InterpNEWS
The International Heritage Interpretation e-magazine.
Special Climate Issue.

A John Veverka & Associates Publication.
A Climate Change Issue? Yep – a few months ago, with all that’s going on around the world with our climate and all the things we are doing to “muck it up”, I thought a special issue on how agencies, organizations, parks, etc were interpreting climate and global warming issues to their visitors. I sent out a huge “call for articles” for this issue in which I received about four – how sad. So I thought making this a “climate change resource issue” might be more useful to my readers – lots of very interesting articles and reprinted articles from around the globe. When you read all of these, as I needed to do, there’s both a message of pending disaster, but some glimmers of hope that we can stop the madness. Note that this issue does not replace the normal Nov/Dec InterpNEWS issue that will be going out shortly too. I’d love to have more articles on this topic for the Jan/Feb 2020 and Mar/April issues if you have a program or exhibit you’d like to share. Hope to hear from you. John Veverka, IN Editor, jvainterp@aol.com.

INDEX:
- Sea level rise, explained. Christina Nunez 3
- Brazil's Amazon rainforest is burning at a record rate, research center says. Jessie Yeung and Abel Alvarado. 6
- The Big Thaw – Daniel Glick 9
- Indonesia's forest fires: clearing for palm oil plantations. The Guardian 18
- Is sea level rising? Yes. NOAA 22
- Tundra threats, explained. Christina Nunez 24
- 47 Alarming Global Warming Facts Karin Lehnardt, 27
- How Climate Change Affects Animals – GREENTUMBLE 33
- 9 animals that are feeling the impacts of climate change US Department of the Interior 37
- Climate Impacts on Agriculture and Food Supply. Environmental Protection Agency. 42
- How agriculture and climate change are related: causes and effects. 48
- The UK becomes the first country in the world to declare a climate emergency 52
- Agriculture and Climate Change. European Environment Agency. 54
- UN climate change report: Land clearing and farming… Mark Howden, 59
- The Most Powerful Evidence Climate Scientists Have of Global Warming. SABRINA SHANKMAN 63
- The Impact of Climate Change on Natural Disasters NASA – Earth Observatory 67
- The Effect of Global Warming on Hurricanes. Tropical Weather.Net 70
- Bees Are Losing Their Habitat Because of Climate Change JUSTIN WORLAND 73
- 7 Species Hit Hard by Climate Change—Including One That's Already Extinct. DELL’AMORE 75
- Top 10 things you can do about climate change. David Suzuki Foundation On Nature 81
- The Affects of Climate Change on Families. Jori Hamilton 86
- Global Hunger Is Threatening Families Because of Climate Change Siddharth Chatterjee 90
- Climate Change is increasing harmful insect pests. Green Home Pest Control 93
- Fisheries, Aquaculture and climate Change – United Nations Fisheries and Aquaculture 98
- Museums and Climate Change Activism - Robert R. Janes 101
- The Coalition of Museums for Climate Justice: An Overview - Robert R. Janes 105
Oceans are rising around the world, causing dangerous flooding. Why is this happening, and what can we do to stem the tide?

As humans continue to pour greenhouse gases into the atmosphere, oceans have tempered the effect. The world's seas have absorbed more than 90 percent of the heat from these gases, but it’s taking a toll on our oceans: 2018 set a new record for ocean heating.

Many people think of global warming and climate change as synonyms, but scientists prefer to use “climate change” when describing the complex shifts now affecting our planet’s weather and climate systems.

Rising seas is one of those climate change effects. Average sea levels have swelled over 8 inches (about 23 cm) since 1880, with about three of those inches gained in the last 25 years. Every year, the sea rises another .13 inches (3.2 mm).

The change in sea levels is linked to three primary factors, all induced by ongoing global climate change:

- **Thermal expansion:** When water heats up, it expands. About half of the sea-level rise over the past 25 years is attributable to warmer oceans simply occupying more space.
- **Melting glaciers:** Large ice formations such as mountain glaciers naturally melt a bit each summer. In the winter, snows, primarily from evaporated seawater, are generally sufficient to balance out the melting. Recently, though, persistently higher temperatures caused by global warming have led to greater-than-average summer melting as well as diminished snowfall due to later winters and earlier springs. That creates an imbalance between runoff and ocean evaporation, causing sea levels to rise.
- **Loss of Greenland and Antarctica’s ice sheets:** As with mountain glaciers, increased heat is causing the massive ice sheets that cover Greenland and Antarctica to melt more quickly. Scientists also believe that meltwater from above and seawater from below is seeping beneath Greenland’s ice sheets, effectively lubricating ice streams and causing them to move more quickly into the sea. While melting in West Antarctica has drawn considerable focus from scientists, especially with the 2017 break in the Larsen C ice shelf, glaciers in East Antarctica are also showing signs of destabilizing.
Consequences

When sea levels rise as rapidly as they have been, even a small increase can have devastating effects on coastal habitats farther inland, it can cause destructive erosion, wetland flooding, aquifer and agricultural soil contamination with salt, and lost habitat for fish, birds, and plants.

Higher sea levels are coinciding with more dangerous hurricanes and typhoons that move more slowly and drop more rain, contributing to more powerful storm surges that can strip away everything in their path. One study found that between 1963 and 2012, almost half of all deaths from Atlantic hurricanes were caused by storm surges.

Already, flooding in low-lying coastal areas is forcing people to migrate to higher ground, and millions more are vulnerable from flood risk and other climate change effects. The prospect of higher coastal water levels threatens basic services such as Internet access, since much of the underlying communications infrastructure lies in the path of rising seas.

Adapting to the threat

As a result of these risks, many coastal cities are already planning adaptation measures to cope with the long-term prospects of higher sea levels, often at considerable cost. Building seawalls, rethinking roads, and planting mangroves or other vegetation to absorb water are all being undertaken.

In Jakarta, a $40 billion project will aim to protect the city with an 80-foot-high seawall. Rotterdam, home to the Global Center on Adaptation, has offered a model to other cities seeking to combat flooding and land loss. The Dutch city has built barriers, drainage, and innovative architectural features such as a “water square” with temporary ponds.

Of course, communities vulnerable to rising seas can only go so far in holding back the tide. In the Marshall Islands, where rising sea levels are forcing a choice between relocating or building up the land, residents will need help from other nations if they decide to undertake the expensive latter option.

How high will it go?

Most predictions say the warming of the planet will continue and is likely to accelerate, causing the oceans to keep rising. This means hundreds of coastal cities face flooding. But forecasting how much and how soon seas will rise remains an area of ongoing research.

The most recent special report from the Intergovernmental Panel on Climate Change says we can expect the oceans to rise between 10 and 30 inches (26 to 77 centimeters) by 2100 with temperatures warming 1.5 °C. That’s enough to seriously affect many of the cities along the U.S. East Coast. Another analysis based on NASA and European data skewed toward the higher end of that range, predicting a rise of 26 inches (65 centimeters) by the end of this century if the current trajectory continues.

If all the ice that currently exists on Earth in glaciers and sheets melted it would raise sea level by 216 feet. That could cause entire states and even some countries to disappear under the waves, from Florida to Bangladesh. That’s not a scenario scientists think is likely, and it would probably take many centuries, but it could eventually happen if the world keeps burning fossil fuels indiscriminately.
In the meantime, scientists keep refining their models of sea-level changes. They also point out that the extent to which countries work together to limit release of more greenhouse gases may have a significant impact on how quickly seas rise, and how much.

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NASA has launched a satellite into orbit that it says will be able to measure the rise in sea level across 95 per cent of the Earth’s ice-free oceans, and help scientists predict extreme weather events linked to global warming.

The “Jason-3” satellite was launched aboard a rocket in California on Sunday and it will be fully operational after a six-month testing phase, the U.S. space agency said in a statement.

Joining its predecessor, “Jason-2,” launched in 2008, the satellite will track the height of the sea level, the speed and direction of ocean currents and tides, and collect information about solar energy stored in the ocean.

They will help climate specialists forecast the strength of extreme weather events, such as tropical cyclones, NASA said.

Jason Thistlethwaite, an assistant professor of business and environment at the University of Waterloo, told the Star that the rise in the sea level is “the greatest physical and economic threat from climate change.”

He said information gleaned from the satellites can help scientists as well as urban planners and governments protect coastal communities vulnerable to storms strengthened by an increase in the sea level.

That includes places in Atlantic Canada such as Halifax, Charlottetown and St. John’s, which may be affected by hurricanes that originate further south in the ocean.

“Reducing our uncertainty around the impacts of sea-level rise and extreme ocean weather will go a long way to reducing our vulnerability to the economic and social impacts of extreme events on our coastlines,” Thistlethwaite said.
Fires are raging at a record rate in Brazil's Amazon rainforest, and scientists warn that it could strike a devastating blow to the fight against climate change.

The fires are burning at the highest rate since the country's space research center, the National Institute for Space Research (known by the abbreviation INPE), began tracking them in 2013, the center said Tuesday.

There have been 72,843 fires in Brazil this year, with more than half in the Amazon region, INPE said. That's more than an 80% increase compared with the same period last year.

The Amazon is often referred to as the planet's lungs, producing 20% of the oxygen in the Earth's atmosphere. It is considered vital in slowing global warming, and it is home to uncountable species of fauna and flora. Roughly half the size of the United States, it is the largest rainforest on the planet.
Dramatic images and videos on social media show giant plumes of smoke rising from the greenery and lines of fire leaving blackened waste in their wake.

The smoke has reached all the way to Sao Paulo, more than 1,700 miles away. Images from the city show the sky pitch-black in the middle of the afternoon, the sun blanketed by smoke and ash.

The European Union's satellite program, Copernicus, released a map showing smoke from the fires spreading all along Brazil to the east Atlantic coast. The smoke has covered nearly half of the country and is even spilling over into neighboring Peru, Bolivia and Paraguay.

The Amazon River stretches across several of these South American countries, but the majority -- more than two-thirds -- of the rainforest lies in Brazil.

According to INPE, more than 1½ soccer fields of Amazon rainforest are being destroyed every minute of every day.

People worldwide are sharing their horror on social media. Fans of the K-Pop band BTS, who call themselves the Army, are even rallying on Twitter to spread word of the fires, with tens of thousands of people tweeting the hashtag #ArmyHelpThePlanet.
Activists blame Brazil's president

Environmental groups have long been campaigning to save the Amazon, blaming Brazil's far-right president, Jair Bolsonaro, for the endangerment of the vital rainforest. They accuse him of relaxing environmental controls in the country and encouraging deforestation.

Bolsonaro's environmental policies have been controversial from the start. A former army captain, he made campaign promises to restore the economy by exploring the Amazon's economic potential.

Scientist who called out Bolsonaro on Amazon deforestation is fired

Just weeks ago, the director of INPE was fired after a spat with the president; the director had defended satellite data that showed deforestation was 88% higher in June than a year earlier, and Bolsonaro called the findings "lies."

Bolsonaro also criticized the agency's deforestation warnings as harmful for trade negotiations, according to the Agencia Brasil news agency.

Bolsonaro's pro-business stance may have emboldened loggers, farmers and miners to seize control of a growing area of Amazon land, Carlos Rittl, executive secretary of the environmental nonprofit organization Observatorio do Clima (Climate Observatory), told CNN en Español last month.

Budget cuts and federal interference are making it even easier for people to exploit the rainforest. Brazil's environmental enforcement agency has seen its budget cut by $23 million, and official data sent to CNN by Observatorio do Clima shows the enforcement agency's operations have gone down since Bolsonaro was sworn in.

On Wednesday, Bolsonaro said that the recent wave of fires in the Amazon may have been caused by nongovernmental organizations in order to draw international criticism to his government. "Crime exists, and we need to make sure that this type of crime does not increase. We took money away from the NGOs," he said.

"They are now feeling the pinch from the lack of funding. So, maybe the NGO types are conducting these criminal acts in order to generate negative attention against me and against the Brazilian government. This is the war we are facing."

In July, Greenpeace called Bolsonaro and his government a "threat to the climate equilibrium" and warned that in the long run, his policies would bear a "heavy cost" for the Brazilian economy.

Environmental activists and organizations like the World Wildlife Fund warn that if the Amazon reaches a point of no return, the rainforest could become a dry savannah, no longer habitable for much of its wildlife. If this happens, instead of being a source of oxygen, it could start emitting carbon -- the major driver of climate change.

*CNN's Flora Charner and AJ Davis contributed to this report.*
"If we don't have it, we don't need it," pronounces Daniel Fagre as we throw on our backpacks. We're armed with crampons, ice axes, rope, GPS receivers, and bear spray to ward off grizzlies, and we're trudging toward Sperry Glacier in Glacier National Park, Montana. I fall in step with Fagre and two other research scientists from the U.S. Geological Survey Global Change Research Program. They're doing what they've been doing for more than a decade: measuring how the park's storied glaciers are melting.

So far, the results have been positively chilling. When President Taft created Glacier National Park in 1910, it was home to an estimated 150 glaciers. Since then the number has decreased to fewer than 30, and most of those remaining have shrunk in area by two-thirds. Fagre predicts that within 30 years most if not all of the park's namesake glaciers will disappear.

