GLOBAL WARMING / CLIMATE CHANGE

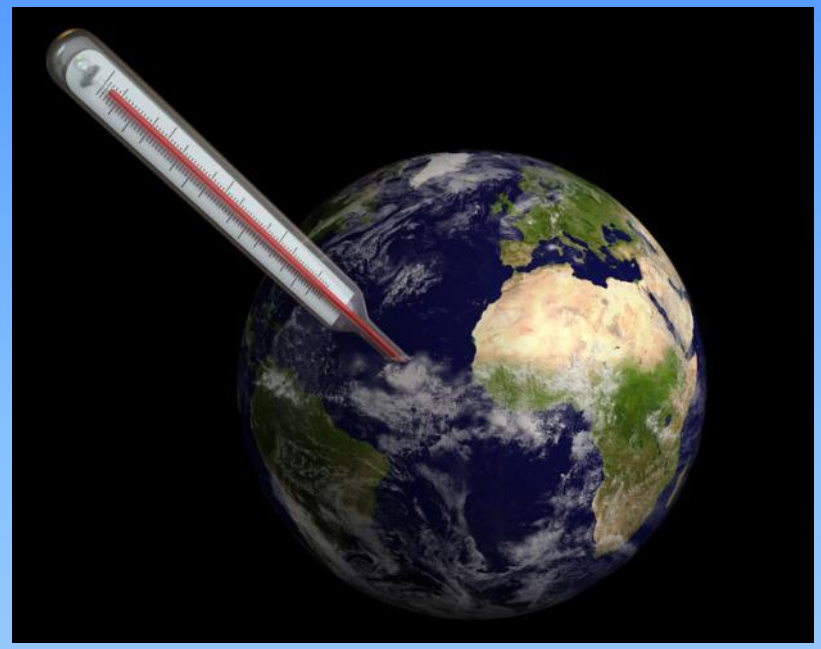
Impacts on our oceans and land

NEREIDA MARINE EDUCATION

May, 2015

Global warming is an increase in the Earth's average temperature, brought about by the accumulation of greenhouse gases (GHGs) that allow sunlight to enter the Earth but prevent heat from escaping it.

Climate change (the changes in the Earth's climate) is resulting from Global warming.



Weather is the atmospheric conditions that are happening now or over a short period of time. Climate is the average of weather patterns over relatively long periods of time.

GLOBAL WARMING / CLIMATE CHANGE

THE GREENHOUSE GAS MOST RESPONSIBLE FOR WARMING IS CARBON DIOXIDE, also called CO_2.

- Most CO_2 comes from burning **fossil fuels** (such as coal oil, gasoline and natural gas) in factories, electricity production, and in our cars, trucks, and airplanes.
- CO_2 and other greenhouse gases, such as methane and nitrous oxide, also come from other human activities. The major ones are **agriculture**, **in particular livestock**, and **deforestation**.
- **Landfills and cement production** also contribute significantly to global warming.

HOW DOES BURNING FOSSIL FUELS RESULT IN CLIMATE CHANGE?

CO_2 is emitted by many natural sources (including humans and other animals, when we exhale). Normally these natural sources are balanced by natural "sinks" that remove CO_2 from the atmosphere, such as trees and the oceans.

Fossil fuels are made from plant materials that have been buried underground for millions of years. These materials contain carbon, and when we burn them the carbon combines with oxygen to form CO_2.

Worldwide, humans are burning fossil fuels in such large quantities that the natural sinks can't remove CO_2 quickly enough, so it builds up in the atmosphere, warming the planet and causing the climate to change. Some of it remains in the atmosphere for thousands of years and will impact future generations.

GLOBAL EMISSIONS

Today, global CO2 emissions from fossil fuels are 4 times higher than they were in 1950 and

total annual global greenhouse gas emissions have risen from about 40 billion metric tonnes or gigatonnes (Gt) CO_2e (carbon dioxide equivalent) in 2000 to about 50 Gt (2010).

The atmosphere now contains about 800 Gt in the form of CO_2, a higher concentration of CO_2 today than at any point in the past 800,000 years or more.

GLOBAL TEMPERATURE AND SPECIES EXTINCTION

The Earth's average global surface temperature has already risen 0.85 °C since 1880.

This may not sound like very much, but over the last 11,000 years global temperatures have varied by only about 0.5°C. The world was only about 3.5–5.0°C cooler in the last ice age.

