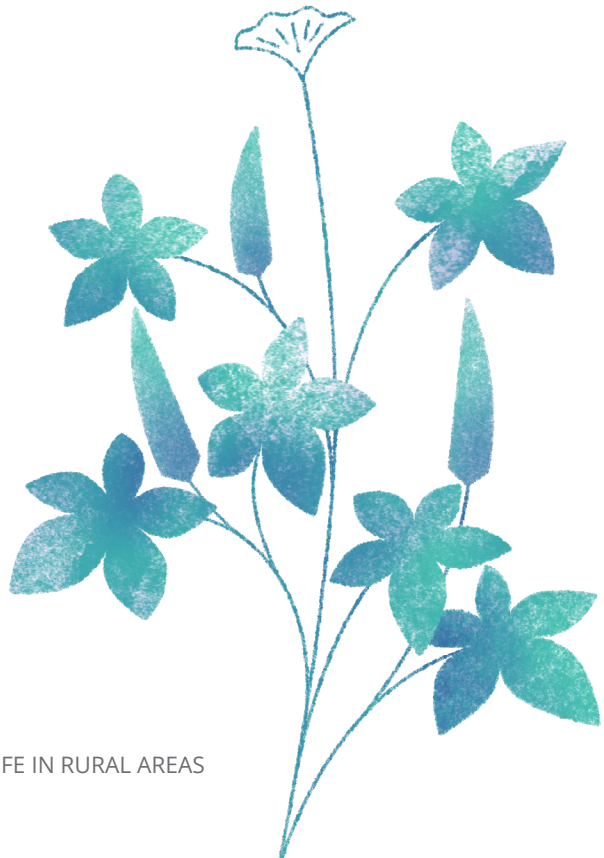
	J	F	M	A	M	J	J	A	S	O	N	D
CROP 1												
CROP 2												
CROP 3												
CROP 4												
CROP 5												

Legend: *Planting* *Crop Management* *Harvesting*

Visit Project SARAI's website at sarai.ph and explore its features. In the homepage, choose a crop (indicate your chosen crop, i.e., rainfed rice or corn) and the farming site nearest you (indicate your chosen site).

Can you identify when is the best time to plant your chosen crop? (Tip: you must read first some relevant production guides for rice/corn.)

www.sarai.ph



DISCUSSION

What is the importance of devising a cropping calendar in increasing farmers' productivity and income? (Relate your answers to the time of planting/harvesting and the climatic requirements of the crops, its cost implications, etc.)

Some farmers have simply changed their planting seasons based on observed weather, but it is not advisable to do this given its unpredictability. Rains coming before the usual planting season do not necessarily mean that the wet season has begun; a dry spell may follow that will kill newly planted seedlings.

In your interview with a farmer, did you hear stories about how their plants or crops were affected by extreme rain or drought? Water is important for the growth of plants, but both an excess and a lack of water can affect crops' development. You can observe this in the following experiment.

ACTIVITY:
SIMULATION OF AN EXCESS AND A LACK OF WATER FOR CROPS

Why is it important to plant crops during the right season? How are they affected if the weather in these seasons does not follow normal patterns? You may observe these through this activity.

You will need:

- nine pots (size 4 or 5 inches). Make sure there are enough holes at the bottom.
- silt loam soil medium with organic fertilizer, enough to fill-up the nine pots
- 18 seeds of bush or pole *sitaw* (sitao), *paayap* (cowpea), or *patani* (lima bean)
- a pair of gloves
- water
- a permanent marker to label the pots
- a 12-inch ruler

Procedure:

1. Divide the nine pots into 3 sets (3 pots per set).
2. Fill up the pots with the soil medium with organic fertilizer, leaving a space of at least 2 cm below the lip of the pot.
3. Dig 2 holes (about 2–3 cm deep) per pot.
4. Drop 1 seed per hole and cover with soil medium.
5. Put all pots in areas with enough sunlight but not open to rainfall (during rainy season).
6. Label each pot in Set 1 as "enough water (EW)."
7. Label each pot in Set 2 as "too much water (TMW)."
8. Label each pot in Set 3 as "lack of water (LOW)."
9. Schedule the watering as shown in the table below.
10. Record the growth of plants and measure the plant height in the Table 2.

For your guide, you may refer to Tables 1 and 2.

TABLE 1	SCHEDULE OF WATERING THE PLANTS		
	ENOUGH WATER	TOO MUCH WATER	LACK OF WATER
At planting, water all pots enough to drain the water at the bottom	✓	✓	✓
Wait until all seeds have germinated before watering again			
2–3 days after germination	✓	✓	
3–4 days after germination		✓	
4–5 days after germination		✓	
5–6 days after germination		✓	
6–7 days after germination	✓	✓	

TABLE 1	SCHEDULE OF WATERING THE PLANTS		
	ENOUGH WATER	TOO MUCH WATER	LACK OF WATER
7–8 days after germination		✓	
8–9 days after germination		✓	
9–10 days after germination		✓	
10–11 days after germination	✓	✓	
11–12 days after germination		✓	
12–13 days after germination		✓	
13–14 days after germination		✓	
14–15 days after germination	✓	✓	

As you go through this activity, write your observations on the growth performance of plants and its height in Table 2.

TABLE 2	GROWTH PERFORMANCE OF PLANTS AT DIFFERENT LEVELS OF WATER TREATMENT		
	ENOUGH WATER	TOO MUCH WATER	LACK OF WATER
At full germination			
5 days after germination			
10 days after germination			
15 days after germination			

Check out some videos online about the ways farmers are adapting to extreme weather events. Specifically, you may watch videos from the Philippine Rice Research Institute or the International Rice Research Institute about technologies on submergence-tolerant rice, rainwater harvesting, and controlled irrigation. These are some adaptation measures to enhance the resilience of agriculture to climate change.

Mga Kwento ng Klima 3: Sinukol ng Gutom bit.ly/3h0ePAv

Submergence tolerant rice bit.ly/3v11Xm0

Rainwater Harvesting for Conservation Agriculture with Trees bit.ly/34Qasps

Controlled irrigation in rice farming bit.ly/3v4UKkH

What conclusions can you draw about the need for farmers to be able to predict how much rain there would be? What would the effect be on the farmers if weather patterns are unpredictable? How will that affect consumers of the crops they grow?

BETTER WAYS OF FARMING

One of the main issues with agriculture is that natural ecosystems are destroyed to have space to grow food. Do you think it is possible to retain some trees and raise crops and animals around them instead of clearing forests completely?

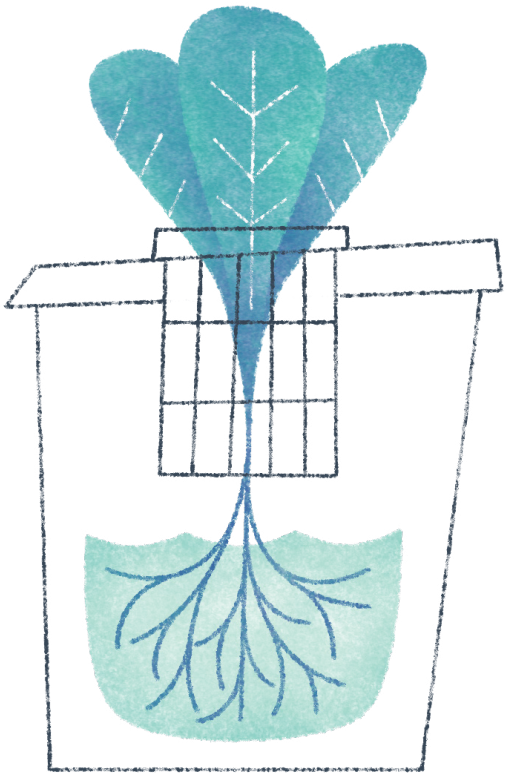
This type of farming, known as **agroforestry**, can successfully be done. While it may seem a sacrifice of more land that can be used for cash crops and pastureland, trees also have benefits for farmers. Trees themselves are sources of timber, fuel, fruit, and other products. They also contribute in ways we can't see, particularly by restoring nutrients to the earth as well as acting as carbon sinks. They help to prevent soil erosion.

They can also protect agricultural crops and animals, even people, from weather extremes. Can you explain how they serve as protection from heat? From strong winds? From extreme rain and floods?

Trees can also be used to provide food for livestock. Trees are farmed for food that people consume too, of course, however, many of these trees are not native. These non-native trees often do not contribute as much to natural ecosystems. Some are completely avoided by native insects, birds, and bats. Some trees, like mahogany, can even negatively alter the composition of the soil.

While we would like the Earth's environment and atmosphere to return to the way it was when forests were all intact, with our growing population, we need space to grow food. It can be possible to do this by working with natural resources instead of eliminating or wasting them. And we can use scientific advances to help too.

Did you know that you can grow food without soil? It might sound very unusual but yes, there is an alternative method of farming called **hydroponics**. It grows food, like your favorite lettuce, without soil, but through water enriched with a nutrient solution. This reduces the effects of too much or too little rain on your crops.



There are different types of hydroponics farming and some can even be done at home. Try to search for videos online and see how it can be done with cheap materials and easy steps. Compare hydroponics versus traditional soil-based home gardening methods so you can see the benefits of exploring innovative ways of farming.

One advantage of hydroponics is that without soil, there are fewer pests. Farmers frequently suffer yield losses from insect pests, diseases, and extreme environmental conditions. Traditional control methods are often time-consuming and ineffective. As a result, most farmers resort to toxic and often illegal pesticides to reduce yield damage. This not only increases production cost but also triggers environmental and health hazards for both farmer and consumer. But there's good news. **Modern biotechnology** through genetic engineering can improve the insect resistance of plants. This will reduce the cost and frequency of insecticide applications. The plants will increase their marketable yield and these harvested fruits and vegetables will have less insecticide residue. One example is Bt Eggplant. To learn more about it, check out this material from SEARCA:

bit.ly/3tmKV0A

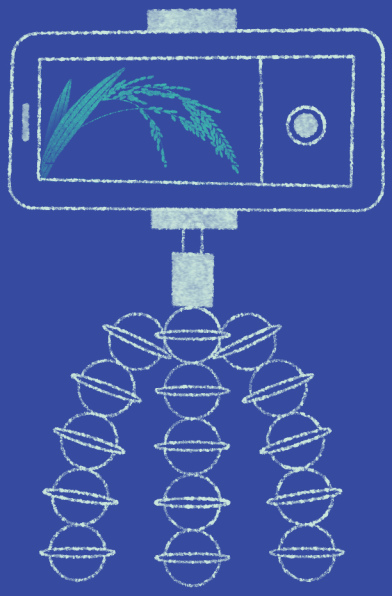
ACTIVITY:
VLOG ON BETTER WAYS OF FARMING

Now that you have been introduced to better ways of farming amidst climate change impacts to agriculture, make use of your creativity and tech-savviness to share your new knowledge with others! Create an informative material for both online and farming communities. Make a vlog about any of the three better ways of farming (agroforestry, hydroponics, modern biotechnology) highlighting how it can help farming households and communities adapt better to climate change. Consider its benefits both to the environment and the livelihood of those in the farming communities. You can share your drawing and the results of your experiments. If you can visit a farm that makes use of your chosen practice, you can film your video there.

Different methods of coping with agricultural problems caused by climate change are being experimented with. The farmers of Negros Occidental have tried planting sugarcane two months earlier than the original May planting season for a successful harvest. Research is being done on developing climate-resistant varieties and new methods of farming.

While the main goal of climate-smart agriculture is maintaining food security, reducing the emissions from farming is also considered in finding the best solutions to agricultural problems. Mitigative measures also prove to benefit farmers. For instance, a method of reducing the carbon footprint in growing rice by allowing the fields to dry out instead of keeping rice constantly submerged was found to not only reduce emissions but to result in a higher yield. Making the effort to mitigate climate effects can also be a means for farming communities to achieve food security.

If you think only farmers can do something about climate change, think again.



FROM THE FARM TO YOUR TABLE

Even if you don't farm, you still make use of agricultural products, particularly when you eat. We all need to eat, and cooking at home is more sustainable than getting takeout. However, our eating habits can still be improved in order to reduce our carbon footprint.

ACTIVITY:
HOW MUCH CO_2 IS EMITTED BY MY FAMILY'S MEALS?

Compute the total CO_2 equivalents of their food based on the major ingredients of the menu you had for breakfast, lunch, and dinner. Refer to the table that shows the GHG emissions produced by one kilo of each food, computed based on emissions from all the steps and processes they have undergone from the farm, in the factory, on the road, and in the supermarket before reaching your home.

FOOD	CO_2 EQUIVALENT (PER KILO)
Lamb / Goat meat	39.2
Beef / Carabao meat	27.0
Cheese	13.5
Pork	12.1
Turkey	10.9
Chicken	6.9
Tuna	6.1
Eggs	4.8
Potatoes	2.9
Rice	2.7
Nuts	2.3
Bean / Tofu	2.0
Vegetables	2.0
Milk	1.9
Fruit	1.1

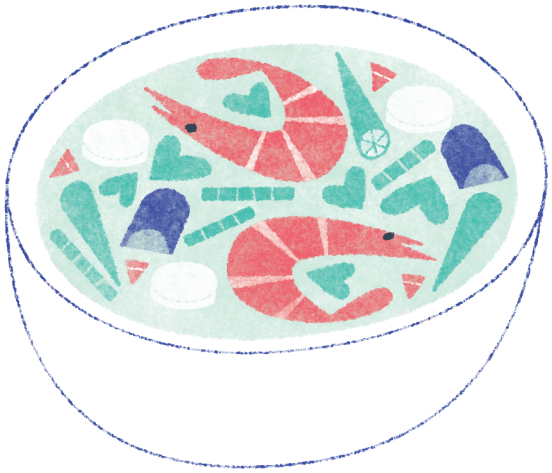
Another factor in food's carbon footprint is the sources of the ingredients. Delivery vehicles produce more emissions the greater the distance they travel. It helps in making a choice to determine whether food items are sourced locally or not. Using the data in the chart, you can track how the ingredients of your meal traveled to reach your home. When the information on the distance the ingredients have traveled has been compiled, calculate the food miles. The farther the food traveled to reach your home, the more carbon dioxide was produced in the atmosphere, and this contributes to carbon footprints.