"Things that normally happen in geologic time are happening during the span of a human lifetime," says Fagre. "It's like watching the Statue of Liberty melt."

Scientists who assess the planet's health see indisputable evidence that Earth has been getting warmer, in some cases rapidly. Most believe that human activity, in particular the burning of fossil fuels and the resulting buildup of greenhouse gases in the atmosphere, have influenced this warming trend. In the past decade scientists have documented record-high average annual surface temperatures and have been observing other signs of change all over the planet: in the distribution of ice, and in the salinity, levels, and temperatures of the oceans.
"This glacier used to be closer," Fagre declares as we crest a steep section, his glasses fogged from exertion. He's only half joking. A trailside sign notes that since 1901, Sperry Glacier has shrunk from more than 800 acres (320 hectares) to 300 acres (120 hectares). "That's out of date," Fagre says, stopping to catch his breath. "It's now less than 250 acres (100 hectares)."

Everywhere on Earth ice is changing. The famed snows of Kilimanjaro have melted more than 80 percent since 1912. Glaciers in the Garhwal Himalaya in India are retreating so fast that researchers believe that most central and eastern Himalayan glaciers could virtually disappear by 2035. Arctic sea ice has thinned significantly over the past half century, and its extent has declined by about 10 percent in the past 30 years. NASA's repeated laser altimeter readings show the edges of Greenland's ice sheet shrinking. Spring freshwater ice breakup in the Northern Hemisphere now occurs nine days earlier than it did 150 years ago, and autumn freeze-up ten days later. Thawing permafrost has caused the ground to subside more than 15 feet (4.6 meters) in parts of Alaska. From the Arctic to Peru, from Switzerland to the equatorial glaciers of Man Jaya in Indonesia, massive ice fields, monstrous glaciers, and sea ice are disappearing, fast.

When temperatures rise and ice melts, more water flows to the seas from glaciers and ice caps, and ocean water warms and expands in volume. This combination of effects has played the major role in raising average global sea level between four and eight inches (10 and 20 centimeters) in the past hundred years, according to the Intergovernmental Panel on Climate Change (IPCC).

Scientists point out that sea levels have risen and fallen substantially over Earth's 4.6-billion-year history. But the recent rate of global sea level rise has departed from the average rate of the past two to three thousand years and is rising more rapidly—about one-tenth of an inch a year. A continuation or acceleration of that trend has the potential to cause striking changes in the world's coastlines.
Driving around Louisiana's Gulf Coast, Windell Curole can see the future, and it looks pretty wet. In southern Louisiana coasts are literally sinking by about three feet (a meter) a century, a process called subsidence. A sinking coastline and a rising ocean combine to yield powerful effects. It's like taking the global sea-level-rise problem and moving it along at fast-forward.

The seventh-generation Cajun and manager of the South Lafourche Levee District navigates his truck down an unpaved mound of dirt that separates civilization from inundation, dry land from a swampy horizon. With his French-tinged lilt, Curole points to places where these bayous, swamps, and fishing villages portend a warmer world: his high school girlfriend's house partly submerged, a cemetery with water lapping against the white tombs, his grandfather's former hunting camp now afloat in a stand of skeleton oak snags. "We live in a place of almost land, almost water," says the 52-year-old Curole.

Rising sea level, sinking land, eroding coasts, and temperamental storms are a fact of life for Curole. Even relatively small storm surges in the past two decades have overwhelmed the system of dikes, levees, and pump stations that he manages, upgraded in the 1990s to forestall the Gulf of Mexico's relentless creep. "I've probably ordered more evacuations than any other person in the country," Curole says.

The current trend is consequential not only in coastal Louisiana but around the world. Never before have so many humans lived so close to the coasts: More than a hundred million people worldwide live within three feet (a meter) of mean sea level. Vulnerable to sea-level rise, Tuvalu, a small country in the South Pacific, has already begun formulating evacuation plans. Megacities where human populations have concentrated near coastal plains or river deltas—Shanghai, Bangkok, Jakarta, Tokyo, and New York—are at risk. The projected economic and humanitarian impacts on low-lying, densely populated, and desperately poor countries like Bangladesh are potentially catastrophic. The scenarios are disturbing even in wealthy countries like the Netherlands, with nearly half its landmass already at or below sea level.
Local projects like that might not do much good in the very long run, though, depending on the course of change elsewhere on the planet. Part of Antarctica’s Larsen Ice Shelf broke apart in early 2002. Although floating ice does not change sea level when it melts (any more than a glass of water will overflow when the ice cubes in it melt), scientists became concerned that the collapse could foreshadow the breakup of other ice shelves in Antarctica and allow increased glacial discharge into the sea from ice sheets on the continent. If the West Antarctic ice sheet were to break up, which scientists consider very unlikely this century, it alone contains enough ice to raise sea level by nearly 20 feet (6 meters).

Even without such a major event, the IPCC projected in its 2001 report that sea level will rise anywhere between 4 and 35 inches (10 and 89 centimeters) by the end of the century. The high end of that projection—nearly three feet (a meter)—would be “an unmitigated disaster,” according to Douglas.

Down on the bayou, all of those predictions make Windell Curole shudder. "We’re the guinea pigs," he says, surveying his aqueous world from the relatively lofty vantage point of a 12-foot-high (3.7-meter) earthen berm. "I don't think anybody down here looks at the sea-level-rise problem and puts their heads in the sand." That’s because soon there may not be much sand left.

Rising sea level is not the only change Earth’s oceans are undergoing. The ten-year-long World Ocean Circulation Experiment, launched in 1990, has helped researchers to better understand what is now called the ocean conveyor belt.
Oceans, in effect, mimic some functions of the human circulatory system. Just as arteries carry oxygenated blood from the heart to the extremities, and veins return blood to be replenished with oxygen, oceans provide life-sustaining circulation to the planet. Propelled mainly by prevailing winds and differences in water density, which changes with the temperature and salinity of the seawater, ocean currents are critical in cooling, warming, and watering the planet's terrestrial surfaces—and in transferring heat from the Equator to the Poles.

The engine running the conveyor belt is the density-driven thermohaline circulation ("thermo" for heat and "haline" for salt). Warm, salty water flows from the tropical Atlantic north toward the Pole in surface currents like the Gulf Stream. This saline water loses heat to the air as it is carried to the far reaches of the North Atlantic. The coldness and high salinity together make the water more dense, and it sinks deep into the ocean. Surface water moves in to replace it. The deep, cold water flows into the South Atlantic, Indian, and Pacific Oceans, eventually mixing again with warm water and rising back to the surface.

Changes in water temperature and salinity, depending on how drastic they are, might have considerable effects on the ocean conveyor belt. Ocean temperatures are rising in all ocean basins and at much deeper depths than previously thought, say scientists at the National Oceanic and Atmospheric Administration (NOAA). Arguably, the largest oceanic change ever measured in the era of modern instruments is in the declining salinity of the subpolar seas bordering the North Atlantic.

Robert Gagosian, president and director of the Woods Hole Oceanographic Institution, believes that oceans hold the key to potential dramatic shifts in the Earth's climate. He warns that too much change in ocean temperature and salinity could disrupt the North Atlantic thermohaline circulation enough to slow down or possibly halt the conveyor belt—causing drastic climate changes in time spans as short as a decade.
The future breakdown of the thermohaline circulation remains a disturbing, if remote, possibility. But the link between changing atmospheric chemistry and the changing oceans is indisputable, says Nicholas Bates, a principal investigator for the Bermuda Atlantic Time-series Study station, which monitors the temperature, chemical composition, and salinity of deep-ocean water in the Sargasso Sea southeast of the Bermuda Triangle.

Oceans are important sinks, or absorption centers, for carbon dioxide, and take up about a third of human-generated CO2. Data from the Bermuda monitoring programs show that CO2 levels at the ocean surface are rising at about the same rate as atmospheric CO2. But it is in the deeper levels where Bates has observed even greater change. In the waters between 820 and 1,476 feet (250 and 450 meters) deep, CO2 levels are rising at nearly twice the rate as in the surface waters. "It's not a belief system; it's an observable scientific fact," Bates says. "And it shouldn't be doing that unless something fundamental has changed in this part of the ocean."

While scientists like Bates monitor changes in the oceans, others evaluate CO2 levels in the atmosphere. In Vestmannaeyjar, Iceland, a lighthouse attendant opens a large silver suitcase that looks like something out of a James Bond movie, telescopes out an attached 15-foot (4.5-meter) rod, and flips a switch, activating a computer that controls several motors, valves, and stopcocks. Two two-and-a-half liter (about 26 quarts) flasks in the suitcase fill with ambient air. In North Africa, an Algerian monk at Assekrem does the same. Around the world, collectors like these are monitoring the cocoon of gases that compose our atmosphere and permit life as we know it to persist.
When the weekly collection is done, all the flasks are sent to Boulder, Colorado. There, Pieter Tans, a Dutch-born atmospheric scientist with NOAA's Climate Monitoring and Diagnostics Laboratory, oversees a slew of sensitive instruments that test the air in the flasks for its chemical composition. In this way Tans helps assess the state of the world's atmosphere.

By all accounts it has changed significantly in the past 150 years.

Walking through the various labs filled with cylinders of standardized gas mixtures, absolute manometers, and gas chromatographs, Tans offers up a short history of atmospheric monitoring. In the late 1950s a researcher named Charles Keeling began measuring CO2 in the atmosphere above Hawaii's 13,679-foot (4,169-meter) Mauna Loa. The first thing that caught Keeling's eye was how CO2 level rose and fell seasonally. That made sense since, during spring and summer, plants take in CO2 during photosynthesis and produce oxygen in the atmosphere. In the fall and winter, when plants decay, they release greater quantities of CO2 through respiration and decay. Keeling's vacillating seasonal curve became famous as a visual representation of the Earth "breathing."

Something else about the way the Earth was breathing attracted Keeling's attention. He watched as CO2 level not only fluctuated seasonally, but also rose year after year. Carbon dioxide level has climbed from about 315 parts per million (ppm) from Keeling's first readings in 1958 to more than 375 ppm today. A primary source for this rise is indisputable: humans' prodigious burning of carbon-laden fossil fuels for their factories, homes, and cars.

Tans shows me a graph depicting levels of three key greenhouse gases—CO2, methane, and nitrous oxide—from the year 1000 to the present. The three gases together help keep Earth, which would otherwise be an inhospitably cold orbiting rock, temperate by orchestrating an intricate dance between the radiation of heat from Earth back to space (cooling the planet) and the absorption of radiation in the atmosphere (trapping it near the surface and thus warming the planet).

Tans and most other scientists believe that greenhouse gases are at the root of our changing climate. "These gases are a climate-change driver," says Tans, poking his graph definitively with his index finger. The three lines on the graph follow almost identical patterns: basically flat until the mid-1800s, then all three move upward in a trend that turns even more sharply upward after 1950. "This is what we did," says Tans, pointing to the parallel spikes. "We have very significantly changed the atmospheric concentration of these gases. We know their radiative properties," he says. "It is inconceivable to me that the increase would not have a significant effect on climate."
Exactly how large that effect might be on the planet's health and respiratory system will continue to be a subject of great scientific and political debate—especially if the lines on the graph continue their upward trajectory.

Eugene Brower, an Inupiat Eskimo and president of the Barrow Whaling Captains' Association, doesn't need fancy parts-per-million measurements of CO2 concentrations or long-term sea-level gauges to tell him that his world is changing.

"It's happening as we speak," the 56-year-old Brower says as we drive around his home in Barrow, Alaska—the United States' northernmost city—on a late August day. In his fire chief's truck, Brower takes me to his family's traditional ice cellars, painstakingly dug into the permafrost, and points out how his stores of muktuk—whale skin and blubber recently began spoiling in the fall because melting water drips down to his food stores. Our next stop is the old Bureau of Indian Affairs school building. The once impenetrable permafrost that kept the foundation solid has bucked and heaved so much that walking through the school is almost like walking down the halls of an amusement park fun house. We head to the eroding beach and gaze out over open water. "Normally by now the ice would be coming in," Brower says, scrunching up his eyes and scanning the blue horizon.

We continue our tour. Barrow looks like a coastal community under siege. The ramshackle conglomeration of weather-beaten houses along the seaside gravel road stands protected from fall storm surges by miles-long berms of gravel and mud that block views of migrating gray whales. Yellow bulldozers and graders patrol the coast like sentries.

The Inupiat language has words that describe many kinds of ice. Piqaluyak is salt-free multiyear sea ice. Ivuniq is a pressure ridge. Sarri is the word for pack ice, tuvaqtaq is bottom-fast ice, and shore-fast ice is tuvaq. For Brower, these words are the currency of hunters who must know and follow ice patterns to track bearded seals, walruses, and bowhead whales.
There are no words, though, to describe how much, and how fast, the ice is changing. Researchers long ago predicted that the most visible impacts from a globally warmer world would occur first at high latitudes: rising air and sea temperatures, earlier snowmelt, later ice freeze-up, reductions in sea ice, thawing permafrost, more erosion, increases in storm intensity. Now all those impacts have been documented in Alaska. "The changes observed here provide an early warning system for the rest of the planet," says Amanda Lynch, an Australian researcher who is the principal investigator on a project that works with Barrow's residents to help them incorporate scientific data into management decisions for the city's threatened infrastructure.