Because much of what we have already put in the atmosphere will stay there for thousands of years, and warming also triggers feedbacks such as melting permafrost, we are already committed to 1°C or more of future warming.

This means a loss of up to 25% of all species.

And if warming rises to 4°C it is estimated that between 40% and 70% of the world's species will become extinct.

Many of these species will be ocean animals.

GLOBAL WARMING AND OUR OCEANS

Image credit: Alaska Maine Conservation Council

"What happens in the oceans translates to what happens on land."
Dr. Datarina Fabricius, Australian Researcher

Background photo: Michelle Mech

THE OCEANS HAVE ABSORBED:

- 80% of the heat that has been added to the atmosphere.
- 30% of the CO_2 released by humans over the past 200 years. They continue to absorb about a million tonnes every hour.

Without the oceans climate change would be far worse than it already is.

However, the oceans have now absorbed so much CO_2, their capacity to soak up our increasing emissions is decreasing.

OCEAN ACIDIFICATION AND OCEAN WARMING



Coral reefs in the Dominican Republic Photos: M.Mech

OCEAN ACIDIFICATION FROM GLOBAL WARMING

When CO_2 is absorbed by seawater, chemical reactions occur that decrease the availabilty of calcium carbonate and reduce seawater pH (making the oceans more acidic).

Therefore, as we continue and increase our emissions, the level of acidity in the oceans also increases, while the availability of calcium carbonate continues to decrease.

Acidity of the world's oceans has already increased 26% since the 1880s and, according to scientists, is occurring at a faster rate than at any time during the last 300 million years – driven by the growth rate of atmospheric CO_2.

Photo: Michelle Mech

INCREASING OCEAN ACIDIFICATION IS THREATENING MANY MARINE ORGANISMS

by reducing their ability to extract calcium carbonate to build their shells or skeletons. These organisms are called "calcifiers".

This is upsetting ocean ecosystems, as the organisms at the bottom of many food chains are having trouble growing and reproducing.

At higher levels of acidification the shells of some calcifiers will start to dissolve.

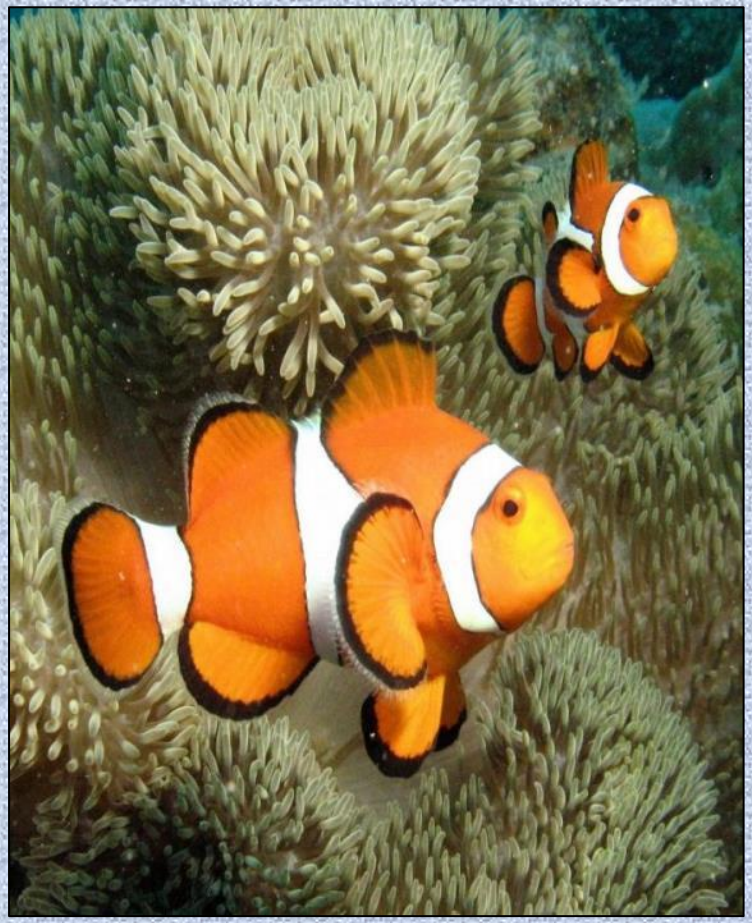
CALCIFIERS INCLUDE:

- Mollusks, like clams and oysters;
- Pteropods, a tiny sea creature that thrives in cold, Arctic waters and is a major food source for organisms such as fish, krill, and whales
- Crustaceans, like barnacles;
- Echinoderms, like sea stars and sea urchins;
- Many species of plankton; and
- Coral reefs.