The chart compares different travel modes by their carbon footprint. Though these are measured by the total amount of GHG emitted per person to travel one kilometer, the values can be used as well to compute the carbon generated by delivery of food ingredients.

MODE OF TRANSPORTATION	CO_2 EQUIVALENT (g/km)
Bus	104.71
Diesel car, 2 pax	85.305
Diesel car, 4 pax	42.6525
Domestic flight	254.93
Truck (diesel)	209.47
Truck (gasoline)	282.95
MRT/LRT and tram	35.08
Aircraft (economy)	149.81
Van (diesel)	170.61
Van (gasoline)	192.28
Motorcycle (large)	135.01
Motorcycle (medium)	102.89
Motorcycle (small)	84.45
Railway train	41.15
Small car (diesel)	142.08
Small car (gasoline)	153.71
Taxi	150.18

DISCUSSION

- Which meal took the most energy to get from farm to plate and which took the least?
- What are your observations about the food sourced from local and non-local?
- Do you have suggestions for reducing the CO_2 emissions from the food that you eat?



Instructions:
Using the template, keep a record of the major ingredients of the menu you have eaten and calculate the CO_2 equivalents involved over the course of a week.

Template 1

	BREAKFAST	LUNCH	DINNER	SNACKS (if any)	CO_2 EQUIVALENTS
MONDAY					
TUESDAY					
WEDNESDAY					
THURSDAY					
FRIDAY					
SATURDAY					
SUNDAY					

On your usual grocery shopping day with family, check the labels of purchased food to determine where they were made. Use an internet search tool to find out how far the food has traveled from the source. By locating and determining the distance and the transportation modes, students can compute the food miles.

Template 2

FOOD ITEMS	DISTANCE	TRANSPORTATION MODES	FOOD MILES

Food Miles Calculator

What are food miles? Food miles measure how far the food has traveled from its origin to the consumer. It looks into the environmental impacts of food (and its ingredients) by measuring the distance it has traveled and how that distance was covered (e.g., by plane, boat, land transportation, etc.)

What mitigative actions can we do? Buy local. Walk to the local shop. Grow your own food. These are some of the ways to reduce "food mileage". Another is to modify your diet to focus on foods with a lower carbon footprint.

www.foodmiles.com

ACTIVITY:
RECIPE REVISIONS

As you have learned from the previous activity, meat has a much higher carbon footprint than plant-based food. This is because raising animals for food produces more emissions than vegetable production. Animals release CO_2 and methane, unlike plants, which take in CO_2.

To choose foods that have low CO_2 footprint:

- Try to buy organic produce: These are crops, fruits, and vegetables grown without chemical pesticides and fertilizers. Although organic produce can be more expensive in supermarkets, they are more affordable if bought directly from local farmers. You can find suppliers who deliver directly from these farmers or from farmer cooperatives on the Internet.

- Eat more vegetables than meat. Beef, in particular, is considered to have a high environmental footprint as cows produce methane as a byproduct of their digestive system through enteric fermentation.

- Be a sustainable consumer.
  - ◊ Use mainly local fruits and vegetables that are in season. Choosing foods in season eases the demand on food production, which can help reduce emissions. Besides, there will be more of them available and at lower prices. Find out the seasons of fruits and vegetables and use them as a guide for shopping lists, though note that these may vary with the weather.
  - ◊ Appreciate the unattractive. You can buy and use produce even when it's damaged, wilting, or old, as long as it's not rotten. Some fruits and vegetables actually have more health benefits when they aren't at their freshest and most attractive. An example is bananas, which are more nutritious when their peels are starting to get dark marks. They can give you more energy and ease menstrual cramps. Overripe fruits can be blended into shakes and vegetables used in soups. In general, throwing out less food means less carbon production.

Eating less meat is a simple way to mitigate climate change and has the added benefit of being better for you nutritionally. Try modifying a favorite recipe by swapping out the meat with plant-based foods. Tofu, nuts, monggo, and beans make good alternative sources of protein. You may have heard of burger patties made out of mushrooms. They have also been made from monggo, eggplant, and *puso ng saging*.

Do some research to find appropriate meat substitutes then experiment with making a small portion of your recipe. Take a photo of the food you prepared with your revised recipe. Upload the picture and recipe on any social media platform with a caption encouraging your friends to become responsible and sustainable food consumers.

Apart from the food we consume, there are many other ways that humans are affected by and contribute to climate change. We will learn about more of these in the next chapter.

KEYWORDS

agriculture
the science and practice of cultivating the soil, producing crops, and raising livestocks

agricultural lands
lands devoted to agriculture

carbon footprint
the amount of carbon dioxide that the human population emit as a result of our activities

Climate-Smart Agriculture (CSA)
a systematic integrated approach for transforming and reorienting agricultural development under the realities of climage change

farming
the act of cultivating the soil, producing crops, and raising livestocks

forestland
land covered with forests or reserved for forests

rural
anything relating to the countryside

vegetation
plant life or total plant cover in a particular area

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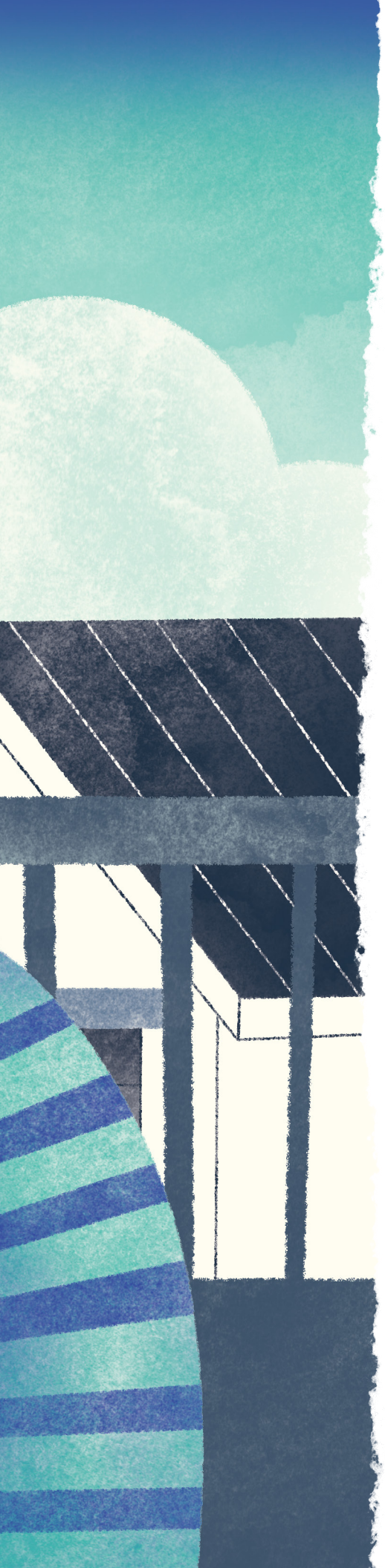
PARTNER ORGANIZATION

The Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) is one of the 26 specialist institutions of the Southeast Asian Ministers of Education Organization (SEAMEO). Founded in 1966, SEARCA is mandated to strengthen institutional capacities in agricultural and rural development in Southeast Asia through education and collective learning, research and thought leadership, and emerging innovation for growth. Gender and Youth Engagement in Agricultural and Rural Development (ARD) is one of SEARCA's priority areas for its 2020-2025 strategic plan with the theme, Accelerating Transformation Through Agricultural Innovation (ATTAIN). SEARCA is hosted by the Government of the Philippines on the campus of the University of the Philippines Los Baños.

Website: https://www.searca.org
Facebook: https://www.facebook.com/seameo.searca
YouTube: https://www.youtube.com/SEAMEOSEARCA


CLIMATE
CHANGE



CHAPTER 6
CLIMATE AND ME

We have learned how climate change can have an impact on you no matter where you live. Whether you live in the city, a farm, or a coastal area, climate change will have effects on various aspects of your life. Adapting to these is essential, especially for those whose livelihood is affected by the weather such as farmers and fishermen. Finding means to adapt to issues affecting our food supply are a particular concern.

Does learning about the problems caused by climate change make you anxious? If it does, you're not alone. A 2021 global study revealed that most people aged 16-25 do, including 92% of Filipino youth. Worry and stress over the consequences of climate change and other environmental problems is called **eco-anxiety**. It's a legitimate feeling, since most of these can't be reversed or may take a long time to, which makes our future uncertain.

One way to relieve feelings of eco-anxiety is to understand how climate change and its effects impact your life and to find ways to take action. You can start by evaluating your immediate surroundings. In this chapter, you will reflect on how climate change has changed your way of life and how it might change it in the future. Then you can think of your own ways of adapting to such changes. Remember, every little thing you do can make a difference.

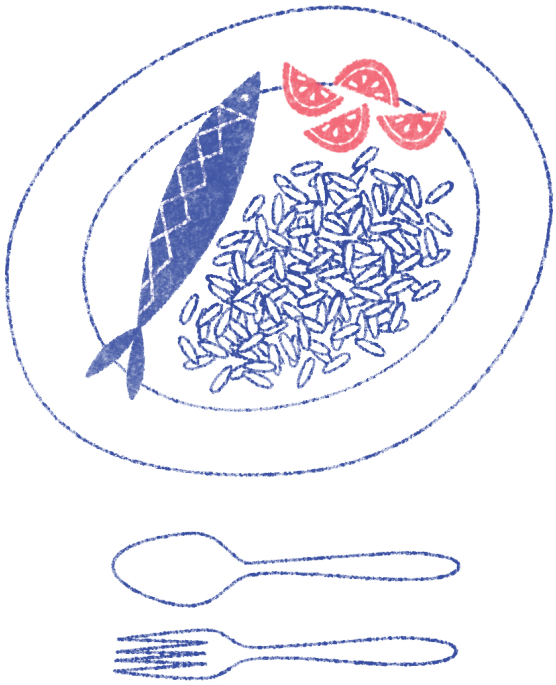
HOW CLIMATE CHANGE AFFECTS MENTAL HEALTH

Those who have gone through a climate disaster are likely to experience post-traumatic stress disorder. Even if you haven't been through a major disaster, your mental health may still be affected by climate change. With all the problems it causes and adjustments we need to make to adapt to it, climate change can give us eco-anxiety. How you feel would depend on what you have experienced and what you are most vulnerable to. You might also worry about its effects on loved ones.

Rate from 1–5 how worried you are about the following effects of climate change:

	Extreme heat
	Increased air pollution
	Frequent / extreme rain
	Risk of disasters
	Effects on loved ones' health

Learn more about the issues you feel most worried about, then discuss with your family possible plans of action. Rate how you feel about your family's plan to deal with these climate hazards.



FOOD SECURITY

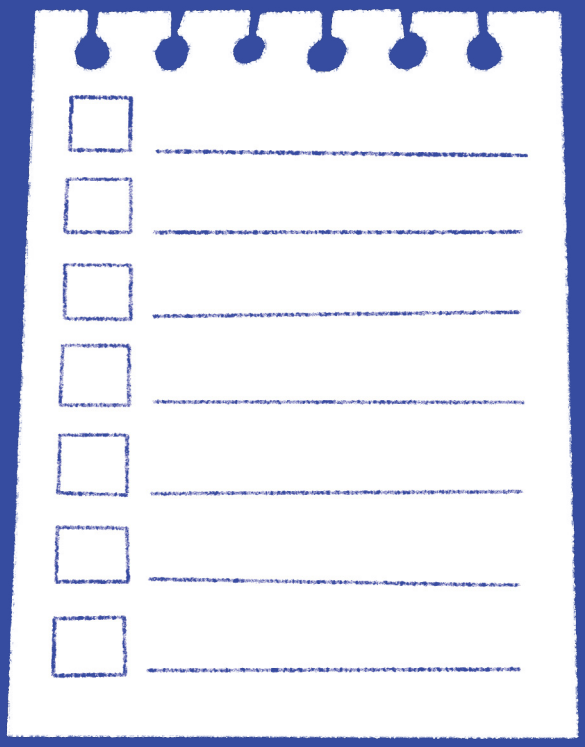
In the previous exercise, did you and your family identify food as a concern?

For there to be food security, there needs to be food availability, food access, utilization, and stability. Food availability is the main dimension that is threatened by climate change, but this also leads to lack of food access. Food access pertains to how food supply can be acquired by people, whether they have the resources or money to get it. Food utilization refers to how much nutrition people can get out of the food, and stability to whether they are able to get enough food all the time.

ACTIVITY:
EMERGENCY FOOD BANK

To help achieve food security, you need to make sure to have access to food even in the case of an emergency. Storms and flooding can make it difficult to purchase food. It's recommended that your family keeps a three-day supply of food and water for emergencies.

Considering the above guidelines, make sure that your emergency food supply is sufficient and provides balanced nutrition. Using a budget set by your family, select canned and preserved foods for your emergency food bank and identify an appropriate place to store it.



PHYSICAL HEALTH AND HYGIENE

Lack of food can lead to malnourishment, which may cause other diseases. Food spoilage, which increases with greater heat, can lead to sickness as well. These are just a few of the many effects climate change can have on health.