Before leaving the Arctic, I drive to Point Barrow alone. There, at the tip of Alaska, roughshod hunting shacks dot the spit of land that marks the dividing line between the Chukchi and Beaufort Seas. Next to one shack someone has planted three eight-foot (2.4-meter) sticks of white driftwood in the sand, then crisscrossed their tops with whale baleen, a horny substance that whales of the same name use to filter life-sustaining plankton out of seawater. The baleen, curiously, looks like palm fronds.

So there, on the North Slope of Alaska, stand three makeshift palm trees. Perhaps they are no more than an elaborate Inupiat joke, but these Arctic palms seem an enigmatic metaphor for the Earth's future.
Where are the fires?

The fires devastating Indonesia have been called a ‘crime against humanity’. How did they start, what damage are they causing and who’s to blame?

As satellite data of the fire hotspots shows, forest fires have affected the length and breadth of Indonesia. Among the worst hit areas are southern Kalimantan (Borneo) and western Sumatra. The fires have been raging since July, with efforts to extinguish them hampered by seasonal dry conditions exacerbated by the El Nino effect. As well as Indonesia, the acrid haze from the fires is engulfing neighbouring Malaysia and Singapore and has reached as far as southern Thailand.
What is the damage?

The most obvious damage is to the forest where the fires are occurring. Indonesia’s tropical forests represent some of the most diverse habitats on the planet. The current fire outbreak adds to decades of existing deforestation by palm oil, timber and other agribusiness operators, further imperilling endangered species such as the orangutan.

The human cost is stark; 19 people have died and an estimated 500,000 cases of respiratory tract infections have been reported since the start of the fires. It’s estimated that the fires could cause more than 100,000 premature deaths in the region.

Financial damage to the region’s economy is still being counted, but the Indonesian government’s own estimates suggest it could be as high as $47bn, a huge blow to the country’s economy. A World Bank study (pdf) on forest fires last year in Riau province estimated that they caused $935m of losses relating to lost agricultural productivity and trade.

What is causing the fires?

Forest fires have become a seasonal phenomenon in Indonesia. At the root of the problem is the practice of forest clearance known as slash and burn, where land is set on fire as a cheaper way to clear it for new planting. Peat soil, which characterises much of the affected areas, is highly flammable, causing localized fires to spread and making them difficult to stop.

Who is responsible?

It’s a blame game, with everyone pointing the finger at someone else. Environmental group WWF Indonesia, which has been highlighting the problem of Indonesia’s recurrent fires for years, says that the fires are caused by the “collective negligence” of companies, smallholders and government (which isn’t investing sufficiently in preventative measures).
Many blame big business. According to a recent analysis of World Resources Institute data in September, more than one third (37%) of the fires in Sumatra are occurring on pulpwood concessions. A good proportion of the rest are on or near land used by palm oil producers. “Many of these fires are a direct result of the industrial manipulation of the landscape for plantation development,” says Lindsey Allen, executive director of the conservation organization Rainforest Action Network.

In September, the Indonesian police arrested seven executives in connection with the fires, including a senior executive from Bumi Mekar Hijau (BMH), which supplied Jakarta-based paper giant Asia Pulp and Paper (APP).

Others look away from the big corporations for blame. According to Henry Purnomo, professor at Indonesia’s Bogor Agricultural University and a scientist at research group CIFOR, there are two culprits: poor small-scale farmers looking to expand their farmland, and rogue operators intent on illegally clearing forests for land acquisition.

Global corporations operating in the area also blame smallholders and under-the-radar companies. The Roundtable on Sustainable Palm Oil, which counts many big palm oil businesses as members, has consistently said that the instances of fire on certified palm plantations in the affected region (which number 137) measure in single digits. Brendan May, chairman of sustainability advisory firm Robertsbridge (which has APP as a client), argues that it’s ‘not in companies’ best interest” to set fire to their own assets – an argument some campaign groups dispute.

What needs to be done?

Ending the practice of slash and burn is vital. Companies – big and small - must be held to account, before the law and the market, if found culpable.

Smallholders need assistance and incentives to pursue alternative, less harmful practices of forest management. Forest-dwelling communities often lack the skills and training, according to a recent CIFOR report. Meanwhile processors and buyers often fail to pay smallholders a fair price, something the signatories to the Sustainable Palm Oil Manifesto (which claims to go beyond RSPO certification standards) have pledged to correct.

Many big firms, such as palm producer Wilmar and timber giant APP, have signed zero-deforestation pledges in recent years. But the real test comes in pushing their commitments beyond the boundary fences of their plantations and down into their supply chains, where smaller firms operate with less public scrutiny.
Many are calling on the Indonesian government to step up. WWF-Indonesia’s deputy director, Irwan Gunawan, says the government action lacks clout and “has not yet resulted in deterrent effect to prevent any recurrence”.

Removing the culture of political patronage that protects private companies in Indonesia is essential, says Purnomo. A budgetary rethink is also required. At present, the ratio of public spending on fire suppression versus prevention is around 80:20, Purnomo says.

Another major contribution to reducing future fires would be an up-to-date online, searchable land registry. Land tenure in Indonesia is often unknown or disputed, making it difficult to establish where responsibility lies. Coupling such a database with digital mapping technologies such as WRI’s Global Forest Watch could make identifying the culprits a whole lot easier. One Map, a government-backed project to develop such a spatial mapping solution, is currently under development.

An oil palm plantation in Sabah. Photo by Rhett A. Butler

The majority of equity investors in the palm oil sector do not take environmental performance into account when making investing decisions. Such ESG screens are usually only done by SRI or screened funds with a specific sustainability focus. Rather, for mainstream funds, the initial investment decision is largely made on the basis of a company’s earnings ability.
With continued ocean and atmospheric warming, sea levels will likely rise for many centuries at rates higher than that of the current century. In the United States, almost 40 percent of the population lives in relatively high-population-density coastal areas, where sea level plays a role in flooding, shoreline erosion, and hazards from storms. Globally, eight of the world’s 10 largest cities are near a coast, according to the U.N. Atlas of the Oceans.

Global sea level has been rising over the past century, and the rate has increased in recent decades. In 2014, global sea level was 2.6 inches above the 1993 average—the highest annual average in the satellite record (1993-present). Sea level continues to rise at a rate of about one-eighth of an inch per year. Higher sea levels mean that deadly and destructive storm surges push farther inland than they once did, which also means more frequent nuisance flooding. Disruptive and expensive, nuisance flooding is estimated to be from 300 percent to 900 percent more frequent within U.S. coastal communities than it was just 50 years ago.

The two major causes of global sea level rise are thermal expansion caused by warming of the ocean (since water expands as it warms) and increased melting of land-based ice, such as glaciers and ice sheets. The oceans are absorbing more than 90 percent of the increased atmospheric heat associated with emissions from human activity.

With continued ocean and atmospheric warming, sea levels will likely rise for many centuries at rates higher than that of the current century. In the United States, almost 40 percent of the population lives in relatively high-population-density coastal areas, where sea level plays a role in flooding, shoreline erosion, and hazards from storms. Globally, eight of the world’s 10 largest cities are near a coast, according to the U.N. Atlas of the Oceans.

Sea level rise at specific locations may be more or less than the global average due to local factors such as land subsidence from natural processes and withdrawal of groundwater and fossil fuels, changes in regional ocean currents, and whether the land is still rebounding from the compressive weight of Ice Age glaciers. In urban settings, rising seas threaten infrastructure necessary for local jobs and regional industries. Roads, bridges, subways, water supplies, oil and gas wells, power plants, sewage treatment plants, landfills—virtually all human infrastructure—is at risk from sea level rise.
What's the difference between global and local sea level?

Global sea level trends and relative sea level trends are different measurements. Just as the surface of the Earth is not flat, the surface of the ocean is also not flat—in other words, the sea surface is not changing at the same rate globally. Sea level rise at specific locations may be more or less than the global average due to many local factors: subsidence, upstream flood control, erosion, regional ocean currents, variations in land height, and whether the land is still rebounding from the compressive weight of Ice Age glaciers.

Sea level is primarily measured using tide stations and satellite laser altimeters. Tide stations around the globe tell us what is happening at a local level—the height of the water as measured along the coast relative to a specific point on land. Satellite measurements provide us with the average height of the entire ocean. Taken together, these tools tell us how our ocean sea levels are changing over time.

10 Islands That Will Vanish When Sea Levels Rise

https://www.youtube.com/watch?v=haC98CLGv-A
Tundras are among the world's coldest, harshest biomes, with extreme temperatures and low rainfall. But these environments in the Arctic and on mountains are far from invulnerable, displaying sensitivity to human disruptions and climate change.

Home to animals including Arctic foxes, polar bears, gray wolves, caribou, snow geese, and musk oxen, the Arctic tundra is changing in broad and somewhat unpredictable ways as global average temperatures rise. Its underlying base of frozen soil and plant matter, called permafrost, is thawing. That is turning the tundra into a source of greenhouse gas emissions, as soil microbes convert carbon into carbon dioxide and methane. The tundra is also slow to repair itself from physical disturbances such as tire tracks from heavy vehicles.

**Threats to tundras**

**Climate change.** A warmer climate could radically change tundra landscapes and what species are able to live in them. Warming creates potential feedback loops that encourage further destabilization of tundra ecosystems. The release of methane from deteriorating permafrost, for example, feeds the thawing cycle, while higher temperatures drive the growth of shrubs, which can change soil temperature and prevent snow from reflecting out heat.
WHAT ARE TUNDRAS?

Thriving shrubs also crowd out lichen, an important food source for caribou and other animals. Warmer tundras could also see increased risk of wildfires and drought—scientists have documented a significant disappearance of lakes in western Greenland between 1969 and 2017.

**Air pollution.** Air pollution affects tundra environments in different ways. A recent study found that Arctic clouds are particularly sensitive to air pollution, which spurs cloud formation and has a blanketing effect. Black carbon from diesel engines, fires, and other combustion can settle on snow, decreasing its ability to reflect sunlight and causing faster melting.

Chemicals used in coolants and aerosol sprays have driven ozone depletion at the North and South Poles, which can let in stronger ultraviolet rays. And toxic mercury, sent into the atmosphere by coal-burning and industrial activity, is accumulating in the Arctic tundra, threatening both humans and animals who live in the region. Air pollution can also harm or kill the important food source of lichen.

**Industrial activity.** The oil, gas, and mining industries can disrupt fragile tundra habitats. Drilling wells can thaw permafrost, while heavy vehicles and pipeline construction can damage soil and prevent vegetation from returning. This activity also increases the risk of toxic spills. Seismic testing for oil and gas operations in the 1980s left tracks on the tundra that are still visible decades later.
Invasive and migrating species. Climate change is driving down populations of some Arctic tundra natives such as caribou (also known as reindeer) by fostering an increase in parasites and disease while damaging food sources. But other species, such as shrubs and the wolf spider, are thriving.

The red fox, which is typically found farther south, is moving north onto the tundra and competing with the Arctic fox for food and territory. Though few invasive species have yet to take root in the Arctic, climate change increases the risk this could happen. And human activity, both near and far, can change the balance: As snow geese have learned to feed on farmlands rather than in the wild on their migration routes, their exploding numbers have threatened to degrade their tundra nesting sites.

Solutions
Cutting harmful, planet-warming pollution by switching away from fossil fuels is key to safeguarding Earth’s tundra habitats. Other measures include creating refuges and protections for certain species and regions while limiting or banning industrial activity. The Arctic Council, an intergovernmental forum of Arctic countries, has also established a working group to study and prevent the spread of invasive species in the region.