In 2011, researchers on the west coast of the United States discovered that 53% of the pteropods sampled in the coastal region had severely dissolved shells. Offshore, about 24% were damaged. Pteropods provide food for a variety of fishes and are are one of the first rungs in the ocean's food chain.

ALTERING THE ACIDITY OF THE OCEAN IS ALSO LIKELY TO HAVE A DIRECT IMPACT ON HOW MARINE ANIMALS FUNCTION.

For example, researchers in Australia have found that young clownfish—the real-life versions of Nemo—can't sniff out predators or find their way to suitable habitat when CO_2 is elevated. Apparently the acidified water impairs their sense of smell.



Clownfish are also suffering from habitat loss as global warming causes coral reefs to decline.

WARMER OCEAN WATER AND LIFE IN THE OCEANS

Warming ocean temperatures can alter ocean circulation and current flow, which can deplete influxes of nutrients or oxygenation.

Less oxygen means less overall life.

Large ‘dead zones’, devoid of fish and other seafood, have already appeared in many areas of the ocean.

Increasing ocean temperatures have also shifted some marine species to cooler waters outside of their normal range.

Photo: Frank Hyde

WARMER OCEAN WATER AND CORAL REEFS

HOW DO CORAL REEFS LIVE?

Corals live off the microscopic algae that dwell inside their tissues. Warmer water temperatures can cause coral bleaching, a whitening of corals that occurs when symbiotic algae leave their coral hosts, depriving corals of essential nutrients.

- While, ocean acidification is reducing the amount of available calcium carbonate that is needed to form reefs,
- ocean warming is causing corals to eventually die, erode and collapse from continuous bleaching.

Photo: Frank Hyde

WHY ARE CORAL REEFS IMPORTANT?

Coral reefs are the most diverse ecosystems in the ocean.

There are about 4,000 coral reef fish species worldwide, and millions of other reef-associated species, accounting for approximately 25% of all marine life.

Reefs protect coastlines by reducing storm surge and erosion.

Reefs provide tourism and recreation (snorkeling, diving).

Photo: Kelsey Mech

Coral reef plants and animals are important sources of new medicines to treat cancer, arthritis, bacterial infections, Alzheimer's disease, heart disease, viruses, and other diseases.

STATUS OF CORAL REEFS

Coral cover in the Caribbean declined by around 80% between 1977 and 2001. Half of the Great Barrier reef has died over the past 27 years. Currently, 27% of all coral reefs worldwide have disappeared.

Our current trajectory of overfishing and unsustainable fishing practices, the mining of coral for construction material, and particularly ocean acidification and warming, is likely to lead to the rapid and terminal decline of tropical coral reefs by 2050.

OTHER IMPACTS OF GLOBAL WARMING - WEATHER, SEA LEVELS, FOOD AND WATER SECURITY

Polar Bears are totally dependent on the Arctic sea ice habitat for their survival

MELTING SEA ICE

Warmer oceans and warmer global temperatures are causing the ice at the poles to melt, which can have major effects on the weather.

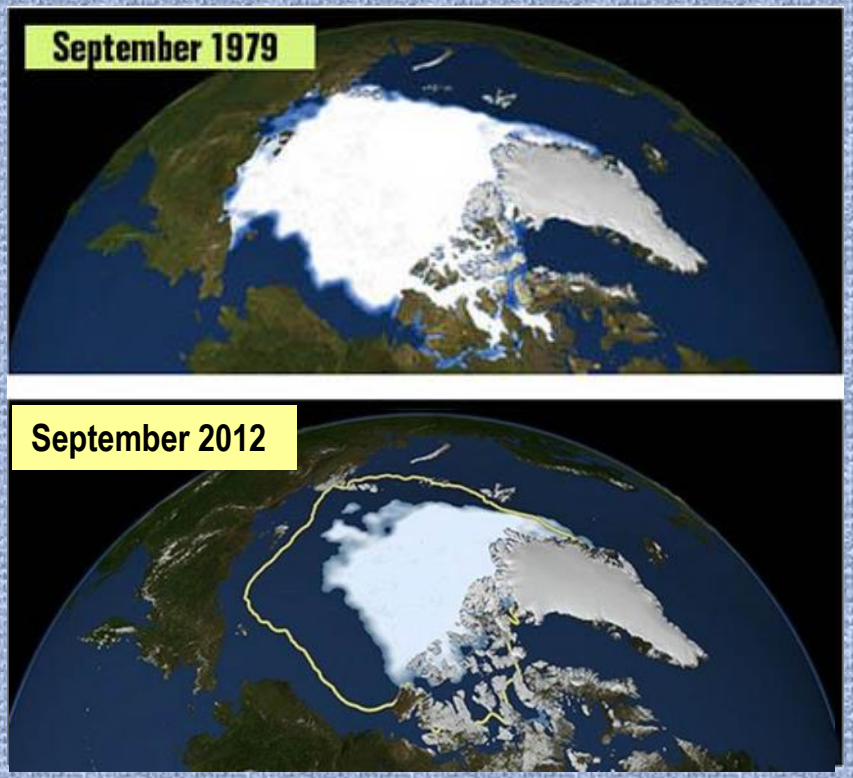
The Arctic is warming twice as fast as the rest of the planet and is currently losing about 900 cubic kilometres of ice annually.