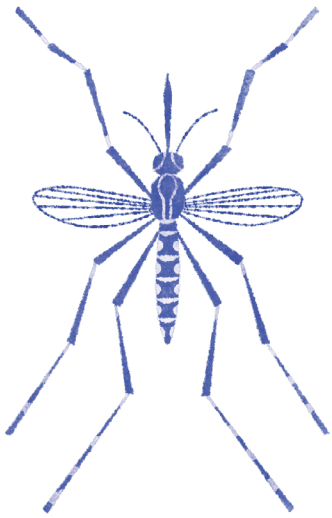
Too much of anything is bad for you, and that certainly goes for weather phenomena like heat and rain. Climate change can cause both extreme heat and overabundance of rain. Vulnerable populations may suffer from heat stress while there is a widespread increase in respiratory diseases in rainy weather.

Water supply is a concern under either weather extreme. It can be contaminated by flooding, leading to health issues. It may also be threatened by drought, which may lead to poor hygiene. You've probably been informed since you were small of what would happen if you didn't take a bath every day or wash your hands before meals. With a water shortage, health issues caused by poor hygiene become more common.

As too much rain and a rise in temperature leads to the growth of the mosquito population, there are worries over the diseases they bring.

Dengue is a disease that may become more widespread due to climate change. Frequent rains cause more water to collect, giving mosquitoes places to lay their eggs. Warm weather also helps mosquitoes to multiply, especially the dengue-bearing species.

Communities adopt various measures to reduce their mosquito population. They may regularly fog during the rainy season. Some schools have adapted by making long pants part of their uniform rather than shorts or skirts.



Aedes aegypti

THINK ABOUT THIS

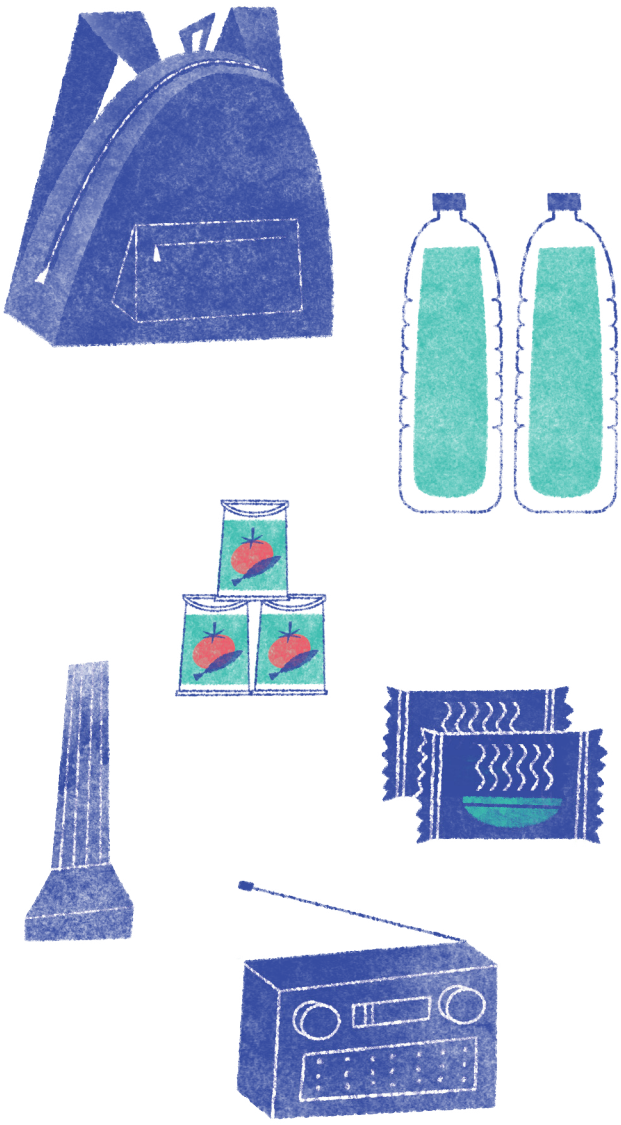
What are some things you should always have with you to keep you healthy in the face of everyday climate effects? Give at least one appropriate item for each climate effect:

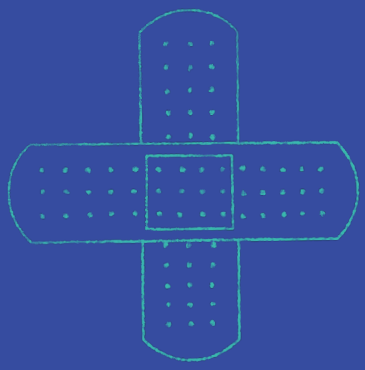
- Extreme heat
- Lack of clean water
- Increased mosquito population

PERSONAL SAFETY

With food and physical well-being at risk, remaining in a place that has been badly affected by a disaster means having to live with fear for your personal safety. The best way to deal with this anxiety is to make whatever changes are necessary to make your home and family less vulnerable to future disasters. This could mean changes to your home, like securing important items where they are out of reach of floodwaters or, if you can afford to, adding another floor.

Having a well-equipped emergency kit and sufficient stock of food and water are essential. Community measures such as flood warning technology and evacuation centers also help address these fears. It is important to address fears with such measures rather than ignoring or denying them. It is only by being prepared and avoiding suffering from future disasters that you can get over your trauma.





ACTIVITY:
LEARNING FIRST AID

What are some common injuries that could happen in a climate emergency? You will feel less anxious if you know how to address these. Make a list then find out what first aid methods can be used in each situation.

CHANGES IN YOUR BACKYARD

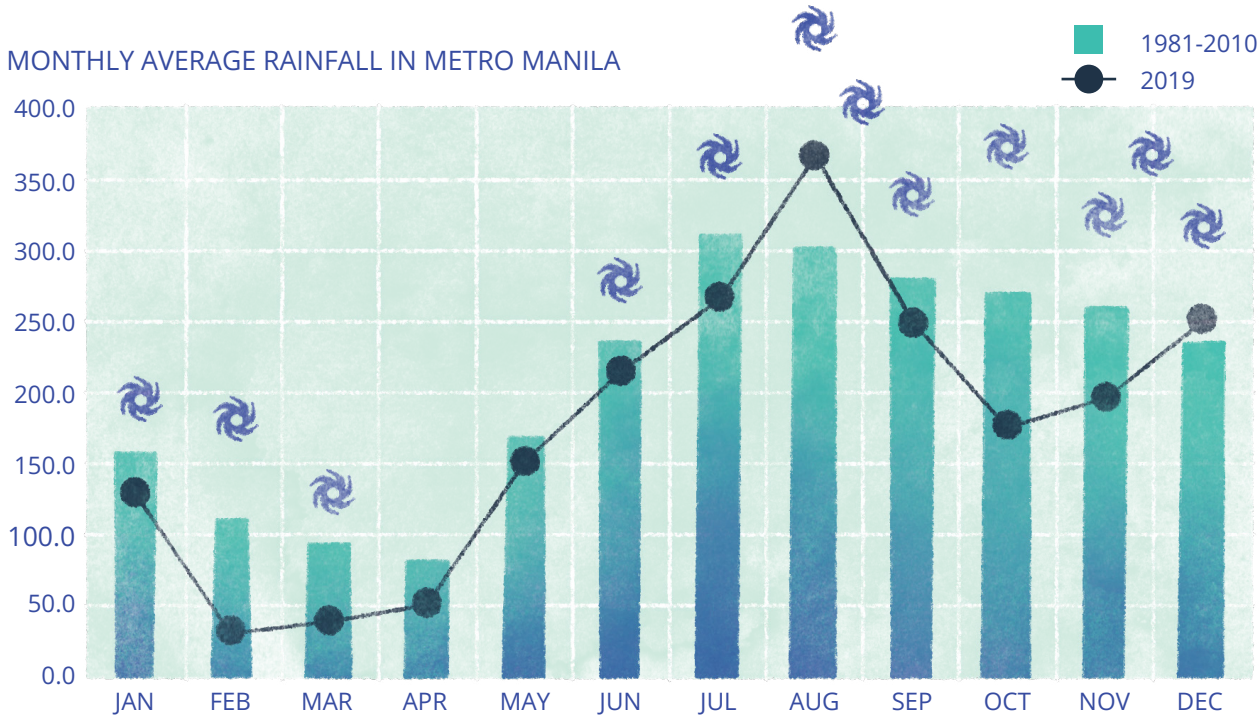
If your place is affected by climate as discussed above, would you want to leave, or would you prefer to stay? If you stay, how will you deal with the climate hazards you may face in the future?

While some people need to move because of the loss of their homes from a disaster, most people prefer to stay in their homes or return to them once they're repaired. Even people whose homes have become permanently flooded decided to stay, while some may have no means to move. Moving is a major change that could expose you to new challenges, and people often prefer the security of remaining in a familiar place, surrounded by familiar people, rather than face the unknown.

In the past, many Filipinos treated flooding as a regular seasonal inconvenience. In the City of Manila many decades ago, flooding in the lower lying areas was only knee-deep at the most. Water flowed readily through the canals, which had no informal settlers living on their banks. The situation remained much the same through the 1960s. In 1972, there were four typhoons, one right after the other from mid-July to the start of August, causing major flooding in the entire Manila area and nearby provinces. There was flood water from Manila Bay to Lingayen Gulf, and everyone had to travel by banca. Ask your parents or grandparents if they remember this disaster.

In other areas, certain climate hazards had occurred so rarely over the past decades that when they did strike in recent years, people were unprepared. In Tacloban, tidal flooding was a regular occurrence along the coast, but the last storm surge they had before Yolanda was in the early 1900s, well beyond any living resident's memory.

It doesn't take a disaster to change the nature of your home. Other changes in climate can affect your home and community. Extreme heat, for instance, may prevent children from playing outdoors and people from gathering in the plaza and parks, reducing a sense of community. Sea level rise can threaten coastal infrastructure and development.



CLIMATE MIGRATION

Though most people would rather not move, sometimes climate change makes it necessary. The area may have been found too vulnerable to flooding or landslides, congestion along riverbanks may have reduced its flow and contributed to flooding, or it is chosen as the site of adaptive infrastructure such as a seawall, or a mangrove forest. Climate migration can also be due to loss of livelihood, such as if fishing or farming are no longer viable.

Government housing is sometimes provided for people who need to relocate. Apart from finding it hard to let go of their original homes, however, many people find it hard to adapt to new housing they did not choose. For many, their means of earning a living is tied to where they have lived for some time. They may have difficulty getting to their place of work whereas before it was close to home.

ACTIVITY:
LEARNING FROM REAL-LIFE STORIES

Watch the second episode of Mga Kwento ng Klima, which shows the ways in which people have adapted in communities that are regularly flooded or have become permanently inundated. Compare their adaptive responses with your family's. What can you learn from the given examples?

tinyurl.com/2s39a9zk

Managed Retreat: The Case of Kiribati

Some countries foresee that at the rate of global warming, significant portions of their land may be underwater in the future. To prepare for this, the Micronesian island nation Kiribati decided to purchase land in Fiji for their people to move to in case they are inundated by waves. However, as they have been building up their islands with sand, scientists have determined that the nation is unlikely to be covered with water. They have therefore decided on another climate-adaptive use for the land. Because they import a majority of their vegetables, they now have plans to use the land for agriculture.

Migration of an entire community is difficult enough, so it's just as well that they have held back on moving their entire country. If your community had to be moved to a whole other island, would you agree to go? Discuss the pros and cons of such a move with your classmates.

CULTURE AND TRADITIONS

How are other parts of the Philippines affected by climate change? Have you seen the Banaue Rice Terraces yet? It may sadden you to learn that this world-famous heritage site is being damaged by climate change. They suffer from temperature extremes. Drought followed by long periods of rain has caused them to erode more quickly in recent years. More and more Ifugao farmers are abandoning their terraces because of the challenges of farming rice, so their unfarmed terraces are neglected, and there are fewer people who remain to maintain their traditions. Their traditional community ritual of *baki*, giving thanks to their gods at the beginning of the

planting season, is difficult to plan because of uncertain seasons, so the tradition is fading.

Aeta youth leader Rica Cahilig laments that the Aeta tradition of *pagdadanso* is endangered because of climate change. This traditional practice entails leaving the city and going to live in the mountains, bringing only rice and salt. As hunter-gatherers, they traditionally get what they need to survive from the forest. But with the extreme heat and drought, that is no longer possible.

Flooding can threaten indigenous peoples as much as drought. For example, with loss of trees due to development as well as increased rainfall, the Agusan Marsh's flooding makes it less habitable for the Manobo people. Though the Manobos survive seasonal floods with their stilt houses and bancas, increased flooding threatens the animal and plant life they depend on. Where will they get food then? They have many traditions we can learn from such as organic farming methods and a tree-planting method which has been adopted by the DENR. Unfortunately, there is a danger that increased flooding may drive Manobos away and dissolve their community.

In general, extreme events can cause damage to heritage sites and also put the preservation of cultures and their traditions at risk. Look into the traditions mentioned. There may also be others more familiar to you.

HOW FUN AND GAMES HAVE CHANGED

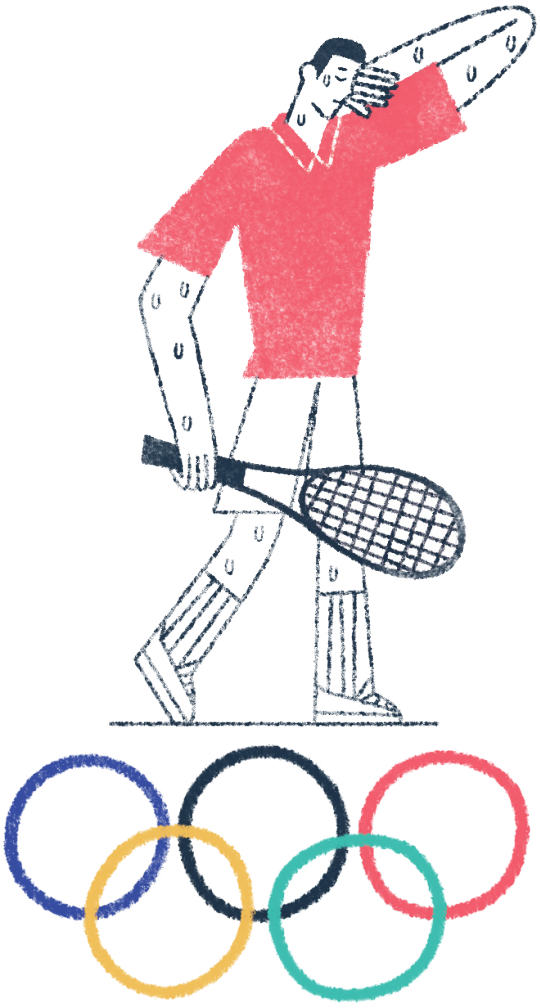
When the Japan Olympics took place in 2021, many athletes were badly affected by the extreme heat. While heat and humidity have always been typical of Tokyo summers, the weather conditions have been growing more extreme due to climate change. A number of Olympic athletes performed badly given the heat, even with adaptations such as early morning start times for outdoor events and relocation of the marathon to cooler Sapporo.