Christina Nunez is a writer and frequent contributor to National Geographic.
• The first animal to go extinct due to global warming was the golden toad in 1989.\[5\]

• Climate change could drive as many as 1 in 6 animals and plant species to extinction.\[3,4\]

• The average global sea level has risen by 8 inches since 1870. Additionally, the annual rate of sea-level rise has increased.\[4\]

• Each year of the 21st century is among the hottest since 1880.\[9\]

• The amount of heat accumulating on Earth because of human emission is roughly equivalent the heat released by 400,000 Hiroshima bombs exploding around the world every day.\[7\]

• Cows burping, pooping, and emitting gas release over 13 million tons of methane each year, which is 70% more emissions than the oil and gas industry. After carbon dioxide, methane is the most widespread greenhouse gas.\[13\]

• Global warming is breeding swarms of giant mosquitoes in the Arctic. Warmer temperatures are causing these giant bloodsuckers to emerge earlier and grow larger.\[3\]

• Swedish scientist Svante Arrhenius was the first to note in 1896 that fossil fuel combustion could result in global warming.\[7\]

*Approximately 31% of white Americans don’t believe in global warming. By contrast, just 11% of Hispanics and 17% of blacks claim there is no solid evidence that the Earth is warming.\[15\]
Global warming will affect Norway the least, and the country of Chad the most.\cite{17}

There is more carbon dioxide in the atmosphere now than there has been in the last 800,000 years.\cite{17}

The United States represents less than 5\% of the world’s population, yet Americans account for 25\% of the world’s commercial energy consumption and 22\% of the world’s industrial emissions of CO2.\cite{17}

Without the atmosphere to create a greenhouse-type effect, the average temperature on Earth would be just 5° Fahrenheit (F).\cite{17}

As of October 2015, the Earth had warmed by about 1.7 degrees Fahrenheit since 1880, when scientists began keeping records\cite{8}

Scientists expect a 3.5° F increase in average global temperatures by the year 2100, resulting in the warmest temperatures in the past million years. The last time the Earth was this warm 1.8 million years ago, when sea levels were also 12-18 feet higher.\cite{17}

Since the 1950s, Arctic sea ice has declined by 15\% and the average annual duration of northern lake and river ice has decreased by two weeks.\cite{11}

Over 100 residents of Tegua Island in the Pacific Ocean were evacuated due to rising sea levels and subsequent flooding. They were the first forced relocation due to global warming.\cite{6}

Climate models predict the loss of Arctic sea ice earlier and more rapidly than the loss of Antarctic land ice if warming trends continue.\cite{7}

Currently there are around 25 million lightning strikes per year. Scientists predict that with every degree rise in global temperatures, lightning strikes will increase by 12\%.\cite{10}

As Arctic ice rapidly disappears, scientists believe the Arctic will experience its first ice-free summer as early as the year 2040.\cite{7}

Average temperatures in the Arctic climates of Alaska, Canada, and Russia have risen at twice the global average in the last century.\cite{7}

In 1910, Glacier National Park in Montana boasted 150 glaciers—today there are just 27.\cite{7}

Deserts worldwide are increasing as a result of warmer temperatures. At the end of the year 2007, Australia lost 25\% of crop production due to desertification.\cite{11}

Fossil fuel burning currently adds nearly six billion tons of CO2 to the atmosphere every year. Oceans and forests only remove half of this CO2.\cite{18}

Rampant deforestation currently causes 20\% of the world’s global warming pollution by prohibiting the reabsorption of CO2.\cite{9}
• While increased concentrations of CO2 in the atmosphere certainly can increase temperatures, many geologists believe that water vapor accounts for more than 90% of the greenhouse warming effect.\(^{[1]}\)

• Between the first Earth Day in 1970 and the new millennium, human-made emissions of greenhouse gases rose 70%.\(^{[23]}\)

• According to the WWF, global warming could kill off polar bears in the next 20 years.\(^{[12]}\)

• Since the 17th century, carbon dioxide in the atmosphere has increased by 34%.\(^{[11]}\)

• By the end of this century over 150,000 people will have died due to heat-related causes.\(^{[17]}\)

• By 2100, the average global temperature will be 5.8 degrees warmer if current CO2 output continues.\(^{[17]}\)

• One study noted that climate change is negatively affecting birth rates around the world. Hotter days tend to decrease people’s sex drive.\(^{[4][21]}\)

• Global warming and severe natural disasters have left millions homeless and impoverished, which has created desperate people vulnerable to human trafficking.\(^{[22]}\)

• The United States is the worst global warming offender on earth, producing about 27% of the world’s total carbon dioxide emissions. China and Russia round out the top three.\(^{[17]}\)
Cars amount to three-quarters of all transportation emissions. At the current rate, there will be over a billion cars in 2030, and a billion more by 2050.\textsuperscript{[17]}

By 2030, the world will be driven on by more than a billion cars

Global warming negatively affects the growth of bamboo, which is almost the sole source of food for endangered giant pandas. It is estimated that 80-100\% of bamboo will disappear by the end of the 21st century.\textsuperscript{[16]}

Due to global warming, the Amazon forest is turning into desert and the Sahara is becoming greener.\textsuperscript{[17]}

Since the beginning of the Industrial Revolution, the ocean’s acidity has increased by approximately 30\%.\textsuperscript{[17]}

Because sea levels continue to rise in the north, for the first time in hundreds of years, ships are able to travel through the Northwest Passage above North America.\textsuperscript{[17]}

Just a one-yard rise in sea level is enough to displace over 100 million people.\textsuperscript{[7]}

Climate change costs the United State about $100 billion annually.\textsuperscript{[14]}

Approximately 37\% of Americans think that global warming is a hoax. About 64\% believe that global warming won’t affect them personally.\textsuperscript{[13]}

Global warming could change wine-growing regions. Specifically, grape-growers may need to move their vineyards to higher elevations to beat the increasing heat.\textsuperscript{[3]}

Parasites usually found in warmer third-world countries are now becoming endemic in the U.S., thanks to global warming. Already, 60 million people in the U.S. are infected with toxoplasma gondii, or the “cat poop parasite.”\textsuperscript{[20]}

Between the years 1961 and 1997, the world’s glaciers lost 890 cubic miles of ice.\textsuperscript{[6]}

Global warming is slowing the currents of the ocean, such as the powerful Gulf Stream. The Gulf Stream, for example, moves water than all the world’s rivers combined. Weakened ocean currents, such as the Gulf Stream, would result in higher sea levels and changing weather patterns.\textsuperscript{[19]}

Global warming is turning jungle leaves into “junk food.” Specifically, jungle leaves are accumulating more fiber and less protein, making them less nutritious for the animals that feed on them.\textsuperscript{[9]}

Glaciers worldwide have lost 890 cubic miles of ice since 1961
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REFERENCES


Dell’Amore, Christine. "7 Species Hit Hard by Climate Change—including One That's Already Extinct." National Geographic. April 2, 2014.


InterpNEWS

How Climate Change Affects Animals

WRITTEN BY GREENTUMBLE
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The record low levels of sea ice extent which both the Arctic and Antarctic experienced this winter made the news around the world. Indeed, scientists were astonished to see that in November, a time when the region enters its coldest period, sea ice retreated in the Arctic [1].

A similar phenomenon was noted in 2013 when a chunk of sea ice as large as Denmark was removed from the Arctic at a time when sea ice is usually growing [1]. It is therefore no surprise that the Earth’s surface temperatures in 2016 were the highest temperatures ever recorded [2].

The impacts of global warming and climate change are becoming increasingly clear, but they not only impact our natural environment. They have impacts on all its inhabitants, both fauna and flora. Our biodiversity is affected by changes in climate and other extreme events. At the same time, climate change also worsens other threats like habitat destruction, overexploitation, and disease [3].

The impacts of climate change on species are clearly illustrated by looking at the cases of the following species, prioritised on the basis of the detrimental effect climate change is having on them.

Examples Of Animals Affected By Climate Change

Shrinking chances for herds of reindeer

One such species is the reindeer found in Eurasia and the Caribou which is a North American version of the same species. Both species are critical to local people for food, shelter, fuel, tools, and other cultural items.
But the Caribou and reindeer depend on the availability of abundant tundra vegetation and good foraging conditions for their survival, especially during the calving season.

Unfortunately, climate-induced changes to the Arctic tundra are going to cause vegetation zones to shift significantly further north, reducing the natural habitat of these herds [4].

Climate change is therefore changing the natural habitat of the two species of reindeer by limiting their food sources and therefore the potential for them to successfully procreate.

**Rhinoceroses suffering through droughts**

Rhinos are already under extreme pressure, being one of the primary species that is being poached worldwide. Last years have unfortunately proven that Black rhinos are susceptible to droughts as well. *For example, in 2009 when Kenya suffered severe droughts, farmers lost about 80% of their cattle and native wildlife, including the Black Rhino, which was severely affected.*

**Climate change is therefore exacerbating an already fragile species.**

The drought created in turn an increase in the poaching of rhinos for their horn as locals struggled to survive. With droughts set to become more often due to climate change, it is becoming increasingly clear that many species will be impacted as a result [5].
Raining on chickless golden eagles

And while droughts can have a negative impact on some animals, increased rainfall – also a consequence of climate change – can also have the same effect. High rainfall can negatively impact on birds, causing reproductive failures and poor chick condition.

For example, in west Scotland, golden eagle populations declined by 25% when there was a significant increase in rainfall in May.

Indeed, flooding has a negative impact on almost all mammals and on ground-nesting birds with free-ranging chicks [6].

Sea turtle girls preferring warm sand

Sea turtles are another species put at particular risk due to climate change. Rising seas and stormy weather affects turtle species by eroding or destroying many of the beaches where they lay their eggs.

On top of that, it appears that hotter sands also cause greater numbers of sea turtles to be born female. While in the short term, this may increase turtle numbers but in about a century or so, it is likely that significantly warmer sands will cause such a preponderance of females that the species could become extinct. It is also important to note that hotter sand can also cause complete nest failure [7].
The examples of these species show how climate change can have a detrimental effect on our biodiversity. The stakes are particularly high as already the UN’s Intergovernmental Panel on Climate Change estimated that if global temperatures increase more than two to three degrees F above current levels, up to one-third of the species on Earth could be at risk for extinction.

What is more destabilising our ecosystems in this way can only worsen the effects of climate change as habitats are rendered weaker and cannot adapt or mitigate the effects of climate change thereby creating a vicious circle [8].

References

[1] https://goo.gl/GhXsL6
[7] https://goo.gl/7wc7TR
Climate change is one of the greatest challenges of our time. We are already seeing its effects with rising seas, catastrophic wildfires and water shortages. These changes are not only having a dramatic impact on diverse ecosystems but also on the wildlife that call these places home. Here are 9 species that are already being affected by climate change.

If we don’t act on climate now, this list is just the tip of the iceberg of what we can expect in years to come. Future generations shouldn’t just see these animals in history books -- we owe it to them to protect these creatures and their habitats.

1. Moose

Rising temperatures and booming parasite populations are expected to cause this cold-weather species that calls the northern United States and Canada home to move farther north. That’s because milder winters and less snow can lead to higher numbers of winter ticks. Tens of thousands of these parasites can gather on a single moose to feed on its blood -- weakening the animal’s immune system and often ending in death, especially the calves. Photo by National Park Service.
2. Salmon

Salmon require cold, fast-flowing streams and rivers to spawn. Changing stream flows and warming waters in the Pacific Northwest are already impacting some salmon species and populations. Higher temperatures have also led a harmful salmon parasite to invade Alaska’s Yukon River. So while salmon might currently be on the menu, climate change is expected to impact major commercial and recreational fishing industries in the coming years. Photo by Bureau of Land Management.

3. Snowshoe Hares

To help hide from predators, this North American rabbit has evolved to turn white in winter to blend in with the snow. With climate change, snow in some areas is melting earlier than the hares have grown accustomed to, leaving stark white hares exposed in snow-less landscapes. This increased vulnerability might cause declines in hare populations that could lead to implications for other species. Snowshoe hares are critical players in forest ecosystems. Photo by National Park Service.
4. American Pikas

About the size and shape of a hamster, the American pika typically lives at high elevations where cool, moist conditions prevail. Research by U.S. Geological Survey has found that pika populations are now disappearing from numerous areas that span from the Sierra Nevadas to the Rocky Mountains. Populations within some areas are migrating to higher elevations likely to avoid reduced snowpacks and warmer summer temperatures. Unfortunately, pikas are strongly tied to rocky-talus habitat that is limited and patchily distributed. This gives them few options as temperatures continue to rise. Photo by Jon LeVasseur (www.sharetheexperience.org).

5. Sea Turtles

Various populations of sea turtle species and their nesting sites are vulnerable to sea-level rise, increased storminess and changing temperatures -- all impacts of climate change. These factors may result in current nesting and foraging sites becoming unsuitable for federally threatened and endangered turtle species -- especially loggerhead sea turtles. Photo by USGS.
6. Puffins

These colorful-billed birds that look like miniature penguins are experiencing population declines in the United States and elsewhere. In the Gulf of Maine, puffins are having difficulty finding their major food sources of white hake and herring. As the sea warms, the fish are moving into deeper waters or further north, making it harder for puffins to catch a meal and feed their young. Adult puffins are compensating by feeding their young butterfish, but young puffins are unable to swallow these large fish and many are dying of starvation. Delayed breeding seasons, low birth rates and chick survival are all affecting the reproductive ability of these birds. Photo by USFWS.

7. Alaskan Caribou

Caribou are always on the move -- it’s not uncommon for them to travel long distances in search of adequate food. But as temperatures increase and wildfires burn hotter and longer in Alaska, it could considerably change the caribou’s habitat and winter food sources. Ultimately, this will affect subsistence hunters who rely on caribou for nutritional, cultural and economic reasons. Photo courtesy of Jacob W. Frank.
8. Piping Plovers

The piping plover is an iconic shorebird that breeds and nests along the Atlantic Coast, the Great Lakes and the Great Plains. Increased human use of their beach habitats, including intense coastal development, as well as rising sea levels and storm surges associated with climate change threaten the species. Photo by USFWS.

9. Polar Bears

Polar bears in many ways have become the symbol of climate change. In 2008, they were listed as a threatened species under the Endangered Species Act -- the first species to be listed because of forecasted population declines from the effects of climate change. The primary cause of their decline: loss of sea ice habitat attributed to Arctic warming. Polar bears need sea ice to hunt seals -- a main source of food -- as well as to move across the large home ranges they need for foraging habitat. Polar bears aren’t alone in feeling the effects of shrinking sea ice. Walruses and other Arctic species are facing similar challenges as summer sea ice continues to retreat. Photo by National Park Service.
Agriculture is an important sector of the U.S. economy. The crops, livestock, and seafood produced in the United States contribute more than $300 billion to the economy each year. When food-service and other agriculture-related industries are included, the agricultural and food sectors contribute more than $750 billion to the gross domestic product.