This is effecting:

- Global temperatures
- Weather patterns
- Sea levels

The Arctic could be ice-free in the summer by 2015 or 2016.

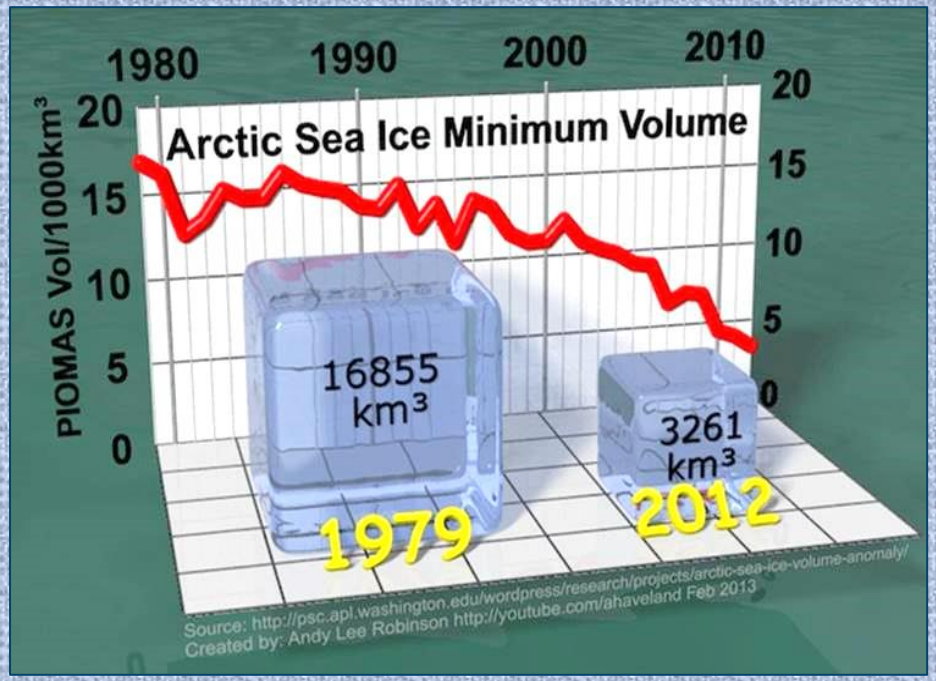
Melting sea ice could also release more than 1 trillion pieces of plastic into the ocean over the next decade.



In the summer of 2012, the Artic sea ice shrunk to the lowest extent ever recorded. Image: EPA

MELTING SEA ICE AND GLOBAL WARMING

Sea ice acts like a windshield sunshade keeping your car cool. Replacing shiny ice surfaces with dark open ocean ones means the Earth absorbs more solar energy. Therefore less sea ice means a warmer planet and an even warmer Arctic.



Because of warming in the Arctic, the Greenland ice is experiencing record melting, and millions of tons of CO_2 and methane, which is 25 times more potent than CO_2, are being released each year from thawing permafrost and marine sediments in the Arctic region.

GLOBAL WARMING AND WEATHER PATTERNS

Arctic temperatures affect jet streams, the high elevation winds that mix air around the planet. When the temperature differential between high and low latitudes is large, the jet streams are more active, drifting north and south more quickly and shifting weather with them.