If you practice outdoor sports, you would probably have experienced some of the effects of heat on athletes: dehydration, cramps, chills, and fatigue. It can also affect your nervous system, impacting your coordination and even decision-making abilities. Knowing how heat would affect teams that were unaccustomed to it caused the organizers of the 2022 Qatar World Cup to set the event for November, well after the hottest and most humid months in the Middle East. And even so, the stadiums for the games will be air conditioned.

Athletic events in colder countries are also affected. In the 2010 and 2014 Winter Olympics, poor conditions such as soft, wet snow caused problems for athletes in some events. By 2050, ten of the nineteen host countries might not have the appropriate conditions for Winter Olympics anymore. By 2080, the number is expected to reach thirteen, leaving only six possible venues.

The International Olympic Committee now mandates that starting in 2030, a country has to be carbon zero to be eligible to host. The expectation behind being carbon zero is not exactly that they will produce no emissions but that they will reduce them as much as possible and compensate for those produced. Compensation is a mitigating practice to make up for the carbon emissions you can't avoid producing in an activity.

Large sports events which draw together many athletes and spectators always cause emissions. Sports facilities and equipment themselves have a carbon footprint.



If you play a sport, you can do something about this on a personal level. Consider renting or sharing equipment. If you have your own, maintain it and repair it whenever possible. If there are options, choose equipment made of sustainable materials. Try to play at outdoor venues in the day, when lights won't be needed. If you play basketball in your neighborhood, it's best to play early in the morning or late in the afternoon to avoid intense heat.

THINK ABOUT THIS

What sport or game do you enjoy?

Is the practice of the game affected by climate change? How?

What are some ways to adapt to climate effects in playing this sport or game?

CLOTHING AND FAST FASHION

These changes in the world of sports show that due to the effects of climate change, we may have to do our favorite activities differently or find alternatives. And it's best if those alternatives are sustainable or help reduce GHG emissions.

Some developments are making the arts more sustainable. One visual art that is found to have a high carbon footprint is fashion. About one-tenth of carbon emissions comes from the fashion industry. Production of cotton and other types of fibers for the materials produces emissions and waste, with as much as 87% of the fibers produced discarded in landfills or incinerated. A half million tons of plastic microfibers are produced as well, which get washed into the ocean where they may harm wildlife. This environmental harm is not caused just by the expensive, high fashion brands. In fact, fast fashion, or the constant production of cheap, trendy clothes, is a business model companies employ to increase sales and encourage wasteful consumption. People are encouraged to keep buying new clothes by low prices, frequent production of new designs, and the generation of new trends.

Clothes are not just a necessity but a means of self-expression and fitting in. There can be more sustainable ways of using fashion in all these ways, though.

Some steps you can take:

- Buy fewer clothes. Choose to buy only what really "sparks joy" and consider buying items a size or two larger to grow into. Try to buy good quality items that will last longer. You can get them more cheaply at sales and outlet stores.

- With temperatures rising, consider buying less clothing designed for cool weather. Instead, layer clothes when you feel chilly.

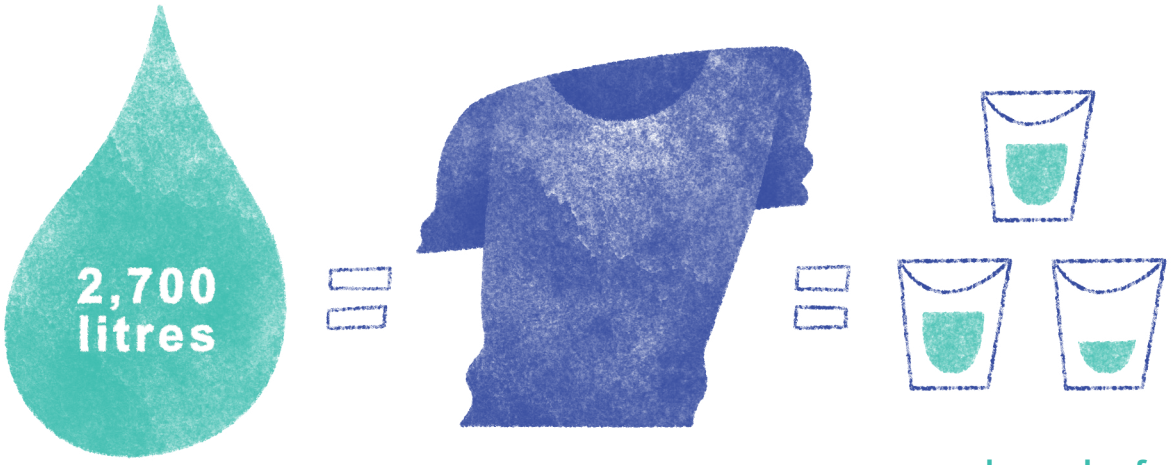
- Repair and refurbish your clothes. You can follow trends without buying new clothes by altering and embellishing clothes you have. You can add beads and patches, turn pants with worn legs into shorts, or add designs or accessories in a trendy color.

- When you have to shop for new clothes, read labels. They may identify the materials and where and how the clothing is made, which can help you make a sustainable choice.

- Pre-loved and hand-me-down items still in good condition are precious. Be happy to receive these. If you have a relative who gives used clothes to you, accept them graciously and try to continue the family recycling chain by taking good care of your own clothes and donating items you have outgrown.

- Shop at *ukay-ukay* or thrift stores. You may be surprised to find some items are completely unused. In some parts of the world, about 40% of clothes bought are never used.

- You can also repurpose old clothes. Aside from being made into rags or rugs, they can also be used to make other items like bags or throw pillow covers.



enough supply of drinking water for one person for 2.5 years

ACTIVITY:
CREATIVE CLOTHING UPDATES

In the olden days, when clothes were more expensive, people often just updated their existing clothes by adding lace, or raising the hemline to follow the trend. These days, this would be considered a form of upcycling, a way to improve an existing object to extend its life and reduce waste.

Try applying upcycling to your own clothes. Look for a picture of a fashion trend you would like to try. Are there existing items that you can combine and/or modify to achieve this look? Apply your creativity in utilizing things you already have to get the look you want. Make a sketch on a scratch paper, labeling the items you will use and noting what changes you will make. Make a vlog about your process or post before and after photos!

EXTREME WEATHER AND THE WORLD OF WORK

Higher temperatures may also badly affect people who need to work outdoors in midday, such as construction workers and traffic enforcers. What do you think they should do to adapt to temperature extremes?

In the earlier chapters, we have discussed some of the effects of climate change on the livelihood of farmers and fishermen. These types of work are among those most directly affected by climate. Weather extremes affect the growth of crops and the health of livestock, forcing farmers to adapt so that they can reap the fruits of their labor and not just survive but profit. Farmers are advised to diversify, growing various types of crops and keeping some animals so they will have a fallback if a crop fails.

Frequent storms make it hard for fishermen to go out in their boats. Even in good weather, they have less plentiful catch. Shellfish, crustaceans, and young fish may have trouble developing due to ocean acidification, and some types of fish swarm away from the warm shallows towards cooler, deeper waters, which makes them harder to catch.

People whose livelihood is likely to be affected by weather are advised to diversify or have alternative sources of income or food. Many social enterprises, or businesses with a mission to help society, help farmers by turning farming by-products into saleable products. For instance, the leaves of *kamote, sampaloc,* and other plants that are grown for other uses are turned into tea.

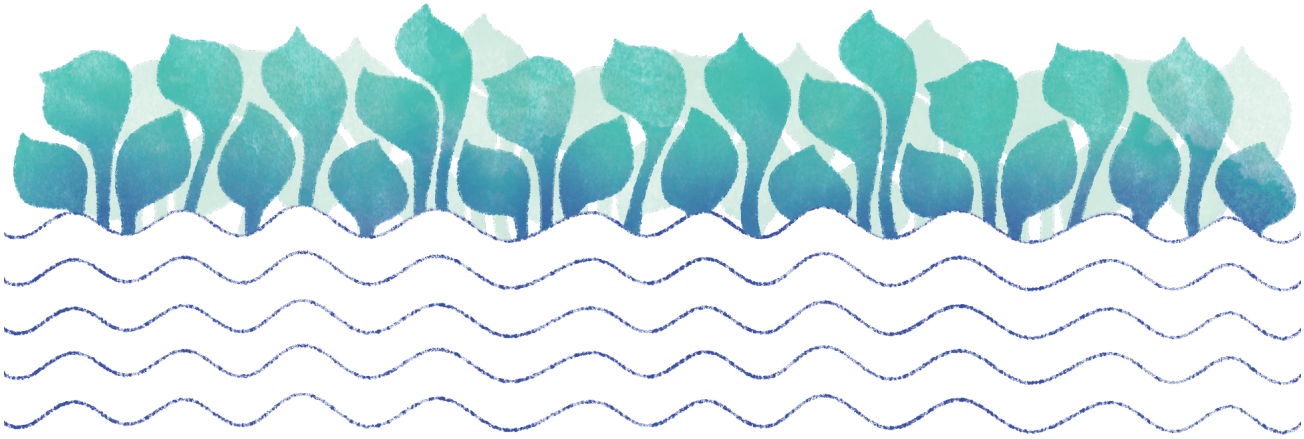
Climate change has led to some of these opportunities. A few species have

been found to proliferate or increase their numbers and thrive due to climate change. Squid, for instance, have been found to adapt easily to warmer, acidified waters. While their increase in population can upset the ecological balance, catching them for food is a simple and profitable way to prevent this. Jellyfish also increase their numbers in higher ocean temperatures; fortunately, many are edible and consumed by Asians. So that even more will be consumed, there have been attempts to turn them into new snack products. One was a more nutritious alternative to potato chips, another was a caramel candy made by Japanese students after a major jellyfish bloom.

Certain plant species also increase in warmer temperatures, such as the worldwide invasive weed water hyacinth. Because its rapid increase threatens freshwater ecosystems, they are being harvested to make woven bags or turned into plant leather.

THINK ABOUT THIS

Overpopulation of species can be turned into an opportunity for new industries that generate more jobs. At the same time, it reduces an impact of climate change. Can you come up with other ideas for industries that can accomplish these? Can these be done in your community?



THE SCHOOL YEAR SHIFT

When you first started going to school, the average school year in the Philippines might have started earlier than it does now. A shift was made in 2014 to align more closely with the school calendars of other countries. Pushing the start of the school year later has long been suggested, so students would not be going to school in the rainiest months and suffer from frequent cancellations due to storm warnings. While the principal rainy seasons vary from region to region, the months from March to May are uniformly hot throughout the country. With the calendar shift, students are in school in the hottest months. Schools therefore need to be prepared to help their staff and students deal with extreme heat.

THINK ABOUT THIS

What months does your school calendar cover? How many are in the rainy season and how many in the hot, dry season?

How will extreme heat affect most students? How do you think it will affect preschool and kindergarten students and elderly staff members, who are more vulnerable to the effects of the heat?

What changes have been made in your school in consideration of the heat?

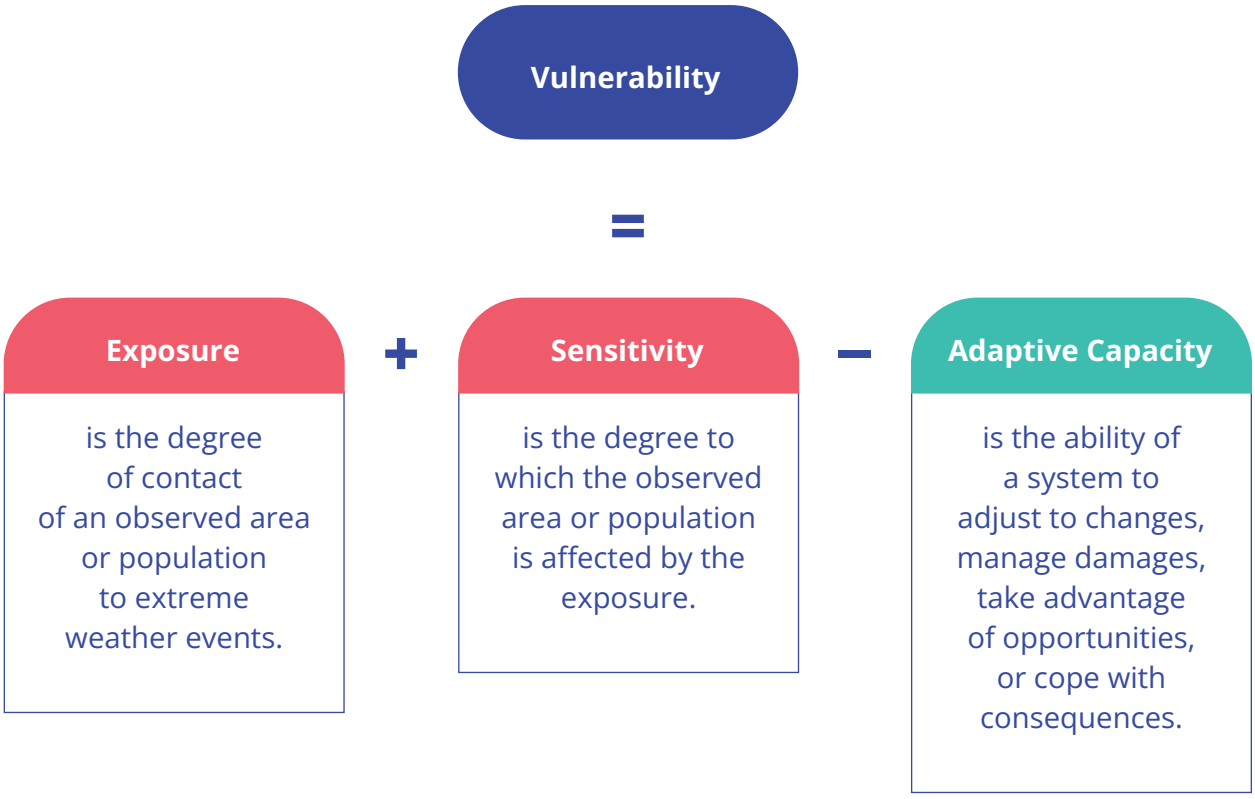
What changes do you think still need to be made?