Agriculture and fisheries are highly dependent on the climate. Increases in temperature and carbon dioxide (CO2) can increase some crop yields in some places. But to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. Changes in the frequency and severity of droughts and floods could pose challenges for farmers and ranchers and threaten food safety. Meanwhile, warmer water temperatures are likely to cause the habitat ranges of many fish and shellfish species to shift, which could disrupt ecosystems. Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as we have done in the past. The effects of climate change also need to be considered along with other evolving factors that affect agricultural production, such as changes in farming practices and technology.

Impacts on Crops

Despite technological improvements that increase corn yields, extreme weather events have caused significant yield reductions in some years. Source: USGCRP (2009)

Click the image to view a larger version. Crops grown in the United States are critical for the food supply here and around the world. U.S. farms supply nearly 25% of all grains (such as wheat, corn, and rice) on the global market. Changes in temperature, atmospheric carbon dioxide (CO2), and the frequency and intensity of extreme weather could have significant impacts on crop yields.
Crops grown in the United States are critical for the food supply here and around the world. U.S. farms supply nearly 25% of all grains (such as wheat, corn, and rice) on the global market. Changes in temperature, atmospheric carbon dioxide (CO₂), and the frequency and intensity of extreme weather could have significant impacts on crop yields.

For any particular crop, the effect of increased temperature will depend on the crop's optimal temperature for growth and reproduction. In some areas, warming may benefit the types of crops that are typically planted there, or allow farmers to shift to crops that are currently grown in warmer areas. Conversely, if the higher temperature exceeds a crop's optimum temperature, yields will decline.

Higher CO₂ levels can affect crop yields. Some laboratory experiments suggest that elevated CO₂ levels can increase plant growth. However, other factors, such as changing temperatures, ozone, and water and nutrient constraints, may counteract these potential increases in yield. For example, if temperature exceeds a crop's optimal level, if sufficient water and nutrients are not available, yield increases may be reduced or reversed. Elevated CO₂ has been associated with reduced protein and nitrogen content in alfalfa and soybean plants, resulting in a loss of quality. Reduced grain and forage quality can reduce the ability of pasture and rangeland to support grazing livestock.

More extreme temperature and precipitation can prevent crops from growing. Extreme events, especially floods and droughts, can harm crops and reduce yields. For example, in 2010 and 2012, high nighttime temperatures affected corn yields across the U.S. Corn Belt, and premature budding due to a warm winter caused $220 million in losses of Michigan cherries in 2012.

Dealing with drought could become a challenge in areas where rising summer temperatures cause soils to become drier. Although increased irrigation might be possible in some places, in other places water supplies may also be reduced, leaving less water available for irrigation when more is needed.

Many weeds, pests, and fungi thrive under warmer temperatures, wetter climates, and increased CO₂ levels. Currently, U.S. farmers spend more than $11 billion per year to fight weeds, which compete with crops for light, water, and nutrients. The ranges and distribution of weeds and pests are likely to increase with climate change. This could cause new problems for farmers' crops previously unexposed to these species.

Though rising CO₂ can stimulate plant growth, it also reduces the nutritional value of most food crops. Rising levels of atmospheric carbon dioxide reduce the concentrations of protein and essential minerals in most plant species, including wheat, soybeans, and rice. This direct effect of rising CO₂ on the nutritional value of crops represents a potential threat to human health. Human health is also threatened by increased pesticide use due to increased pest pressures and reductions in the efficacy of pesticides.

Impacts on Livestock

Americans consume more than 36 million metric tons of meat and poultry annually. Livestock and poultry account for over half of U.S. agricultural cash receipts, often over $100 billion per year. Changes in climate could affect animals both directly and indirectly.
Heat waves, which are projected to increase under climate change, could directly threaten livestock. In 2011, exposure to high temperature events caused over $1 billion in heat-related losses to agricultural producers.[1] Heat stress affects animals both directly and indirectly. Over time, heat stress can increase vulnerability to disease, reduce fertility, and reduce milk production.

Drought may threaten pasture and feed supplies. Drought reduces the amount of quality forage available to grazing livestock. Some areas could experience longer, more intense droughts, resulting from higher summer temperatures and reduced precipitation. For animals that rely on grain, changes in crop production due to drought could also become a problem.

Climate change may increase the prevalence of parasites and diseases that affect livestock. The earlier onset of spring and warmer winters could allow some parasites and pathogens to survive more easily. In areas with increased rainfall, moisture-reliant pathogens could thrive.[6]

Potential changes in veterinary practices, including an increase in the use of parasiticides and other animal health treatments, are likely to be adopted to maintain livestock health in response to climate-induced changes in pests, parasites, and microbes. This could increase the risk of pesticides entering the food chain or lead to evolution of pesticide resistance, with subsequent implications for the safety, distribution, and consumption of livestock and aquaculture products.[5]

Increases in carbon dioxide (CO₂) may increase the productivity of pastures, but may also decrease their quality. Increases in atmospheric CO₂ can increase the productivity of plants on which livestock feed. However, the quality of some of the forage found in pasturelands decreases with higher CO₂. As a result, cattle would need to eat more to get the same nutritional benefits.

Impacts on Fisheries
American fishermen catch or harvest five million metric tons of fish and shellfish each year.[7] U.S. fisheries contribute more than $1.55 billion to the economy annually (as of 2012).[8] Many fisheries already face multiple stresses, including overfishing and water pollution. Climate change may worsen these stresses. In particular, temperature changes could lead to significant impacts.

This map shows the annual centers of biomass for three species in the northeastern United States from 1968 to 2015. Dots are shaded from light to dark to show change over time. Source: US EPA (2016). Climate Change Indicators in the United States: Marine Species Distribution. Data Source: NOAA (2016).
The ranges of many fish and shellfish species may change. In waters off the northeastern United States, several economically important species have shifted northward since the late 1960s. The three species shown in [the figure to the left] (American lobster, red hake, and black sea bass) have moved northward by an average of 119 miles. [9]

Many aquatic species can find colder areas of streams and lakes or move north along the coast or in the ocean. Nevertheless, moving into new areas may put these species into competition with other species over food and other resources, as explained on the Ecosystems Impacts page.

Some marine disease outbreaks have been linked with changing climate. Higher water temperatures and higher estuarine salinities have enabled an oyster parasite to spread farther north along the Atlantic coast. Winter warming in the Arctic is contributing to salmon diseases in the Bering Sea and a resulting reduction in the Yukon Chinook Salmon. Finally, warmer temperatures have caused disease outbreaks in coral, eelgrass, and abalone. [3],[10]

Changes in temperature and seasons can affect the timing of reproduction and migration. Many steps within an aquatic animal’s lifecycle are controlled by temperature and the changing of the seasons. For example, in the Northwest warmer water temperatures may affect the lifecycle of salmon and increase the likelihood of disease. Combined with other climate impacts, these effects are projected to lead to large declines in salmon populations. [1],[11],[12]

In addition to warming, the world's oceans are gradually becoming more acidic due to increases in atmospheric carbon dioxide (CO₂). Increasing acidity could harm shellfish by weakening their shells, which are created by removing calcium from seawater. [10] Acidification also threatens the structures of sensitive ecosystems upon which some fish and shellfish rely. [1],[13]

![Figure 1. Ocean Acidification Impact Pathway for Shellfish](image-url)

This diagram shows the impact pathway of carbon dioxide emissions on the shellfish market. Carbon dioxide is absorbed by oceans, resulting in ocean acidification. Acidification reduces the size and abundance of shellfish, which in turn leads to decreased harvest and eventually to changes in prices for consumers. Source: US EPA
Climate change is very likely to affect food security at the global, regional, and local level. Climate change can disrupt food availability, reduce access to food, and affect food quality.\[^{14}\] For example, projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity. Increases in the frequency and severity of extreme weather events can also interrupt food delivery, and resulting spikes in food prices after extreme events are expected to be more frequent in the future. Increasing temperatures can contribute to spoilage and contamination.

Internationally, these effects of climate change on agriculture and food supply are likely to be similar to those seen in the United States. However, other stressors such as population growth may magnify the effects of climate change on food security. In developing countries, adaptation options like changes in crop-management or ranching practices, or improvements to irrigation are more limited than in the United States and other industrialized nations.

Any climate-related disturbance to food distribution and transport, internationally or domestically, may have significant impacts not only on safety and quality but also on food access. For example, the food transportation system in the United States frequently moves large volumes of grain by water. In the case of an extreme weather event affecting a waterway, there are few, if any, alternate pathways for transport. High temperatures and a shortage of rain in the summer of 2012 led to one of the most severe summer droughts the nation has seen and posed serious impacts to the Mississippi River watershed, a major transcontinental shipping route for Midwestern agriculture. This drought resulted in significant food and economic losses due to reductions in barge traffic, the volume of goods carried, and the number of Americans employed by the tugboat industry. The 2012 drought was immediately followed by flooding throughout the Mississippi in the spring of 2013, which also resulted in disruptions of barge traffic and food transport.\[^{3}\] Transportation changes such as these reduce the ability of farmers to export their grains to international markets, and can affect global food prices.

Impacts to the global food supply concern the United States because food shortages can cause humanitarian crises and national security concerns. They also can increase domestic food prices.

References


Agriculture and climate change are deeply intertwined. The effects of global warming on food supply are dire, whilst world population is increasing. It's time to change the way agriculture affects the environment, and vice versa.

The relationship between agriculture and climate change is problematic to say the least, and it is putting food safety at risk. Using the “which came first, the chicken or the egg?” question as an analogy, it is difficult to understand exactly when this conflict began. Over time, has the effect of global warming on agriculture and food supply been to decrease crop production or has intensive agriculture contributed to climate change by causing average global temperatures to increase?

- The world population is increasing
- The effect of climate change on crop production: how is climate related to agriculture?
- How does agriculture contribute to climate change?
- Agriculture and climate change: is agroecology the answer?
- How does agriculture affect the environment? Eating habits matter, especially in Europe

The world population is increasing

Population increase is a determining factor that must be immediately taken into consideration if we wish to gain a clearer picture of this dichotomy. The world population is in fact rapidly increasing and according to the United Nations Department of Economic and Social Affairs (UN/DESA) it could increase to 9.7 billion people by 2050, compared to today’s 7.5 billion. At the same time, crop yields, mainly grain and corn, could decrease by 50 per cent over the next 35 years because of altered climatic conditions. A risk we must avoid and prevent, especially at this moment in history in which the number of people affected by famine is slightly decreasing. There are nearly 795 million people who regularly still don’t have enough food to eat, The State Of Food Insecurity In The World 2015 report by the International Fund for Agricultural Development (IFAD) and World Food Programme (WFP) calculates. This number was 1 billion in 1990-1992.
The effect of climate change on crop production: how is climate related to agriculture?

“Climate change is acting as a brake. We need yields to grow to meet growing demand, but already climate change is slowing those yields,” Michael Oppenheimer, professor at Princeton University and co-author of the fifth report by the IPCC (Intergovernmental Panel on Climate Change, which brings together scientists from all around the world). It is in this report that the scientific community came together to point out that decrease in crop yields is already taking place due to global warming.

How does agriculture contribute to climate change?

At the same time, agriculture – especially intensive agriculture, characterised by monocultures and aimed at feeding farm animals – is one of the sectors that generates the highest amount of emissions of CO2 (the main greenhouse gas). This quantity can be compared only to the sum total of the CO2 emitted by all forms of transportation.

By looking deeper, we can observe that agriculture and the deforestation it causes were responsible for one fifth (21 per cent) of all CO2 emissions in the decade from 2000 to 2010 (approximately 44 billion tonnes). This occurs because agriculture needs an increasing amount of space alongside massive amounts of chemical fertilisers now that the demand for meat and its products has increased dramatically in developing countries. This is damaging forests, which in turn would be able to absorb CO2 and mitigate anthropic (man-made) emissions. A vicious cycle that makes agriculture both a victim (given the negative effects of global warming on food supply) and a perpetrator (one of the main causes of climate change).

Most of the time, when agriculture perpetrates its crimes, it isn’t even contributing to feeding the ever-increasing world population. In fact, 95 per cent of the soy produced in the world is consumed by farm animals – mostly bovines – which demonstrates this conflict. Also, according to a study conducted by the Chalmers University of Technology in Goteborg, Sweden this means that producing one kilogramme of bovine meat require 200 kilos of CO2 emissions. There are 700 million pigs in China alone, one for every two citizens, half of the global population of farm pigs. In order to feed these animals, forced to live in cages inside industrial warehouses, Beijing imports 80 million tonnes of soy, especially from Latin America and more specifically from the Brazilian Amazon where endless fields of soy are destroying one of the most biodiverse places in the world. One of the world’s green lungs.
Agriculture and climate change: is agroecology the answer?

The Food and Agriculture Organization (FAO) seems to have a clear idea of what should be done and is promoting sustainable practices in various countries through agroecology. This is a series of social and environmental measures aimed at creating a sustainable agricultural system that optimises and stabilises crop yields. These practices also tackle the effects of climate change, such as desertification and the rise in sea levels, and among them organic agriculture plays an essential role as it respects natural cycles, drastically reducing human impact.