Warming in the Arctic is slowing down the jet stream in the northern hemisphere, which can cause weather systems to stay in place for longer periods.

Droughts, heat waves, heavy rain, and hurricanes, can therefore last longer and result in increased crop failures, wildfires, flooding, and loss of life.

Melting sea ice and warmer ocean water in the Arctic is also allowing cold air to flow southward and contribute to severe winter weather.

WARMER OCEAN WATER AND SEVERE WEATHER EVENTS

HURRICANES, TYPHOONS

Warmer ocean waters provide the energy that keeps a hurricane going. So a warmer ocean also means a more powerful storm with winds that blow for longer.

Scientist believe that because of global warming the strongest storms are getting stronger.

Typhoon Haiyan, 2013

MELTING GLACIERS - WATER AND FOOD SECURITY

Warmer global temperatures are also causing glaciers to melt and recede at unprecedented rates in all of the world's major mountain ranges.

Glaciers store about 69% of the world's freshwater.

In many areas of the world, ice melt from mountain glaciers sustains river flows during dry seasons, when irrigation needs are the greatest. Farmers produce much of their crops with the water from these glaciers, so the loss of these glaciers threatens food security.

Glacial meltwater also feeds hydroelectric plants and provides drinking water for millions of people.

The Qori Kalis glacier in Peru receded 1300 meters from 1963-2005

A lake of meltwater occupies what 24 years earlier had been a deep field of flowing ice.

With abnormally high rates of glacial melting a glacial lake can burst. This can cause flash floods that can sweep away roads, bridges, and entire villages.

MELTING GLACIERS - EXAMPLES AND IMPACTS

Quelccaya Glacier in Peru, the largest in the topics, was retreating 6 meters per year in the 1960s; is now retreating 60 meters per year.

70% of the Earth's tropical glaciers are in Peru.
They have already lost 22% of their mass and many South American communities are already experiencing water shortages and conflicts over water use.

Bolivia's 18,000 year old Chacaltaya glacier completely melted away in 2009

Ice melt from Himalayan glaciers sustains major rivers in China, India, and other Asian countries. China and India are the world's leading producers of wheat and rice. Therefore, the rapid melting of the Himilayan glaciers threatens food security, not only for the over one billion Asian people that rely on their meltwater, but also globally.

RISING SEA LEVELS

Melting ice caps and glaciers results in higher sea levels, which means higher storm surges, even from relatively minor storms, which causes more severe flooding and storm damage. Because water expands when it warms, global sea levels are also increasing as a result of ocean warming.

2008 flood

In Venice, sea level rise has made the city's natural tidal flooding much more frequent and severe.

What Manhattan, New York could look like with a major rise in sea level

Sea-level rise in coastal regions affects groundwater aquifers, reducing the availability of freshwater.

HIGHER LEVELS OF PRECIPITATION

In a warming world, dry regions tend to get drier, while wet regions get wetter.

Higher ocean surface temperatures mean increased water vapor in the atmosphere. This results in increasing humidity, cloud formation, and rainfall and, in some areas of the world, increases the risk of flooding.

2010 floods in Pakistan and China

Flooding in Melaque, Mexico

Photo: Michelle Mech

Increases in global surface temperature will increase DESERTIFICATION and the length of DROUGHTS, affecting food and water supplies. Water scarcity already affects 1.2 billion people worldwide.

For example, in Mexico, if temperatures rise another 1–3 °C, researchers predict a 10-48% drop in crop yields, depending on adaptation.

- In Northern Mexico a 2011/12 drought left nearly 2.5 million people without a secure food or water supply and destroyed almost 2 million hectares. Crop yields declined significantly and reservoirs were drying up. Financial losses surpassed US$1.3 billion.
- The Mexican government has already predicted crop yields to drop to 20 million tons per year from the typical 28 million tons per year.

Corn, the most important agricultural in Mexico, is highly susceptible to climate variability and droughts.

The Mexican drought left over 1 million cattle dead.

CLIMATE CHANGE IS ALREADY THREATENING MANY ANIMALS

It is estimated that climate change is already taking 5 million human lives a year. It is also affecting and/or threatening many animals in the wild. Some examples are:

In Australia, rising atmospheric CO_2 levels are reducing the amount of protein available from Eucalyptus leaves – the koalas' only food – and thousands of koalas have been killed or injured in wildfires from increasing heat waves.