ASSESSING YOUR RISK AND VULNERABILITY

Maybe you have not experienced any of the impacts we have just discussed. More likely, you have experienced at least one, possibly even all of them, where you live. With climate change, chances are the risks will increase. But they can also be decreased in your area if action is taken by your community to address the risks!

How concerned you should actually be about possible hazards depends on your area's risk and vulnerability. You will know your area is at risk of an extreme weather event if it has happened there before or come very close. Because of the constant increase of rain, we have to expect water levels in the rainy season will become higher in the future even if it hasn't actually flooded yet in the area. News reports may also warn you of risk. You might also consider changes in the environment around you, such as the loss of a protective forest or reef, as increasing your risk.

Vulnerability is determined by one's exposure, sensitivity, and adaptive capacity. For example, two houses along the coast may be exposed to flooding, but because one of the houses is made of lighter materials, it is more sensitive to the hazard. If that house is built on stilts, though, it has higher adaptive capacity. This means it is possible that it could be less vulnerable to flooding than the other house. This may be presented as a formula:



Risk Assessment Apps

You can assess your risk level with the help of apps where you can pin your location. Try these out and compare the results:

Hazard Hunter

tinyurl.com/2rkjw772

NOAH

tinyurl.com/hny7wj95

Climate Central

tinyurl.com/3ahb4wd5

THINK ABOUT THIS

What are some climate hazards you have experienced in your area? What others could happen in the future? Assess your degree of vulnerability to each risk using the formula. Compare your observations with your classmates and your family's.

Make sure to note the perspectives of the members of your household. In the next chapter, you will come up with plans to adapt and prepare for hazards with your family.

Since the only thing constant is change, much as we feel insecure about changes around us, all that can make us secure is to make our own changes. We need to change in order to adapt, and this will make us secure that we can survive the current and future consequences of climate change. Making changes to help mitigate it will also assure us that the situation will eventually get better as well.

KEYWORDS

adaptive capacity
the ability of a system to adjust to changes, manage dangers, take advantage of opportunities, or cope with consequences

climate migration
moving from one place to another due to drought, flood, and other climate change impacts

exposure
is the degree of contact of an observed area or population to extreme weather events

fashion
as an industry, a global enterprise devoted to making and selling clothes and accessories

food access
how food supply can be acquired by people

hazards
dangers or risks

heritage sites
a historical site, building, area with legal protection and considered significant to the country or region's heritage

indigenous peoples
according to the United Nations, they are inheritors and practitioners of unique cultures and ways of relating to people and the environment

livelihood
a person's means of supporting their existence

rainy season
also known as "wet season," it is the time of the year where majority of the country's precipitation occurs

sensitivity
is the degree to which the observed area or population is affected by the exposure.

sport
any form of competitive activity using physical exertion or skill by an individual or a team

upcycling
a way to improve an existing object to extend its life and reduce waste

vulnerability
determined by one's exposure, sensitivity, and adaptive capacity

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CHAPTER 7

ADAPTATION AND MITIGATION IN THE HOME

By now you already have an idea of what climate hazards are affecting or may affect you and your family. You need to make sure your family is aware of them too. This way, you can come up with a plan that will help you keep healthy and safe in the face of climate change.

Start with yourself, as they say. To which climate hazard are you most vulnerable? What is making you vulnerable?

KNOWING YOUR VULNERABILITIES

In the previous chapter, you were asked to check out what hazards might be affecting you or your area.

Family Adaptation to Extreme Rain Hazards

What are some climate hazards that your family might face? Apart from preparing for problems you have experienced in the past, you also need to assess your level of risk for future hazards. That way, you can be prepared to handle them.

ACTIVITY:

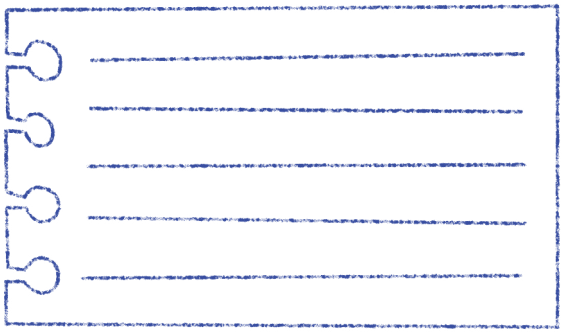
For this activity, list them down and assess their impacts on you by filling up the table below:

Hazard What are you vulnerable to?	Tropical cyclones			
Associated risks / impacts How is it affecting you?	Flooding			
Exposure	house is in a flood-prone area			
Sensitivity Is there something that might worsen the impact on you?	baby in the family			
Adaptive Capacity Is there something that might lessen the impact on you?	house is insured			

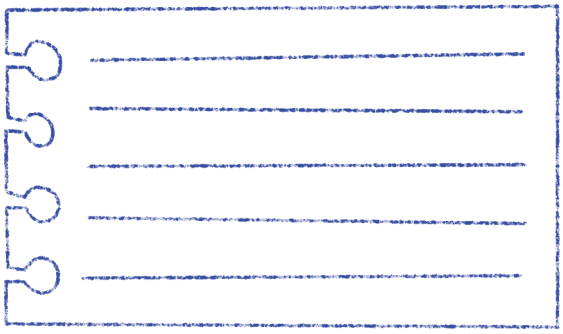
Discuss your answers. This is a good opportunity to see what your family members' concerns are and to think of ways that can reassure them if necessary, such as increasing your adaptive capacity.

Discuss how you can prepare for extreme weather events. Your hazard plan will vary, but you should discuss the following:

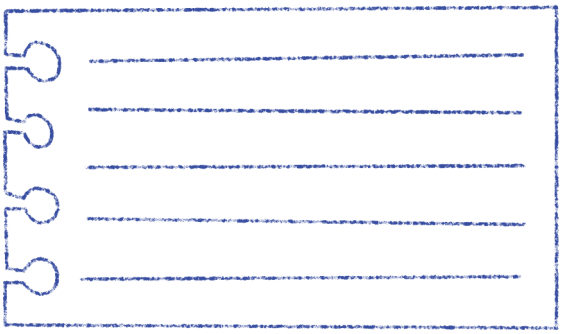
The emergency numbers and web addresses you need to know. List them below:



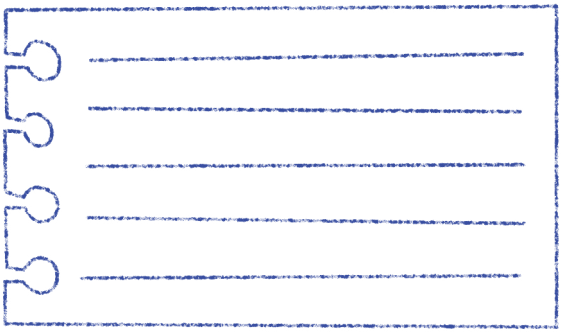
Your appointed evacuation center. It's also a good plan to tap a relative or friend with a home in a safer area. Make a map labeled with addresses of these places below:



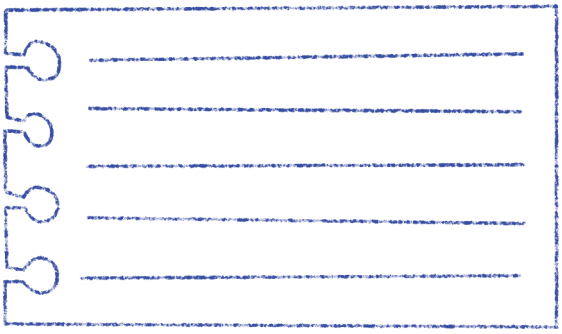
What do you need to do when evacuating the home? Some tasks can be appointed to particular family members. Make an evacuation plan below, indicating the persons responsible for each task:



What supplies should you include in your emergency kit? Make a checklist here.



Who are some vulnerable members of your community? How can you help them when there is a disaster? List your ideas here:



Family Adaptation to Extreme Heat

Is your family exposed or sensitive to heat? As the hot, dry season approaches, your family should come up with a plan to cope with heat while still conserving energy. Remember that more electrical use adds emissions to the atmosphere, which ultimately increases global warming! Some ways to help your household handle the heat together include:

- Planting trees or shrubs that provide shade. You can also hang up plant pots or train vines to grow on a wall that reflects heat or a fence that lets sunlight through. Positioning plants outside to shield your air con unit, if you have one, will help it cool more efficiently.
- If you don't have space to plant, install awnings over sunny windows and/or use thick curtains to reduce the amount of sunlight that enters. You can try making your own from old tarps or sheets.
- Have screens on windows so they can be kept open while still keeping mosquitoes and other pests out.
- If you have an upper floor, it's best to keep the windows there closed during the day. Since hot air rises, the air that enters upper floor windows or upper halves of jalousies will be warmer. As much as possible, keep upper rooms closed and stay downstairs in the day, keeping the downstairs windows open.
- Good ventilation helps to cool the air. Ideally, you should have cross ventilation, which was naturally present in traditional homes where the large *salas* had large windows across from each other. If you don't have windows across each other or even on perpendicular walls, you can still create cross ventilation by positioning fans facing the windows to blow warm air out.
- Keep your cooling appliances clean. More air will pass through a fan when it's dust-free; the same goes for an air conditioner.

- If you have one, use your air conditioner efficiently. Keep windows open when you first turn it on to let the warm air out and use an electric fan as well to drive out warm air and circulate the cool air. At night, you can set a timer to turn it off after an hour while the fan stays on. Try to save air con use for midday, when it is hottest and use the natural methods above during the cooler early morning and evening.
- Keep a supply of cool water, low-sugar drinks, and juicy fruits and vegetables and make sure everyone stays hydrated. Salty and sugary foods and drinks actually contribute to dehydration and should be avoided.
- Conserve water and keep a supply in case of a drought.

Rainy Day Woes

Climate change also causes increased rainfall, which comes with its own inconveniences! Discuss with your family what problems you experience with this and come up with possible solutions. Consider the effects of extreme rain on your:

Daily activities: Going to school and work and drying laundry are essential activities that can be hampered by rain.

Garden or crops: Plants can suffer from too much rain as well as too little. Have you observed certain plants die or some crops do badly when it gets very rainy?

Home's exterior and interior: Have you noticed any leaks or places where rainwater enters your home? Some of these problems may be due to damage. The structure or the design of your home could also be a cause. You may need to make your home more adaptive to climate change.

ADAPTING BY DESIGN: TRADITIONAL AND NEW ELEMENTS FOR ADAPTATION

Have you ever wondered how people kept their homes cool before there was electricity or why *bahay kubos* are on stilts?

Study the styles of older houses in your area. How are they adapted to the climate? How can you use these features in modern homes?

People have been building homes to help them shelter from the climate for thousands of years, and there are constantly new ideas and designs that change with the times and needs of homeowners. It's not all about style.

Traditional architecture has been developed over a long period of time, during which people had few options for dealing with climate or for lighting their homes. With no electric fans or lights, they had to be sure to design their homes to be energy efficient. A *bahay na bato* has many big windows, large common areas, and is painted in light colors that reflect the strong sunlight. How did these features help to cool their residents?

The receiving area of these homes was generally on the second floor. The ground floor was kept quite empty. What reason could there be for this that has to do with our climate?

Bahay kubo, on the other hand, are raised from the ground and have steeply sloping roofs. How do you think these helped their residents adapt to heat? To frequent rain?

Architecture keeps developing and there are many new designs and materials that can help us adapt. Homes with high ceilings have come into fashion and with good reason.

In a hot climate, high ceilings are cooling while in a cool climate, low ceilings retain more heat. Regardless of ceiling height, insulation can be placed between roof and ceiling to reduce heat from the sun.