According to the latest Eurostat data, from 2010 to today organic agriculture in Europe has grown by 2 million hectares, reaching a total of 11 million hectares of land (more that 6 per cent of the European total). If we want to continue the comparison with China – which was until recently one of the least evolved countries with regards to organic practices – this type of agriculture occupies 1.6 million hectares and generates 4.7 billion euros, according to data presented by Federbio, the Italian Federation of organic and biodynamic agriculture.

How does agriculture affect the environment? Eating habits matter, especially in Europe

Agriculture and climate change. Concluding our world tour in the Old Continent, the afore-mentioned Chalmers University of Technology in Goteborg points us in a specific direction so that we can meet the CO2 emission reduction targets set by the European Union: we must eat less bovine meat and dairy products. We can’t protect the environment without changing our eating habits. Agricultural industries and intensive farming are in fact responsible for about one quarter of CO2 emissions in Europe.
The Paris Agreement has set a clear objective: limiting the global temperature rise to “well below 2 degrees Celsius”, and to do everything in our power to “limit the temperature increase to 1.5 degrees”. In addition to the impact of energy (we of course can’t ignore the terrible damage caused by fossil fuels combustion), making agriculture and all the activities connected to it sustainable is the answer to win the battle against global warming, as well as accelerate the transition to a healthier and more just society.

Translated by ANDREA CUTOLO

Agriculture in Viet Nam.
The UK becomes the first country in the world to declare a climate emergency

Published on 06 MAY 2019

CAMILLA SOLDATI
LEGGI L’ARTICOLO IN ITALIANO

The UK is the first nation to have officially declared a state of climate emergency. Dozens of local governments all over the world have already done so, and many others will follow suit. We look at what this means, and who has adopted it.

“You can’t solve an emergency without treating it like an emergency”. These are the words of young activist Greta Thunberg, and their simple and direct message resonated clearly when, on the 1st of May 1, the UK Parliament declared an environmental and climate emergency, becoming the first country in the world to do so.

According to the founders of Extinction Rebellion, “the government has to tell the truth by declaring a state of climate and ecological emergency, collaborating with other institutions to communicate the urgent need for change: to stop the loss of biodiversity and reduce greenhouse gas emissions reaching null net emissions by 2025” © Leon Neal/Getty Images
All these movements have been able to join in a call not to arms, but to the conscience of every individual, to
understand that the crises that afflict the climate, environment and planet aren’t just numbers and statistics
predicting future change, but are already happening, even in our back garden. In fact, as UK Secretary of State
for the Environment Michael Gove commented: “While statistics can sometimes be abstract and the impact
can seem distant, we can all know that as individual citizens and as parents that the next generation will face
the consequences if we do not take action now to deal with climate change”.

This can set off a wave of action from parliaments and governments around the globe. Jeremy Corbyn, Labour
Party leader

The hope now is that more and more governments all over the world follow this example, and that along with
the declarations there will also be concrete actions to reduce emissions and protect the planet. Although many
feel it’s only a symbolic gesture, the declaration of a climate emergency is certainly a good starting point.
Because admitting that a problem exists is the first step towards solving it.

Translated by PATRICK BRACELLI
Agriculture both contributes to climate change and is affected by climate change. The EU needs to reduce its greenhouse-gas emissions from agriculture and adapt its food-production system to cope with climate change. But climate change is only one of many pressures on agriculture. Faced with growing global demand and competition for resources, the EU’s food production and consumption need to be seen in a broader context, linking agriculture, energy, and food security.

Image © Javier Arcenillas, Environment & Me/EEA
Food is a basic human need, and a healthy diet is a key component of our health and wellbeing. A complex and increasingly globalised system of production and delivery has developed over time to meet our need for food and for different flavours. In today’s world, a fish caught in the Atlantic might be served within days in a restaurant in Prague alongside rice imported from India. Similarly, European food products are sold and consumed in the rest of the world.

**Agriculture contributes to climate change**

Before reaching our plates, our food is produced, stored, processed, packaged, transported, prepared, and served. At every stage, food provisioning releases greenhouse gases into the atmosphere. Farming in particular releases significant amounts of methane and nitrous oxide, two powerful greenhouse gases. Methane is produced by livestock during digestion due to enteric fermentation and is released via belches. It can also escape from stored manure and organic waste in landfills. Nitrous oxide emissions are an indirect product of organic and mineral nitrogen fertilisers.

Agriculture accounted for 10% of the EU’s total greenhouse-gas emissions in 2012. A significant decline in livestock numbers, more efficient application of fertilisers, and better manure management reduced the EU’s emissions from agriculture by 24% between 1990 and 2012.

However, agriculture in the rest of the world is moving in the opposite direction. Between 2001 and 2011, global emissions from crop and livestock production grew by 14%. The increase occurred mainly in developing countries, due to a rise in total agricultural output. This was driven by increased global food demand and changes in food-consumption patterns due to rising incomes in some developing countries. Emissions from enteric fermentation increased 11% in this period and accounted for 39% of the sector's total greenhouse-gas outputs in 2011.

Given the central importance of food in our lives, a further reduction of greenhouse-gas emissions from agriculture remains quite challenging. Nevertheless, there is still potential to further reduce the greenhouse-gas emissions linked to food production in the EU. A better integration of innovative techniques into production methods, such as capturing methane from manure, more efficient use of fertilisers, and greater efficiency in meat and dairy production (i.e. reducing emissions per unit of food produced) can help.

In addition to such efficiency gains, changes on the consumption side can help to further lower greenhouse-gas emissions linked to food. In general, meat and dairy products have the highest global footprint of carbon, raw materials, and water per kilogramme of any food. In terms of greenhouse-gas emissions, livestock and fodder production each generate more than 3 billion tonnes of CO₂ equivalent. Post-farm transport and processing account for only a tiny fraction of the emissions linked to food. By reducing food waste and our consumption of emission-intensive food products, we can contribute to cutting the greenhouse-gas emissions of agriculture.

**Climate change affects agriculture**

Crops need suitable soil, water, sunlight, and heat to grow. Warmer air temperatures have already affected the length of the growing season over large parts of Europe. Flowering and harvest dates for cereal crops are now happening several days earlier in the season. These changes are expected to continue in many regions.
In general, in northern Europe agricultural productivity might increase due to a longer growing season and an extension of the frost-free period. Warmer temperatures and longer growing seasons might also allow new crops to be cultivated. In southern Europe, however, extreme heat events and reductions in precipitation and water availability are expected to hamper crop productivity. Crop yields are also expected to vary increasingly from year to year due to extreme weather events and other factors such as pests and diseases.

In parts of the Mediterranean area, due to extreme heat and water stress in summer months, some summer crops might be cultivated in winter instead. Other areas, such as western France and south-eastern Europe, are expected to face yield reductions due to hot and dry summers without the possibility of shifting crop production into winter.

Changes in temperatures and growing seasons might also affect the proliferation and the spreading of some species, such as insects, invasive weeds, or diseases, all of which might in turn affect crop yields. A part of the potential yield losses can be offset by farming practices, such as rotating crops to match water availability, adjusting sowing dates to temperature and rainfall patterns, and using crop varieties better suited to new conditions (e.g. heat- and drought-resilient crops).

Land-based food sources are not the only food sources affected by climate change. The distribution of some fish stocks has already changed in the Northeast Atlantic, affecting the communities relying on these stocks throughout the supply chain. Along with increased maritime shipping, warmer water temperatures can also help facilitate the establishment of invasive marine species, causing local fish stocks to collapse.

Some EU funds, including the European Agricultural Fund for Rural Development, Common Agricultural Policy (CAP), and loans from the European Investment Bank, are available to help farmers and fishing communities to adapt to climate change. There are also other funds under the CAP aimed at helping to reduce greenhouse-gas emissions from agricultural activities.
Global market, global demand, global warming…

In line with projected population growth and changes in dietary habits in favour of higher meat consumption, the global demand for food is expected to grow by up to 70% in the coming decades. Agriculture is already one of the economic sectors with the largest environmental impact. This substantial increase in demand will unsurprisingly create additional pressures. How can we meet this increasing global demand while at the same time reducing the impacts of European food production and consumption on the environment?

Reducing the amount of food produced is not a viable solution. The EU is one of the world’s largest food producers, producing around one eighth of the global cereal output, two thirds of the world’s wine, half of its sugar beet, and three quarters of its olive oil. Any reduction in key staples is likely to jeopardise food security in the EU and in the world, and increase global food prices. This would make it harder for many groups around the world to access affordable and nutritious food.

Producing more food out of the land that is already used for agriculture often requires heavier use of nitrogen-based fertilisers, which in turn release nitrous oxide emissions and contribute to climate change. Intensive agriculture and fertiliser use also release nitrates to the soil and to water bodies. Although not directly linked to climate change, high concentrations of nutrients (especially phosphates and nitrates) in water bodies cause eutrophication. Eutrophication promotes algae growth and depletes oxygen in the water, which in turn has severe impacts on aquatic life and water quality.

Whether in Europe or the rest of the world, meeting the growing demand for food by using more land would have serious impacts on the environment and the climate. The areas most suitable to agriculture in Europe are already cultivated to a large extent. Land, especially fertile agricultural land, is a limited resource in Europe and across the world.

Converting forest areas into agricultural land is also not a solution as this process is a source of greenhouse-gas emissions. Similar to many other land-use changes, deforestation (currently occurring mainly outside the European Union) also puts biodiversity at risk, further undermining nature’s ability to cope with climate change impacts (such as absorbing heavy rainfall).
Competing demands

It is clear that the world will need to produce more food and that key resources are limited. Agriculture has high impacts on the environment and the climate. Moreover, climate change affects — and will continue to affect — how much food can be produced and where.

Who gets to produce what and where is a socio-political question and is likely to become more controversial in the future. The global competition for these essential resources, especially with the pending impacts of climate change, is driving developed countries to purchase large patches of agricultural land in less-developed countries. Such land purchases and climate change impacts raise questions about food security in developing countries in particular. Food security is not only a matter of producing sufficient quantities of food, but also of having access to food of sufficient nutritional value.

This complex problem requires a coherent and integrated policy approach to climate change, energy, and food security. Faced with climate change and competition for scarce resources, the entire food system will need to transform itself and be much more resource efficient while continuously reducing its environmental impacts, including its greenhouse-gas emissions. We need to increase yields while reducing our dependence on agrochemicals, to reduce food waste, and to reduce our consumption of resource-intensive and greenhouse gas-intensive foods such as meat.

In doing this, we must also remember that farmers can play a key role in maintaining and managing Europe’s biodiversity. They are also a critical component of the rural economy. Therefore, policy measures to tackle this highly complex problem of food and the environment should take into consideration agriculture’s impacts on the environment and its socio-economic importance for many communities.

Agricultural Biodiversity

- Agricultural biodiversity is a broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agricultural ecosystems, also named agro-ecosystems.
Farming emits greenhouse gases, but the land can also store them.

We can't achieve the goals of the Paris Climate Agreement without managing emissions from land use, according to a special report released by the Intergovernmental Panel on Climate Change (IPCC).

Emissions from land use, largely agriculture, forestry and land clearing, make up some 22 percent of the world's greenhouse gas emissions. Counting the entire food chain (including fertiliser, transport, processing, and sale) takes this contribution up to 29 percent.

The report, which synthesises information from some 7,000 scientific papers, found there is no way to keep global warming under 2°C without significant reductions in land sector emissions.

Land puts out emissions—and absorbs them

The land plays a vital role in the carbon cycle, both by absorbing greenhouse gases and by releasing them into the atmosphere. This means our land resources are both part of the climate change problem and potentially part of the solution.

Improving how we manage the land could reduce climate change at the same time as it improves agricultural sustainability, supports biodiversity, and increases food security.

While the food system emits nearly a third of the world's greenhouse gases—a situation also reflected in Australia—land-based ecosystems absorb the equivalent of about 22 percent of global greenhouse gas emissions. This happens through natural processes that store carbon in soil and plants, in both farmed lands and managed forests as well as in natural "carbon sinks" such as forests, seagrass and wetlands.

There are opportunities to reduce the emissions related to land use, especially food production, while at the same time protecting and expanding these greenhouse gas sinks.

But it is also immediately obvious that the land sector cannot achieve these goals by itself. It will require substantial reductions in fossil fuel emissions from our energy, transport, industrial, and infrastructure sectors.
Overburdened land
So, what is the current state of our land resources? Not that great.

The report shows there are unprecedented rates of global land and freshwater used to provide food and other products for the record global population levels and consumption rates.

For example, consumption of food calories per person worldwide has increased by about one-third since 1961, and the average person's consumption of meat and vegetable oils has more than doubled.

The pressure to increase agricultural production has helped push about a quarter of the Earth's ice-free land area into various states of degradation via loss of soil, nutrients and vegetation.

Simultaneously, biodiversity has declined globally, largely because of deforestation, cropland expansion and unsustainable land-use intensification. Australia has experienced much the same trends.

Climate change exacerbates land degradation

Climate change is already having a major impact on the land. Temperatures over land are rising at almost twice the rate of global average temperatures.