Emperor penguins raise their chicks on thick sea ice. Early ice break-up from warmer temperatures has caused chicks to be swept into the ocean and drowned, and can also lead to lower food availability for adults.

Arctic foxes use the sea ice as habitat to travel and to find food. The loss of sea-ice is likely to result in lower survival and reproductive rates.

The sex of sea turtles is determined by the sand temperature during incubation, with higher temperatures producing more females. If the nest sand is too hot, eggs won't hatch at all. As well, erosion of nesting beaches by rising sea level and more intense storms threatens to reduce turtle habitat.

MARINE MAMMALS IN DANGER FROM MELTING ARCTIC SEA ICE

Many Arctic animals use sea ice as a platform for resting, hunting, mating and breeding. Ice loss may lead to large population losses and even extinctions of these species.

Adult polar bears and cubs have drowned when they've been forced to cross vast expanses of open ocean that exceed their strong swimming capacity.

Walrus

ICE SEALS – Bearded, newborn Ringed, and Harp pup

Photo: Paul Nicklen, National Geographic

A narwhal's entire life is connected to sea ice, both as a place to feed and a place to take refuge. Photo: Paul Nicklen, National Geographic **

The survival of many species now relies on humanity's ability to reduce greenhouse gas emissions.

The climate related disasters the world is already experiencing are happening when the average global temperature has increased by 0.85ºC. Therefore, even though it is widely recognized that we must keep warming below 2ºC, many experts say that we must hold it to 1.5 ºC or less.

However, under current worldwide climate policies to reduce emissions, many organizations* and scientists warn that we could reach 4°C of warming within this century – and even sooner, if existing commitments are not met.

A world in which warming reaches 4°C above preindustrial levels would be one of more frequent and severe weather events, heat waves, droughts and major floods in many regions, food and water shortages, a sea-level rise of 0.5 to 1 meter or more by 2100, an increase of about 150% in acidity of the oceans, new invading pests and diseases, massive species extinction and large scale loss of biodiversity, and hundreds of millions of human deaths.

Many societies and natural areas may not be able to adapt.

*e.g. The International Energy Agency, the World Bank, and the International Monetary fund; International Panel on Climate Change, 2014: "A business-as-usual scenario will lead to 3.7C to 4.8C rise in temperature before 2100."

Global greenhouse gas emissions must be substantially reduced, not only to save our oceans, but also to save life as we know it on the planet. Yet global emissions continue to rise.

The Intergovernmental Panel on Climate Change (IPCC, 2014), has stated that to have a chance at staying below 2°C of warming, global greenhouse gas emissions must be lowered by 40 to 70% compared with 2010 by mid-century, and to near-zero by the end of this century. Even more will have to be done to stay below 1.5°C of warming.

This will require emissions reductions from energy production and use, transportation, buildings, industry, land use (including deforestation and agriculture), and human settlements.

Solar panel plant and wind generator farm

SOME OF THE WAYS TO REDUCE GREENHOUSE GAS EMISSIONS INCLUDE:

For governments –

- transition to energy from renewable resources, such as solar and wind, and produce energy from waste;
- eliminate fossil fuel subsidies;
- decouple economic growth from dependency on fossil fuels;
- improve energy efficiency to reduce energy use, set energy-efficiency standards for vehicles;
- implement mass public transit;
- provide infrastructure to support the use of electric vehicles;
- reduce deforestation and increase tree planting;
- implement a global price for carbon and commit to international cooperation on reducing emissions.

Electric taxi plugged into a quick-charging station in Mexico City.

SOME OF THE WAYS TO REDUCE GREENHOUSE GAS EMISSIONS INCLUDE:

For individuals and institutions –

- reduce energy use, for example: use low energy light bulbs and turn off lights when you leave a room, and TVs, computers, and other electronics when not in use; reduce use of hot water;
- eat locally grown food and less meat (particularly red meat);
- generate less waste and recycle (to reduce methane emissions from landfills and energy used for manufacturing goods);
- use less gasoline; use public transportation, walk, cycle;
- use renewable energy sources.

Students installing solar panels on a school in Africa

Floating school in Bangladesh powered by solar panels

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ACKNOWLEGEMENTS

Editing assistance:	Diana Gutierrez Carrillo, teacher, and volunteer students at Preparatoria tecnológica Cecytej y Preparatoria de Melaque, Melaque
Coordination and support:	Ramón Velasco Medina, Superintendent, Preparatoria de San Patricio de Melaque