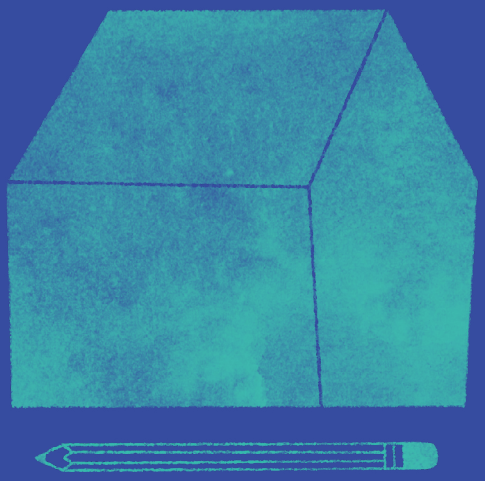
What can you do to your current home to help in adapting to climate risks and/or mitigating them? Look around your home and see what changes you can make now. Some small additions you could make to your home include:

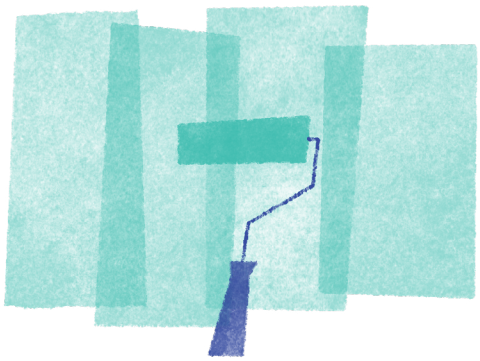
Green wall
Is there a bare wall outside your house that is often bathed with sunlight? You can hang special pots on it or make your own from large softdrink bottles. Just cut out one side of each bottle and punch holes in the other, hang on the wall and fill with soil and plant seeds. It will keep the wall cool and provide greenery.

ACTIVITY:

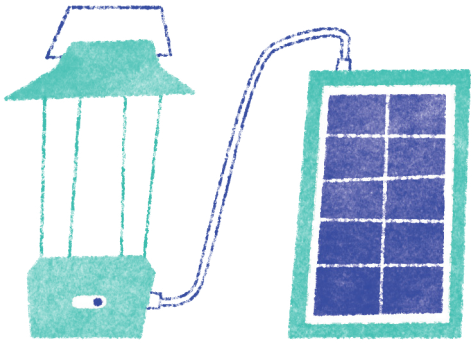
DESIGN YOUR FUTURE HOME

Consider both traditional and modern adaptive design in planning your future home. Sketch the design on a sheet of paper, labeling the features that will help you adapt to the climate. You may also build a model of it with recycled materials.





Paint
If your external walls or roof are ready for a paint job, try choosing light colors that will reflect heat. If mold grows in your home due to long periods of damp weather, you can use anti-mold and mildew paint for these rooms.



Solar lighting
Solar panels are expensive, but there are many inexpensive solar lights available. You can use them for outdoor lighting and in case of a power failure, you can bring a solar lantern inside—much safer than candles.

What else could you do to make your home adaptive in the future? Imagine what an ideal home in your city would be like.

A Garden for All Spaces and Seasons

You can actually try to plant a garden that will address climate hazards and at the same time suit your family's needs and interests. You can use your compost to fertilize it and the rainwater you collect to water it! Here are some garden types to try:

Is your family also vulnerable to floods? Consider creating a **rain garden** to absorb excess rainwater. If there is a depression in your landscape where water collects, it's a good place for native plants that absorb a lot of water. This can help reduce flooding. Native plants, which are adapted to our climate, will only need watering in the dry season. It's also good to locate plants where rain drips from your roof or from an air con unit.

If climate change impacts your food supply, consider starting an **edible garden** to provide supplementary food. This is always useful. Although edible plants do best with plenty of sunlight, you can also find some that will grow in part-shade and even indoors. You can actually start such a garden from seeds or cut-off roots and tops of fruits and vegetables your family consumes.

You would be happy to know that gardens not only help us in adapting to climate hazards but are good for our physical and mental health. Having live plants around can help improve the quality of the air in your home. Of course, you want to make sure that you don't end up increasing your carbon footprint more than your garden can absorb, such as using more water for your garden than is necessary.

How else can your family help in reducing your carbon footprint?

Water Conservation

It was a hot summer. Luisa was sticky and uncomfortable because of the heat. She'd taken a shower that morning but couldn't take another one that afternoon, or even wash her long, shiny hair. Instead, she had to keep it tied up so she'd feel cooler. This didn't really bother her until her crush passed by her family's *haluhalo* stand every afternoon. She longed to be able to get his attention by flipping her shiny hair like shampoo models did. But she had more important things to worry about. *Haluhalo* was really popular in this weather, leaving her constantly washing glasses. The problem was that there was barely enough water for this.

This scenario may be familiar to you from a period of water shortage, such as the one that hit Manila in 2019. To supply its growing population, 1.75 billion liters of water need to be drawn from Angat Dam every day. The much smaller La Mesa Dam is used to supplement this when necessary. It was the fallback in the dry months of El Niño year 2019. Being much smaller, though, it is unable to meet the demand of the city's population. Faucets were dry for as much as 20 hours a day. Water trucks and fire trucks were deployed to the worst-hit areas to distribute water, and people lined up with their containers for a supply. People were compelled to use the smallest amounts possible for washing and reuse bathwater for laundry.

Have you ever had an experience like this? We usually think of water as being cheap and readily replaceable. Until there is a water shortage due to drought or an emptied reservoir. We then realize just how valuable water is.

ACTIVITY:
HOW MUCH WATER DO YOU USE?

Measure your water use for a weekend to see how much you use when doing essential activities.

You will need:
- basins and trays
- 1 large measuring cup
- a copy of your family's current water bill

1. Collect water using the measuring cup and basins when doing essential activities such as washing your hands, showering, and washing and rinsing dishes. Keep basins in your sinks and shower and a tray under your drying dishes to catch the dripping water. Collect water used for cooking that isn't meant to be consumed, like water for rinsing rice and from boiling eggs, vegetables, and noodles. Wait for it to cool before handling!

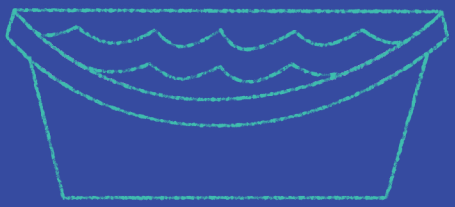
2. Pour water into the measuring cup to measure and record the amounts. Water used for rinsing rice and cooking may be used to water plants and the rest may be used to flush the toilet or wash floors.

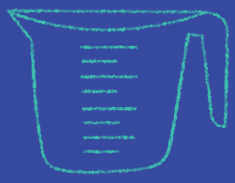
3. Compare the amount of water you use with your classmates'. What are factors that could increase or decrease the amount of water you use? What are some things you can do to use less water?

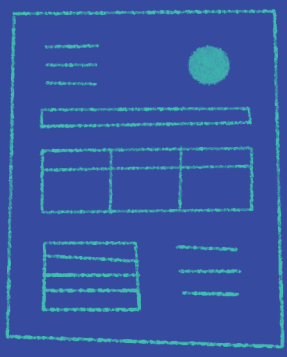
4. Each member of your class should choose a strategy to try. Practice your assigned task on the following weekend and see if your water consumption is reduced.

5. Report on what you have learned. Which strategies have proven most effective in saving water while still allowing you to perform your tasks effectively?

What would you advise Luisa in the story from the previous page to help her adapt to low water supply in the hot season?







MITIGATION: REDUCING YOUR FAMILY'S CLIMATE EFFECTS

Your whole family's collective contribution to emissions is naturally much more than you each produce individually. Fortunately, by sharing resources and working together, you can reduce these emissions. You can start with simple actions like coordinating plans so you can share a vehicle when you go out or choosing to watch the same show together instead of streaming different ones on different gadgets at once.

You may need to assess how your family uses certain resources so you can use them more efficiently and sustainably. In the activities that follow, you will examine some of your family's practices and see how you can modify them to be more climate-friendly.

GETTING AROUND

How do your family members get around? Estimate the costs of the forms of transportation you take. Could there be a way to reduce these costs?

Transportation by car can be costly in terms of gas and maintenance and has a high environmental footprint. Family motorbikes or tricycles are even worse, even if they use less fuel. They emit less carbon dioxide but produce much more nitrogen oxide.

Carpooling and taking public transportation are better because they mean more people using one vehicle instead of each of them taking individual vehicles. Using bikes and walking, of course, produce no emissions at all.

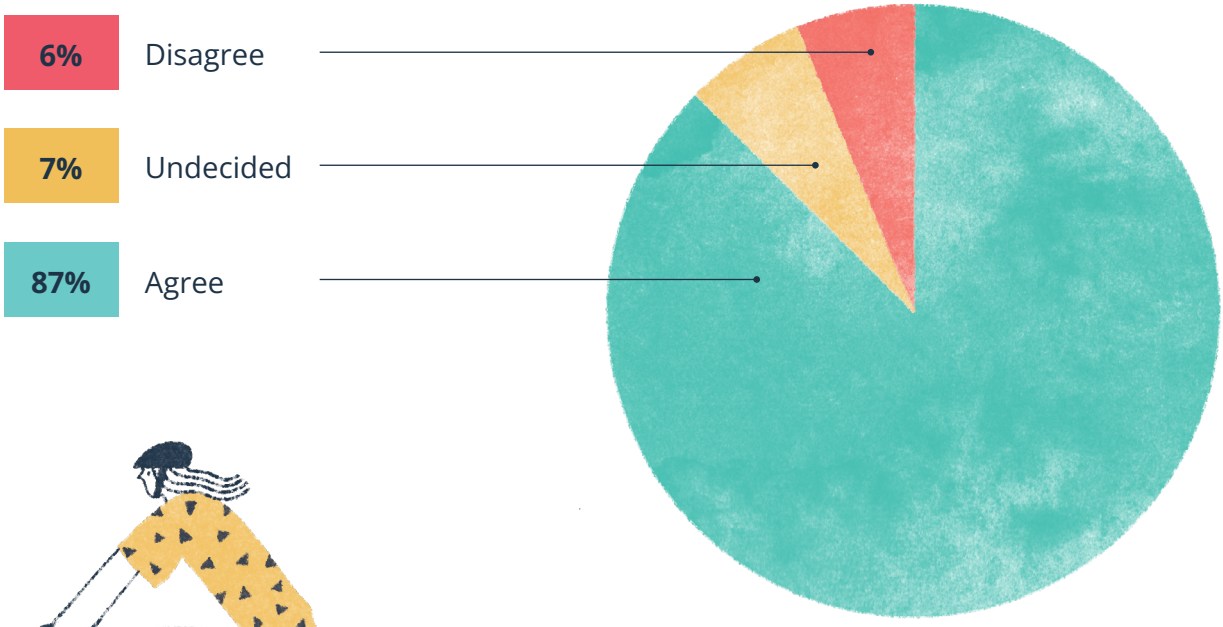
What types of transportation does each member of your family use? What changes could they make to contribute less emissions?

Family Member	Types of Transportation Used and Frequency	Better Alternatives

Thinking Of Starting Your Cycling Journey? Join A Cycling Community

Cycling has become a more popular way to get around, especially with issues with public transportation during the pandemic. Having discovered this healthy and eco-friendly way of getting around, many Filipinos have embraced cycling. However, there are many safety issues on the roads that need to be addressed to encourage this as a dominant mode of transportation. With many people now clamoring for them, there are now more bike lanes. This is a start to making cycling safer and more convenient.

"Roads in the Philippine cities and municipalities will be better off if public transportation, bicycles, and pedestrians are given priority over private vehicles" : Philippines, Nov 2020



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Do you bike? Where in your community are you able to bike?

If you have a bike or can get one, why not look for a cycling community that you can join? The group can lobby with you for safer roads for cyclists. More experienced group members can provide safety tips and having other people to bike with can not only be fun but help you stay safe on the road. You can look for these groups on social media. You can also start your own in your school or community!

HELPING YOUR APPLIANCES AND DEVICES WORK EFFICIENTLY

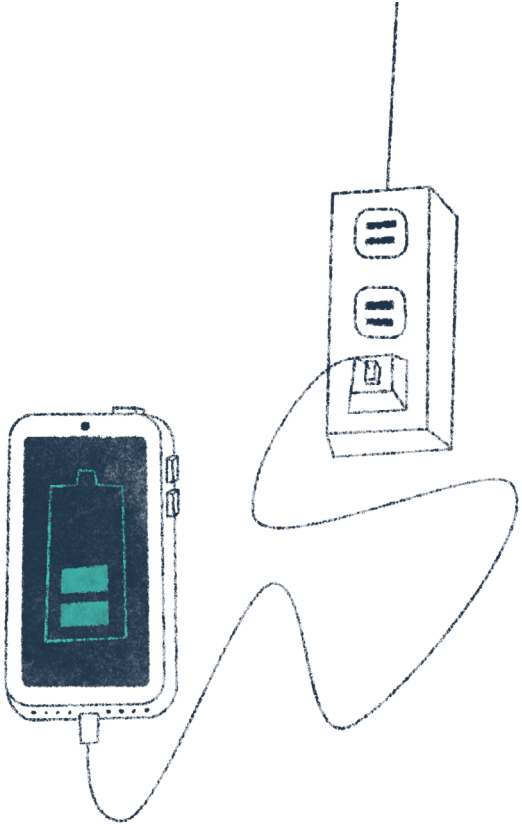
When buying a new appliance, you can check its energy-efficiency rating and choose those with a better rating. This will save on electricity in the long run. There are also some things you can do to make sure the gadgets you have will use less electricity and last longer, reducing waste.

Lights
Turn on lights only when you need them. LED bulbs last longer than other bulbs and are the most energy-efficient, so switch to them as soon as you can. Solar lights can be used outdoors.

Refrigerator
Take the temperature of the refrigerator by turning on a thermometer and placing it inside for three minutes. Your refrigerator should have a temperature of 4 °C or below. To keep the freezer running efficiently, defrost when the ice build-up is more than half a centimeter thick. Keeping the refrigerator and freezer running well helps prevent waste of electricity.

Mobile devices and laptops
Charge them just up to 80% and recharge when the battery is at 40%, and avoid using the devices while plugged. This will make the battery last longer and will avoid the waste of energy from leaving them plugged even after they reach 100% charge. Observe how long it takes to drain to 40% from 80% the first time, then you can set an alarm for when you need to recharge your device afterwards.