Linked to this, the frequency and intensity of extreme events such as heatwaves and flooding rainfall has increased. The global area of drylands in drought has increased by over 40 percent since 1961.

These and other changes have reduced agricultural productivity in many regions—including Australia. Further climate changes will likely spur soil degradation, loss of vegetation, biodiversity and permafrost, and increases in fire damage and coastal degradation.

Water will become more scarce, and our food supply will become less stable. Exactly how these risks will evolve will depend on population growth, consumption patterns and also how the global community responds.
Overall, proactive and informed management of our land (for food, water and biodiversity) will become increasingly important.

**Stopping land degradation helps everyone**

Tackling the interlinked problems of land degradation, climate change adaptation and mitigation, and food security can deliver win-wins for farmers, communities, governments, and ecosystems.

The report provides many examples of on-ground and policy options that could improve the management of agriculture and forests, to enhance production, reduce greenhouse gas emissions, and make these areas more robust to climate change. Leading Australian farmers are already heading down these paths, and we have a lot to teach the world about how to do this.

We may also need to reassess what we demand from the land. Farmed animals are a major contributor to these emissions, so plant-based diets are increasingly being adopted.

Similarly, the report found about 25-30 percent of food globally is lost or wasted. Reducing this can significantly lower emissions, and ease pressure on agricultural systems.

### Food is lost or wasted along the entire value chain

- **Production:** During or immediately after harvesting on the farm
- **Handling and Storage:** After produce leaves the farm for handling, storage, and transport
- **Processing and Packaging:** During industrial or domestic processing and/or packaging
- **Distribution and Market:** During distribution to markets, including losses at wholesale and retail markets
- **Consumption:** Losses in the home or business of the consumer, including restaurants and caterers

How do we make this happen?

Many people around the world are doing impressive work in addressing some of these problems. But the solutions they generate are not necessarily widely used or applied comprehensively.

To be successful, coordinated policy packages and land management approaches are pivotal. Inevitably, all solutions are highly location-specific and contextual, and it is vital to bring together local communities and industry, as well as governments at all levels.

Given the mounting impacts of climate change on food security and land condition, there is no time to lose.

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Earth's temperature is rising, and it isn't just in the air around us. More than 90 percent of the excess heat trapped by greenhouse gas emissions has been absorbed into the oceans that cover two-thirds of the planet's surface. Their temperature is rising, too, and it tells a story of how humans are changing the planet.

This accrued heat is "really the memory of past climate change," said Kevin Trenberth, the head of climate analysis at the National Center for Atmospheric Research and co-author of a new paper on ocean warming.

It's not just the amount of warming that is significant—it's also the pace. The rate at which the oceans are heating up has nearly doubled since 1992, and that heat is reaching ever deeper waters, according to a recent study. At the same time, concentrations of carbon dioxide in the atmosphere have been rising. The charts that follow show how the oceans are changing and what they're telling us as a thermometer of global warming.

Scientists say the accumulation of heat in the oceans is the strongest evidence of how fast Earth is warming due to heat-trapping gases released by the burning of fossil fuels.

Oceans have enormous capacity to hold heat. So ocean temperatures, unlike temperatures on land, are slow to fluctuate from natural forces, such as El Niño/La Niña patterns or volcanic eruptions. Think night and day, said Trenberth. As night falls on land, so do air temperatures. But in the oceans, temperatures vary little.

This makes it easier to tease out the influence of human-caused climate change from other possible causes of surging ocean heat.
How much extra heat are we talking about? And what are the impacts on the climate system? "On a day-to-day a basis, it's really quite small," Trenberth said, but the cumulative effects are not.

According to research by Trenberth and Lijing Cheng, of the Institute for Atmospheric Physics in Beijing, the heat storage in the oceans during 2015 and 2016 amounted to a stunning force: an increase of 30.4 X 1022 joules of energy roiling Earth's systems since 1960. The overload is helping throw off Earth's energy balance, needed for the climate to be relatively stable. Put another way: The excess energy amassed in the oceans since 1992 is roughly equivalent to 2,000 times U.S. electricity generation during the past decade, the researchers explained. Ocean temperatures have been rising about 0.12 degrees Celsius per decade on average over the past 50 years. The higher temperatures are driving marine life toward the poles in search of livable habitats, bleaching coral reefs, and causing severe impacts on fisheries and aquacultures. They also contribute to more frequent and intense extreme weather events. In the three back-to-back deadly hurricanes of 2017—Harvey, Irma and Maria—warmer waters played a role in worsening the storms.
Though ocean temperature represents a clear signal of climate change, one challenge for researchers is that the record only goes back so far. Since the early 2000s, an international effort called Argo has launched nearly 4,000 ocean-going sensors that gather important data about the oceans, including temperature.
Meanwhile, as oceans heat up, thermal expansion causes sea levels that are already rising from the melting of land ice (triggered by higher air and sea temperatures) to rise even more. Nearly 50 percent of the sea level rise so far has come from ocean warming, according to new work by Cheng and Trenberth. Much of the rest comes from the melting of ice on Antarctica and Greenland.

Ocean warming can impact sea level rise in another way, too. This year has seen extensive losses from Antarctica's ice shelves. "It's most likely because that ice is being undermined through warmer ocean underneath the ice, which is contributing to the thinning of the ice and weakening of the shelf," Trenberth said. The ice shelves themselves are already floating, but they are attached to land and play a critical role in slowing the ocean-bound ice flow from the massive ice sheets behind them. Scientists say the West Antarctic Ice Sheet alone holds enough ice to raise global sea level by about 11 feet.

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CLIMATE SCIENCE
CLIMATE CHANGE

Where is global warming going?

Ocean 93.4%

- Atmosphere 2.3%
- Continents 2.1%
- Glaciers & ice caps 0.9%
- Arctic sea ice 0.8%
- Greenland Ice Sheet 0.2%
- Antarctic Ice Sheet 0.2%
Climate change may not be responsible for the recent skyrocketing cost of natural disasters, but it is very likely that it will impact future catastrophes. Climate models provide a glimpse of the future, and while they do not agree on all of the details, most models predict a few general trends. First, according to the Intergovernmental Panel on Climate Change, an increase of greenhouse gases in the atmosphere will probably boost temperatures over most land surfaces, though the exact change will vary regionally. More uncertain—but possible—outcomes of an increase in global temperatures include increased risk of drought and increased intensity of storms, including tropical cyclones with higher wind speeds, a wetter Asian monsoon, and, possibly, more intense mid-latitude storms.

Global warming could affect storm formation by decreasing the temperature difference between the poles and the equator. That temperature difference fuels the mid-latitude storms affect the Earth’s most populated regions. Warmer temperatures could increase the amount of water vapor that enters the atmosphere. The result is a hotter, more humid environment. At the equator, where conditions are already hot and humid, the change isn’t expected to be large. At the poles, however, the air is cold and dry; a little extra heat and water vapor could raise temperatures greatly. As a result, global warming may cause the temperature difference between the poles and the equator to decrease. and as the difference decreases, so should the number of storms, says George Tselioudis, a research scientist at NASA Goddard Institute for Space Studies (GISS) and Columbia University.
But even as a warming climate might decrease the overall number of storms that form, it could increase the number of intense storms. As temperatures continue to rise, more and more water vapor could evaporate into the atmosphere, and water vapor is the fuel for storms. “If we are creating an atmosphere more loaded with humidity, any storm that does develop has greater potential to develop into an intense storm,” says Tselioudis.

The combined result of increased temperatures over land, decreased equator-versus-pole temperature differences, and increased humidity could be increasingly intense cycles of droughts and floods as more of a region’s precipitation falls in a single large storm rather than a series of small ones. A warmer, wetter atmosphere could also affect tropical storms (hurricanes), but changes to tropical storms are harder to predict and track. Some scientists have speculated that a warmer climate that allows more intense storms to develop would also spawn more hurricanes. Warmer temperatures may also heat ocean waters farther from the Equator, expanding the reach of large tropical storms. But there is little evidence to support the either of these theories, says Kerry Emanuel, a professor of tropical meteorology and climate in the Massachusetts Institute of Technology’s Program in Atmospheres, Oceans, and Climate.

The one way in which global warming could impact hurricanes is by making them more intense. More heat and water in the atmosphere and warmer sea surface temperatures could provide more fuel to increase the wind speeds of tropical storms. Warming that has already occurred since 1980 has increased sea surface temperatures 0.3 degrees Celsius, which should increase the maximum potential wind speed of hurricanes by 1 knot, according to hurricane intensity models. But increases that small could not have been observed yet. “At present, hurricane intensity is measured only to an accuracy of plus or minus five knots, so it is not possible to discern any change that might have occurred owing to warming that has already taken place,” says Emanuel.
Even if tropical storms don’t change significantly, other environmental changes brought on by global warming could make the storms more deadly. Melting glaciers and ice caps will likely cause sea levels to rise, which would make coastal flooding more severe when a storm comes ashore. In their 2001 report, the Intergovernmental Panel on Climate Change stated that global warming should cause sea levels to rise 0.11 to 0.77 meters (0.36 to 2.5 feet) by 2100.
What is Global Warming?

Global Warming is a term denoting a gradual warming of the earth's average temperature. The term has become synonymous to the earth's warming exclusively due to man-made effects (anthropogenic) especially from carbon dioxide. Carbon dioxide concentrations have increased from 300 parts per million from 1900, to 404 parts per million by 2016. The most accelerated increase has been during the past 40 years. Some scientists have drawn the conclusion that the increase in the earth's average temperature (about 1°F since 1975) is essentially solely based on man-made activities such as the burning of fossil fuels, biomass burning, and deforestation. It is interesting to note that during the autumn of 2013, the United Nations confirmed that the earth has nearly stopped warming since 1998. The cause for the drop in the rate of increase is now under study.

Watch our Youtube Climate Change video with meteorologist Rich Johnson

Causes of Global Warming

The earths atmosphere is made up of different gases. Nitrogen makes up 78% of the total composition, oxygen 21%, argon 1% and traces gases .1%. Carbon dioxide makes up most of the volume of the rare gases. Water vapor varies from almost 0% over the deserts to 4% over the oceans. Water vapor, carbon dioxide, methane, nitrous oxide, ozone, and chlorofluorocarbons are the gases of interest since these are greenhouse gases. Greenhouse gases can reradiate heat or trap heat absorbed by the earth from the sun. Water vapor is by far the largest mechanism by percentage for heat retention out of the greenhouse gases, but changes little over time in atmospheric concentrations. Carbon dioxide and other greenhouse gases have been increasing. The largest contributor is China which produces nearly 1/4 of the world's carbon dioxide emissions.

In the past, the earths orbital eccentricity, variance of the tilt and wobble have led to periods of warmer weather. Even though the solar energy from the sun is considered a constant, a slight change could cause temperature fluctuations. Recently, Mars has also shown a decrease in ice coverage without greenhouse gas changes (Fenton, 2007). The cause for the reduction in aerial coverage and possibly warming may be from dust (Kahn, 1992).
In summary, there are four main mechanisms which would cause global warming, or in other words allow for a warming (or even cooling) of the earth's average surface temperature. These are: (1) solar energy variance, (2) gradual changes in the earth's orbit, tilt, and wobble, (3) change in the earth's albedo, and (4) greenhouse gas changes. It is difficult to calculate what percentage of the recent warming could be attributed to human activities. We can eliminate changes in the earth's orbit, tilt, and wobble causing a temperature increase since these are long term effects.

**What are the Effects of Global Warming on Hurricanes?**

There is a common misconception that because the global temperature has increased, hurricanes also must increase in number and intensity. The primary factor in the ability of a hurricane to strengthen or weaken after formation is the wind shear profile of the atmosphere - not ocean water temperature. Another major factor is the amount of moisture in the lower and middle atmosphere. It has been warm enough in the tropics to produce hurricanes for a very long time. The temperature for tropical cyclone formation equates to a sea surface temperature of about 80°F (26.5°C). If the behavior of hurricanes are studied, cases can be found where hurricanes have strengthened over cooler water and have weakened over warmer water. There maybe a small "boost" to a hurricane's strength as it moves over the Gulf Stream if upper air wind profiles do not change much. Some of the computer generated hurricane models have this bias built in and will rapidly strengthen a tropical cyclone if predicted to go over a warm pool of water.

The recent upturn in tropical cyclone activity was predicted long before Global Warming became a household name. Tropical cyclone activity in the tropical north Atlantic has been known to vary in cycles and an increase was anticipated. For the 20th century, there were nine tropical storms of which five became hurricanes on average. Since 1995, there has been a marked increase to fifteen tropical storms of which eight became hurricanes on average. The 2013 season showed a slow down in numbers of tropical cyclones. In fact, only two hurricanes formed. This is the lowest number since 1982. Looking at the past century, there were other active periods such as the early to mid 1930's. In general the 1930's through the 1960's were an above average period.