Air conditioner
This uses a lot of electricity even if there are now much more energy-efficient models. If you have an air conditioner, use it only when necessary, after you have tried other cooling techniques. Even when running the air con, keep using other cooling techniques such as electric fans, curtains, and awnings as well, so you can run it on a lower setting.



ACTIVITY: CLIMATE-FRIENDLY REMINDERS

Make reminders that you can post near switches, appliances, and charging stations or tape to chargers. Try to use discarded paper, cardboard, or plastic for these. Put on each sign the best practices for using the device efficiently and reminders when to turn it off or charge it. Try to come up with a catchy slogan that will help users to remember these practices!

The Unnecessary Aspects of Laundry

Whoever does the laundry in your home will be relieved to know that some things can be eliminated to reduce work and cost as well as emissions. These include:

Washing after one use
If you didn't get really sweaty or dirty, you can use some of the clothes you wore again. You can try wearing the same pair of maong jeans for the whole weekend, for instance. Using your clothes more than once will reduce the amount of washing to be done.

Wringing clothes
If you're in no rush to get the clothes dry, don't wring them anymore. The weight of water actually helps reduce wrinkles as the clothes dry out. If you hang the clothes in a garden, the dripping also serves to water plants. You can also collect the water by placing basins underneath and use it for more washing.

You can also try this experiment:
Get two pieces of the same kind of cloth and soak them. Squeeze water out of one. Hang them both to dry in the same spot, making sure they get equal amounts of sunlight and ventilation. Check them at regular intervals. Which gets dry first? What is the difference in the time it takes each to dry? You can try this out with different types of material. This will give you an idea how much difference there is in drying time and whether it is enough to justify wringing clothes of each material (and having to iron them afterwards).

Fabric softener
It's better to avoid using this plastic-packaged product. It not only contains chemicals that can cause allergies, but it can also lead to a residue building up inside your washing machine that can make it run less efficiently. It actually isn't necessary for most clothes, but you can use half a cup of baking soda as a substitute.

Ironing
If you hang your clothes to dry, they might not need ironing, especially if they were hung in the sun, which also disinfects them. Only iron clothes if they are really wrinkled.

MINDFUL CONSUMPTION

Have you heard of the three R's: Reduce, Reuse, Recycle? Do you try to practice all three?

These three R's are actually given in order of importance. The most important of all is to reduce consumption, especially of disposable items. Reusing these helps in reducing waste as well.

Recycling is good, but even if you segregate trash and bring it to recycling facilities, the process of recycling materials still causes additional waste of energy. In addition, many of these items still end up in landfills even after being sent to the recycling facility. Some small plastic wrappers might end up being blown out of garbage cans and trucks and contribute to the clogging of waterways or even end up being consumed by sea creatures. That's why it's still best to avoid using single-use plastics even if they can be recycled.

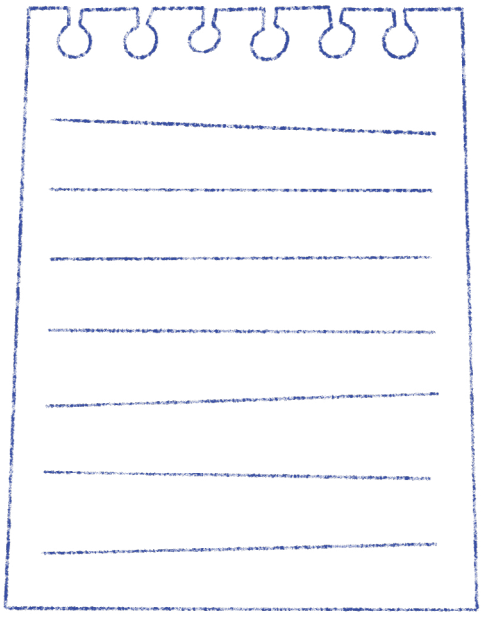
Sometimes it may take some planning to make sure you can avoid these, such as making sure to bring your own bag when shopping, remembering to tell servers not to put plastic straws in your drinks, maybe even bringing your own cup and containers when you get takeout meals. For occasions that normally generate lots of waste like parties, you can think of alternatives such as serving only finger foods so you won't need plastic utensils or even plates, or having a boodle meal using banana leaves. When choosing what to buy for a snack you can avoid those in packaging made of plastic or foil (which also has a layer of plastic).

Think about what waste items are normally used in the following situations, especially single-use plastics. Then suggest an action you can do to avoid using these.

Situation	Waste Items Usually Generated	Ways to Avoid Using These
Buying taho		
Packing your baon		
Ordering food deliveries or shopping online		
Having a class party		
Shopping for new school supplies		

WORKING WITH YOUR FAMILY TO MITIGATE CLIMATE CHANGE

Knowing how careless consumption can contribute to climate change and its hazards. How do you think your family can change their practices to help mitigate climate change? Make a list below.



Have a family meeting and ask for more suggestions on what to do to mitigate climate change and its effects. Then choose one action you can all do for a week for a sustainable development challenge. It could be as simple as electrical use by unplugging items and reducing gadget use, buying consumable items in larger packs rather than individual servings, or switching to shampoo bars. Explain the climate impact behind each practice that you are changing. Also discuss how it could help save money: on water or electric bills or groceries, for instance. You can decide to spend the money you save on a reward for the best participant or for the whole family.

Journal on it for the whole month using the format below. Have a check-in at the end of each week.

At the end of the month, compute your savings if any and ask for your family's input on the entire experience. Reflect on their comments and your experience. Then discuss with your family if they think they can keep this up or will commit to a different challenge (or both!). Have your whole family sign the contract that follows.

Electricity bill in the past month	
Water bill in the past month	
Grocery expenses in the past month	
Family savings goal	

CHALLENGE	MY OBSERVATIONS	OBSERVATIONS FROM FAMILY MEMBERS
[Example] Day 1: Cut down bath time by three (3) minutes		
Day 1:		
Day 2:		
Day 3:		
Day 4:		
Day 5:		
Day 6:		
Day 7:		
AT THE END OF THE CHALLENGE		
	Expenses After One Month	**Difference**
Electricity bill		
Water bill		
Grocery expenses		
Overall savings		
Family reflections on challenge:		
Rating:		
Overall savings:		

We the _____ family promise to:

_____

_____

_____

_____

Signed: _____ Date: _____

LEARNING TOGETHER

Going back to your risk and vulnerability assessment, try to see what you all need to learn more about climate change and how to mitigate it and adapt to it. Make a plan to learn more, as a family. Aim to get information from credible sources. These are normally provided by well-known scientific organizations, institutions, and publications. You can subscribe to their newsletters or channels or follow their social media pages.

Apart from doing research, you can also attend seminars or workshops together, develop skills such as upcycling clothes or gardening, or go on an educational trip. You can bond as a family while learning about climate change and grow more secure in the knowledge that you can do something about this global problem. In the next chapter, you will have the opportunity to share that knowledge with a wider community.

KEYWORDS

careless consumption
the practice of purchasing products or services without carefully thinking if it can contribute to climate change and its hazards

carpool
an arrangement between two or more people to travel in a single vehicle

climate-friendly
anything that is not making climate change worse

Energy Efficiency Rating
also known as Energy Efficiency Ratio of a cooling or heating equipment, it is a value used to determine how much power an AC provides for a given amount electrical energy

family adaptation
adaptation strategies done by families or in the household

household
a social unit composed of a family or a group of people living together

mindful consumption
the practice of purchasing products and services after considering one's consumption needs while being environmentally responsible and looking for possible ways on how to reduce consumption

water shortage
lack of water supply

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PARTNER ORGANIZATION

The Climate Reality Project®
PHILIPPINES

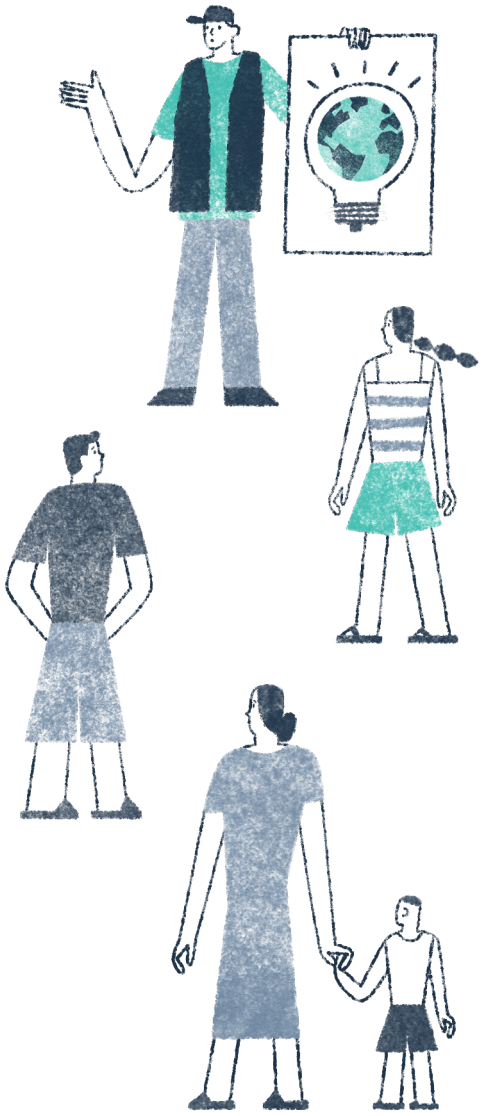
The Climate Reality Project Philippines is a collaborative, diverse, and multi-disciplinary community of Pinoy Climate Reality Leaders innovating to find solutions to the climate crisis through skills-sharing, value-formation, and capacity-building activities; mobilization; and institutionalization of nation-building efforts towards an inclusive, empowered, and transformed Philippines.

Website: climatereality.ph
Facebook: www.facebook.com/climaterealityphilippines
Instagram: www.instagram.com/climaterealityph
Twitter: twitter.com/climaterealph
YouTube: www.youtube.com/channel/UChvAZvLxL0kiFEnU0fnVmIg

CHAPTER 8
BACK TO THE COMMUNITY

How would you describe the community you live in? Who are the people in your community and how do you interact with each other? Do the people in your barangay cooperate in following rules and do they work together to maintain order and cleanliness? Who are your barangay officials and what kinds of projects do they prioritize?

As you observe your immediate environment and the people in your barangay, consider how your community has been affected by climate change. How aware do people seem about these impacts, especially the risks? What do you think needs to be done in your barangay to address these?



SEEKING CLIMATE CHANGE SOLUTIONS FOR YOUR COMMUNITY

A climate change solution is an action that addresses climate-related risks and impacts. It may take the form of a new system, technology, or policy and governance, research and development, education, or direct actions—anything that helps to reduce emissions, risks, or vulnerability, or that builds the adaptive capacity and resilience of communities against climate change.

A community can join forces to find and enact solutions to target issues in its area. For more resources and for broader and more consistent enforcement of such actions, it is helpful to get government involvement.

ACTIVITY
LEARNING FROM EXAMPLES

Watch Parts 4 and 5 of *Mga Kwento ng Klima*. List down the climate change solutions suggested in these episodes. Have you observed any of these in your community? Check those items off. Mark with a star the solutions that you think could benefit your community or that you think your community needs.

tinyurl.com/2p9fmepe

tinyurl.com/2p8ap7jd

LEARNING FROM THE PAST

Your community has probably changed much over the years, especially if it is urban. To better understand how things in your community have changed, ask an older resident who has lived at least 15 years in your community the following questions:

1. How has the landscape of our community changed? Have there been changes in the plant and animal species seen around, temperature, rainfall, and flooding? Compare the kinds of houses and buildings there were then with the ones you have now.

2. What is the most memorable climate hazard you have experienced in our area?

3. How likely do you think something similar will happen again? Why or why not?

4. Do you think the changes in your community or the environment contributed to this event?

Do additional research about your area's recent history. Look for news stories about the extreme weather event mentioned. This will give you a better idea of the resources and needs of your community.

YOUR COMMUNITY WATERSHED

Do you know where your water comes from? Before it reaches the faucet, it came from your watershed.

Watersheds are areas of land that naturally drain rainfall into a larger body of water. They are our source of water for daily use. They also help protect us from floods and landslides. Water travels down slopes and eventually collects in large bodies of water.

Areas of land where water naturally overflows from bodies of water when there are rainstorms are called floodplains. They perform their function best when they are rich in vegetation.

ACTIVITY:
WATERSHED EXPERIMENT

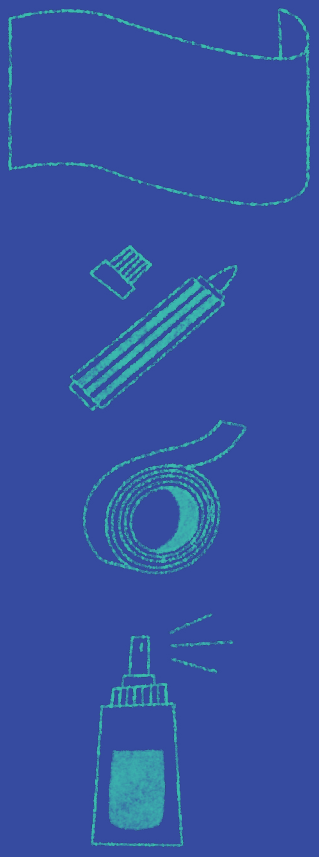
This experiment will demonstrate how watersheds channel rainwater to different bodies of water and the effects of human factors on this distribution, given climate change.

You will need:

- 1 sheet of scratch paper, blank on one side
- a blue water-based (not whiteboard) marker
- cellophane tape
- a small spray bottle of water

1. Lightly crumple the sheet of paper.
2. Outline the ridges with the marker.
3. Place squares of tape on some of the low points at the bottom of outlined ridges.
4. Spray the paper with water.
5. Observe. What happened to the blue marker lines? How are the spaces with tape different from low points in the paper with no tape?

The taped parts of the paper represent non-absorbent surfaces, like pavement. Some drops of water may pool on the tape, the rest will spread around it. What does this suggest about paving and building in natural floodplains? What problems could these cause?



Compare the stretch of the Marikina River in an undeveloped area with the one below in the Marikina City Riverbanks area. What would happen to the overflow of the river in each one? What would be the effects on the communities by the riverbanks?

Upper Marikina River Basin Protected Landscape Tributary below Wawa Dam, Wikimedia Commons

Marikina Riverbanks Center at night, Wikimedia Commons

YOUR COMMUNITY'S WATER SUPPLY

Different areas source their water from different watersheds. The amount of water that is available depends on the climate in the area of this watershed. The conditions of the environment surrounding it affect the water that collects there as well.

Where is your watershed? What are some issues that may affect its supply? What are some times when its supply may be low?

Learn more about the area around your watershed. Observe how the water supply could be affected by factors of its environment as well as by climate change. Some things to look for include sources of pollutants, not only from industrial areas but also farms that may use excessive amounts of fertilizer that get washed into bodies of water.

Soil sediments may also be washed down from bare slopes during heavy rainfall. Maintaining forests in this area helps to prevent the erosion of soil and this washing of sediments into the rivers.

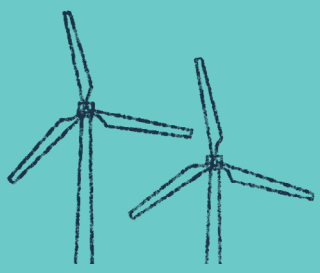
Learn what the state of the forests in the area of your watershed is like and if there are any tree-planting projects there. You may be able to contribute to these.

Your Community's Source of Power

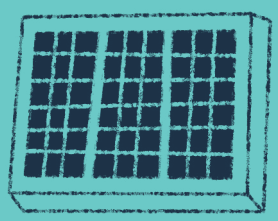
Another important utility is electricity, which is for the most part generated by coal-powered plants that add tons of carbon to the atmosphere. As you have seen in the videos, however, some areas are already being powered by renewable energy. They are not yet widely used and some have disadvantages such as being less reliable in certain seasons. Some displace and disrupt wildlife. And of course, emissions are still produced by the production of their components. They also tend to be expensive to build. Once they are set up, though, they produce clean energy with less cost. The type of renewable energy that is best for an area depends on the environmental features. You already learned about three new types of renewable energy in Chapter 3. In addition, here are several others:

***Hydroelectric power** – Hydroelectricity, which is powered by waterfalls, has been in use in the Philippines since 1913. It currently generates as much as 16% of electrical power in the country. In Mindanao, it dominates energy production, with hydroelectricity producing 52% of energy compared to 40% from fossil fuels. Throughout the entire country, as many as 293 potential locations for hydropower plants have been identified. There are just a few months when hydroelectric plants may produce energy less consistently due to drought.*

***Geothermal energy** – This is energy produced by the heat within the Earth. With the number of volcanoes in the country, it is one of the first renewable resources to be tapped. The Philippines has been using geothermal energy since 1962 and is the one of the largest users in the world of this form of power. There are just seven geothermal fields in use here, providing about 12% of our electrical needs but there are plans to increase these, with the goal of 40% of the nation's electricity coming from geothermal power by 2030. This form of renewable power is reliable and has little effect on the environment.*



***Wind Turbines** – These are modern versions of windmills. A number are already being successfully used in the Philippines, the largest of which is in Burgos, Ilocos Norte. Their main disadvantage is being initially expensive to build; birds and bats have also gotten injured by flying into them. There are periods of less wind as well, but in the right location, they can provide sufficient energy at a low cost to the consumers.*



***Solar Panels** – The energy from the sun is absorbed by panels which are connected to electric generators. The Philippines has the largest solar power company in Southeast Asia, with solar farms in Batangas, Tarlac, and Nueva Ecija. Solar panels take up a lot of space and currently there are issues about how they will eventually be recycled. And of course, they naturally produce less energy in cloudy weather. They have been helpful in providing electricity, though, to places that are inaccessible to power plants.*

Which type of renewable energy do you think is most suitable for your area? How do you think its disadvantages could be addressed? Can your community make use of any of these in a small scale, such as solar lighting in public spaces?

GOOD GOVERNANCE

The government has a commitment to reduce emissions and deal with the effects of climate change. These have to be translated into concrete measures that we can observe around us.

Have you observed any government action on climate change and its effects in your own community? Learn more about these projects and how successful they have been. Focus on solutions to the major climate risks in your area.

Interview an officer from your homeowners' association or barangay about what actions they have taken to address climate risks. Learn also what plans they are making to deal with climate effects. Ask what kind of community involvement is needed to support these solutions.

COMMUNITY FOOD SECURITY

The most essential need for everyone in the community is enough nutritious food to eat. Some types of food may become less abundant and more expensive owing to certain climate effects, as discussed in Chapters 3 and 5. This could mean more people will struggle to get enough food to feed their families.

Some communities have sought to remedy this problem by establishing programs to provide food to families. There are feeding programs in some public schools. There have also been community pantries in some areas, in which donated food is made available for anyone who needs it.

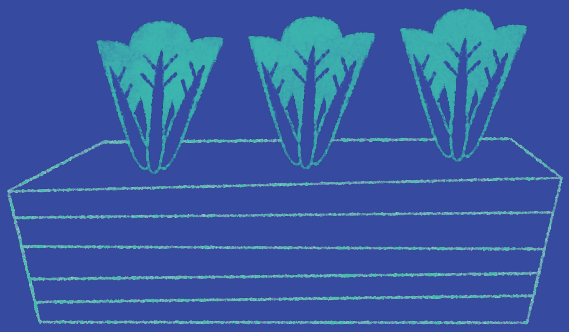
Do you have a community pantry to help those who are struggling to get enough food? If yes, find out how you can support this project. If not, ask your community members and officials for help in organizing one.

ACTIVITY:
PLANNING A COMMUNITY GARDEN

Name your favorite local fruit, vegetable, and tree. Have you tried growing any of these? Now consider whether you can grow these in your barangay.

To make sure everyone in the community can get enough food, growing a community garden can help. There has been encouragement from government officials to utilize vacant lots for urban farming, especially during the pandemic crisis. During the COVID-19 lockdown that prevented many people from going out to work, a community garden was initiated by a founding member of the Homeless People's Federation of the Philippines to serve Payatas. Three women began the garden and with the help of the parish priest, they were able to get many more volunteers. The city mayor showed support for the project by donating seed starter kits. You may learn more from the video in the link below.

tinyurl.com/2p949u3a



This example shows that a community garden can serve as a community pantry or supplement one. To succeed, it should have a selection of edible plants that are easy to maintain and be in a place where the people in the community can easily access it. Once you are able to find an appropriate place for a garden in your community, write to barangay officials for permission to use it. If you can't find an appropriate piece of land, try to be resourceful. You can make a vertical garden by getting permission to hang pots upcycled from large soda bottles on a wall or on wire strung between posts. You can also try to start such a garden in your school grounds.

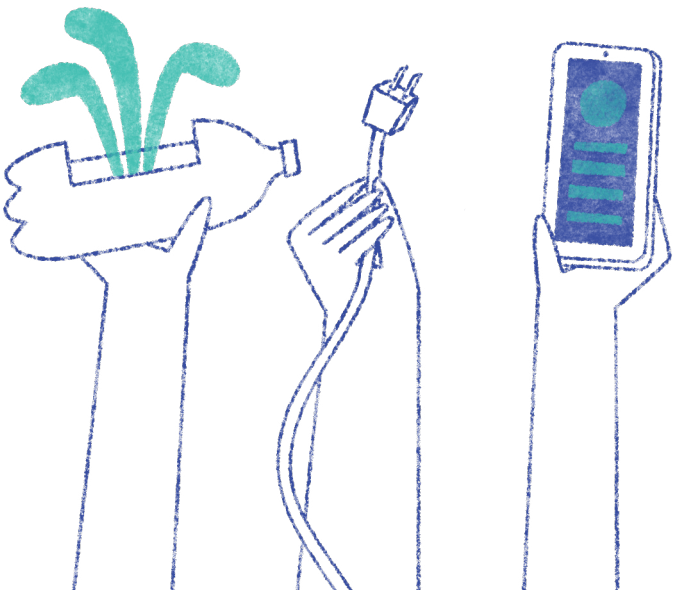
Once you have obtained permission, start collecting seeds. You can get many of these from vegetables that you eat. Involve members of the community by asking for donations of seeds, plants, and, if necessary, soil. Volunteers will also be needed to help in composting and in tending the plants.

Plan out your garden. Refer to Chapters 5 and 7 for ideas on what type of garden you will grow. In arranging the plants, the amount of sunlight needed by each type of plant as well as the climate. Sketch out a plan on a sheet of paper.

EDUCATING YOUR COMMUNITY

Getting the help and support of the people around you in coming up with climate solutions is more effective than working on your own or just with your classmates and family. If you know enough people in your community, you should share with them information on hazards and prepare for them. You all suffer from the same climate effects, after all, and should help each other prepare for these and adapt.

The types of projects you can do to make your community more climate resilient will depend on what current policies and systems you have and how effective they are. Observe ways your community still needs to improve when it comes to adapting to and mitigating climate change. Tap existing leaders and organizations to help you build concern among your neighbors about this. Find out the names and contact information of your barangay captain, homeowners' or building association president and other officers. Find out when they have meetings and when they can discuss climate concerns. Learn also about other community organizations in your area which you can interest in your projects.



BUILDING COMMUNITY CONNECTIONS

What are the channels for communication within your community? Is there a central location with a bulletin board or a newsletter, whether printed or online? If your neighborhood doesn't have one yet, it will be helpful to build a social media forum for your community.

Communicating with your neighbors can help you in sharing resources. You can reduce fuel emissions by organizing a carpool or a shuttle. On a simple level, this can be done by making an arrangement with a tricycle serving your area to pick up several people along a route instead of many individuals hailing one for themselves. You could also ask your barangay officials about appointing a larger vehicle as a shuttle during rush hour.

Also helpful is a community marketplace where people can sell, swap, or give away used items. This reduces going to a mall to shop and allows goods to be reused efficiently.

If you bike, you might want to try to connect with other bikers in your area. Apart from having company when cycling, together you can lobby for safe biking facilities.

You can also connect with gardeners for tips on gardening, plants, and supplies. Growing plants, especially native and organic ones, can have both adaptive and mitigative effects and sharing gardening resources fosters community bonds.

GREEN RECREATIONAL SPACES

Most communities have recreational areas provided for the youth, like a basketball court and a playground. Usually these are built on paved surfaces. But trees and greenery reduce not only flooding and heat, but also anxiety and stress. Playing in nature engages all the senses and enhances creativity. It also makes children feel more connected with and appreciative of the world around them, which will lead to a new generation that is concerned about the environment and climate change.

What do you think a green play area should look like? Draw a picture based on the recreational space or plaza you have in your barangay, making adaptations that consider climate effects. You may look up some examples for inspiration. Consider not only attractiveness and fun, but also possible climate solutions you can incorporate, such as protection from extreme heat and mosquitoes.

Survey the children of the community to find out what natural elements in your sketch appeal to them. Ask parents as well to assess your ideas for safety and practicality as well as attractiveness.

You can then write a letter requesting some of these natural elements to be added. Be sure to support your request with research proving the benefits of green spaces for the community. Once you get permission, you can ask for volunteers in your community to help in greenifying the area.

ACTIVITY

A SOCIAL ENTERPRISE TO SERVE YOUR COMMUNITY

A social enterprise is a business for a good cause. Social enterprises often aim to give employment to struggling sectors of the community. Many have ecological goals as well. For instance, they may train people to recycle or upcycle to make new products.

One organization, the Advocates for Heritage Preservation sells *parols* made by struggling farmers and fishermen to give them supplementary income. Another, Alima Community, makes use of trash found on beaches for accessories crafted by mothers from a rural mountain community.

Similarly, the Invisible Sisters' advocacy employs women to crochet products from sanitized plastic bags. Other groups help farmers. For example, The Amigo Coffee begun by a group of De La Salle University students, sells coffee blends sourced from sustainable farmers from ethnic groups in Mt. Apo and from the Cordilleras.

Come up with an idea for a product that reduces emissions and waste. Make a business plan that describes the product, how it can help in adapting to/mitigating climate change. You may be able to use your earnings from this to fund your community pantry and other barangay projects or propose this project to an organization like the ones mentioned above.

REGENERATING RESILIENCE AND HOPE

While progress cannot be stopped, it can be led in a better, more climate-friendly direction. Envision what will help your community become more climate resilient. Very likely, it was more so before we began to feel the effects of climate change. It can be again with proper adaptation and mitigation.

Go back to the interview you did with an older person in your community. Do you see any possible connection between the current climate risks in your immediate environment and how your area has changed over the years? Identify what aspects of the past community landscape would be helpful in addressing the risks and if they could be restored. We often think of progress in terms of building something new. It can be more helpful when it comes to climate risks, though, to work with the natural systems of the environment rather than against them.

While climate change and its impacts may cause us anxiety, taking action to adapt to and mitigate it can help reduce our worries. We can learn from the past to make things better in the present and prevent future disasters. By being well-informed on climate change and sharing this knowledge, you can help your family and all those around you handle the changes in our world. With this, you are taking steps to improving the community around you and helping build climate resilience in your country.

KEYWORDS

climate change solution
any action that addresses climate-related risks and impacts

community
a group of people living in the same place or having a common characteristic

floodplains
areas of land where water naturally overflows from bodies of water when there are rainstorms

social enterprise
a business for a good cause

watersheds
areas of land that naturally drain rainfall into a larger body of water

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A workbook about climate change, its impact on humans and natural systems, and how students can become agents of change in their schools, households, and communities.

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