Other considerations should take into account medium to long-term atmospheric - oceanic processes. ENSO is a well know process that has distinct effects on north Atlantic tropical cyclone activity. Kelvin waves and the Madden-Julian Oscillation are also currently being studied on their affects of tropical cyclone activity. The PDO or Pacific Decadal Oscillation also may be connected. There are many different types of waves or oscillations in the atmosphere and ocean. There is much research to be done on how these processes contribute to tropical cyclone formation and intensification.
The Effects of Global Warming on Hurricanes: Summary

There has been a noted increase in the number of hurricanes in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico since the mid-1990's. The long term average is that nine tropical storms will form per year, of which about five will become hurricanes. Since the mid-1990's the average has been fifteen tropical storms, of which eight became hurricanes. There has also been an upward trend in the concentration of the greenhouse gas carbon dioxide in the atmosphere and oceans due to man's activities over the past 100 years. During this time, hurricanes have gone through cycles where they have been more numerous, such as the cycle that we are experiencing now. Some scientists have drawn a one to one correlation between the earth's temperature increase and the number of hurricanes and their intensity. As it was noted, the number one factor in tropical cyclone intensity is related to the atmospheric wind shear profile. Research is not conclusive that a small increase in the earth's temperature would correlate with increased intensity and number of tropical cyclones. If the current trend of above average tropical cyclone activity were to continue for a considerably longer period, only then could the conclusion be drawn that warmer temperatures have played some part to cause an increase in tropical cyclone formation.
As if pesticides, disease and habitat loss were not enough, there’s more bad news for bees. Changing temperature and weather conditions due to climate change has restricted the area where bees can survive, and the pollinators have struggled to adapt, according to new research published in the journal Science.

“They just aren’t colonizing new areas and establishing new populations fast enough to track rapid human-caused climate change,” said study author Jeremy Kerr, a professor at the University of Ottawa, on a call for journalists. “Impacts are large and they are underway. They are not just something to worry about at some vague, future time.”

For the study, researchers looked at 110 years of data on 67 bumblebee species to track their movements over time. Activity between 1901 and 1974 was compared to movement in recent decades when climate change accelerated. In the northern end of their range, bees have failed to migrate closer to the North pole. In the southern end, many populations have died. Altogether, bees have lost a range of up to nearly 200 miles in both North America and Europe. The study, which evaluated land use changes and pesticide application in addition to weather conditions, attributed the drop to climate change.

The landmark study adds to scientists’ understanding of how different species respond to climate change. Many animals—like the butterfly—have adjusted to a changing climate by migrating towards the Earth’s poles. But the research on bees suggests that not all species have the same ability to adjust. Though bees can easily move from location to location, researchers suggested the migration may not have occurred because they have trouble setting up a home in a new place.
“This paper is important because it reinforces our understanding that species will not all be able to shift their ranges in order to adapt to a changing climate,” said Sacha Vignieri, an associate editor for the journal *Science*. “It provides important insight into further potential stressors to bee populations, which are already generally declining and under significant threat.”

While climate change threatens many species, bees and other pollinators have received special attention at least in part because of the important role they play in agriculture. The White House, along with environmental groups, has been a particularly strong advocate, calling for an increase in the size of pollinator habitats. Bees add $15 billion in value to the U.S. agricultural sector by pollinating fruits, nuts and vegetables, according to the White House.

**Impact of Climate change on pollinators:**

- Climate change affect the phonology, local abundance and large scale distribution on plants and pollination. Insect pollinated plants react more strongly to increased warming than wind pollinated plants.

- Quantum of pollination decrease as there is disruption of natural synchronization between the flower opening and visit of the pollinators like honey bees, wasps and butterflies.

- Increasing spring temperatures may decrease flower abundance and affect the relative abundance of pollinator species. Recent study says that for every one degree celsius rise in temperature there will be 14% loss in butterfly population.
Climate change is doing "widespread and consequential" harm to animals and plants, which are struggling to adapt to new conditions, according to a major report released Monday.

The report, from the UN's Intergovernmental Panel on Climate Change (IPCC), finds that many life-forms are moving north or into deeper waters to survive as their habitats shift.

They're also being forced to change their behaviors. For instance, many birds are nesting, breeding, and migrating earlier as spring arrives sooner than before. (Related: "Ten U.S. Species Feeling Global Warming's Heat.")

"Evidence of climate change impacts is strongest and most comprehensive for natural systems," the report said. (See: "New Climate Change Report Warns of Dire Consequences.")

Current research suggests that winners in this transformation will be adaptable species that are expanding their ranges, including many weeds and pests, and also cold-sensitive, invasive species like the Burmese python in Florida, said Peter Alpert, a program director in environmental biology at the U.S. National Science Foundation in Arlington, Virginia.

The losers, Alpert said, will likely be the species that are highly specialized in what they eat or where they live, especially those whose habitats disappear completely.

That might include species such as koalas, which depend mainly on eucalyptus for survival, and the many animal and plant species that live only on isolated mountaintops.

"You have to hope that they can change fast enough to keep up with it," he said. "Species have experienced swings like this in the past, but [the changes] have probably taken a thousand times longer."
Bob Scholes and Hans-Otto Pörtner, both IPCC authors who contributed to the report's ecosystems chapters, agreed, in a joint statement to National Geographic, that the current human-made climate change is happening much faster than in the past. (See a map of global warming's effects.)

Scholes, a systems ecologist at the Council for Scientific and Industrial Research (CSIR) in Pretoria, South Africa, and Pörtner, an animal physiologist and marine biologist based at the Alfred Wegener Institute in Bremerhaven, Germany, highlighted six species that are already in decline due to climate change:

Orange-spotted filefish (Oxymonacanthus longirostris). The filefish dwells in coral reef habitats, on which it is totally dependent, and which themselves are declining in part due to climate change. In addition, the orange-spotted filefish is highly sensitive to warm water: The animal went extinct in Japan during an episode of warmer ocean temperatures in 1988.

- Quiver tree (Aloe dichotoma). This succulent tree is endemic to (and emblematic of) the arid west of South Africa and Namibia. Chapter Four of the fifth IPCC report "shows, for the first time, that the rate of climate change can be just as important for species survival as the magnitude, and that trees are the most vulnerable to rapid change," Scholes said. A well-studied species, the quiver tree is unable to grow and disperse quickly enough to keep up with a fast-changing climate. (Related: "Rain Forest Plants Race to Outrun Global Warming.")
Polar bear. The large predator's story is well known: The Arctic sea ice on which the animals hunt is progressively disappearing during the summer. Sea ice is forming later in the fall and disappearing earlier in the spring. "As the Arctic sea ice retreats, polar bears have to exploit alternative food sources, such as on land," the scientists said, and some hungry polar bears have turned to goose eggs. But it's not the best alternative, Steven Amstrup, chief scientist for Polar Bears International, noted in a previous story. "Some media reports have suggested that this might mean polar bears could just come ashore and eat terrestrial foods and somehow do fine without the sea ice," Amstrup said. "We have absolutely no evidence that they have the ability to do this." (Read "On Thin Ice" in National Geographic magazine.)

Adélie penguin. These Antarctic birds mostly live on tiny crustaceans called krill. Krill live on the undersides of ice sheets, where they find refuge and algae as food. But as Antarctic sea ice retreats, krill populations are falling—meaning that the penguins have to migrate farther to find food. Spending a lot more energy to find food makes penguins less successful at breeding and raising young, the scientists said.
North Atlantic cod. Overfishing has historically caused numbers of this fish to plunge, but its populations usually bounce back. Not so off the northeastern coast of North America, where populations have not recovered since crashing in the 1990s. "The entire ecosystem seems to have changed," the scientists said, and "this may involve a climate influence due to changing ocean currents and the influx of cold Arctic waters." (Read more about overfishing's impact on New England cod.)

- *Acropora cervicornis* and coral worldwide. This reef-building animal "is in decline almost everywhere, for a combination of reasons," said Pörtner, including warming waters—coral are sensitive to changes in ocean temperature. Acropora cervicornis, for instance, used to be widespread in the Caribbean but is now restricted to a few small areas, likely due to warming. (Read more about coral and global warming.)
• **EXTINCT**: Golden toad (Bufo periglenes). Along with the Monteverde harlequin frog (Atelopus varius), also of Central America, the golden toad is among the very small number of species whose recent extinction has been attributed with medium confidence to climate change, according to Scholes and Pörtner. Last seen in 1989, the golden frog lived in mountaintop cloud forests that have disappeared due to drought and other climatic changes. Other confounding factors are involved, such as the deadly chytrid fungus, which has killed off many amphibians worldwide. (See: "Photos: Ten Most Wanted 'Extinct' Amphibians.")

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**CAUSES AND EFFECTS OF CLIMATE CHANGE**

What causes climate change (also known as global warming)? And what are the effects of climate change? Learn the human impact and consequences of climate change for the environment, and our lives.

**Radical Action Needed**

Trying to slow the rate of climate change "is critical for the future of many species," Scholes and Pörtner said.

"To spare many thousands of species, not only do we need to radically reduce greenhouse gas emissions, but we also have to do it soon," they said.
Potential climate change solutions include making vehicles, homes, and buildings more energy efficient and increasing wind and solar power, hydrogen produced from renewable sources, and other alternative energies.

Meanwhile, the world can "greatly assist by reducing the other pressures facing species, principally habitat loss, overharvesting, and pollution; and by ensuring that species have unimpeded pathways for movement."
As the world warms, extreme weather events are becoming more frequent and intense, sea levels are rising, prolonged droughts are putting pressure on food crops, and many animal and plant species are being driven to extinction. It’s hard to imagine what we as individuals can do to resolve a problem of this scale and severity.

The good news: We are not alone. People, communities, cities, businesses, schools, faith groups and other organizations are taking action. We’re fighting like our lives depend on it — because they do.

In a world of more than seven billion people, each of us is a drop in the bucket. But with enough drops, we can fill any bucket.

David Suzuki

TEN WAYS YOU CAN HELP FIGHT CLIMATE CHANGE

1. Demand climate solutions this election

On October 21, Canadians will vote in a federal election. This is a key moment for climate action in our country. We must elect a government that will take bold action to reduce emissions, prepare for climate change and build a strong, diverse, equitable and clean economy.
Start by sending a letter to all party leaders and the candidates in your riding, telling them that your vote depends on bold action. Up until the election, you can also call or visit your candidates, volunteer for a candidate or organization that you support and talk to friends and family about the importance of voting for climate action.

On election day, show your support for climate solutions by voting for a party with a strong and credible climate action plan.

2. Use energy wisely — and save money too!

Canada is the top per-capita energy consumer in the world! By becoming more energy-efficient, you not only pollute less but save money too.

Consider making some or all of these small changes. Together, they can really add up.

- Change to energy-efficient light bulbs
- Install a heat pump in your home. Heat pumps work by extracting heat from one location and transferring it to another
- Unplug computers, TVs and other electronics when you’re not using them
- Wash clothes in cold or warm water (not hot)
- Hang-dry your clothes when you can and use dryer balls when you can’t
- Install a programmable thermostat
- Look for the Energy Star label when buying new appliances
- Winterize your home to prevent heat from escaping and try to keep it cool in the summer without an air conditioner
- Get a home or workplace energy audit to identify where you can make the most energy-saving gains

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<th>10 SIMPLE WAYS TO USE ENERGY WISELY</th>
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<td>Turn off lights</td>
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<td>Use energy saving light bulbs</td>
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<td>Use natural light, heat and cooling</td>
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<td>Shut off computers.</td>
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<td>Unplug your phone charger when not in use</td>
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<td>Talk to your parents about Home improvements (windows, doors, etc)</td>
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<td>Talk to your parents about programmable digital thermostats</td>
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<td>Talk to your parents about ENERGY STAR appliance</td>
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<td>Use “Smart” Power Strips.</td>
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3. Get charged up with renewables

The global push for cleaner, healthier energy is on. With costs dropping every day, renewable energy is the best choice for the environment and the economy.

People throughout Canada are leading the renewable energy transition, making a big difference in towns, cities and rural areas. You can, too!

Start by sending a message to Canada’s federal party leaders, telling them you want to see Canada get charged up with renewables.

4. Eat for a climate-stable planet

The decisions we make about food can have a profound effect on the environment. Here are four simple ways you can make your diet more climate-friendly.

- Eat more meat-free meals
- Buy organic and local whenever possible
- Don’t waste food
- Grow your own

Get more info on how to eat for the climate and how eating less meat will reduce Earth’s heat.

**Fun fact:** You can also help save the planet by eating insects!

5. Start a climate conversation

Although most of us believe climate change is a crucial issue that must be tackled immediately, we’re also reluctant to talk about it, even with friends and family. Conversations about climate change can bring up all kinds of difficult emotions.

And yet, solving climate change will require us all to work together, and we can’t do that without communicating effectively. It’s time for us all to have more climate conversations.

Start by asking one person you’re close to how climate change has affected them. Listen to their thoughts and stories, then share your own.
6. Green your commute

In Canada, transportation accounts for 24 per cent of climate-polluting emissions, a close second to the oil and gas industry.

The many ways to reduce your transportation emissions will also make you healthier, happier and save you a few bucks. Whenever and wherever you can:

- Take public transit
- Ride a bike or advocate for bike lanes in your community
- Car-share
- Switch to an electric or hybrid vehicle
- Fly less (if you do fly, make sure you offset your emissions)

7. Consume less, waste less, enjoy life more

“We use too much, too much of it is toxic and we don’t share it very well. But that’s not the way things have to be. Together, we can build a society based on better not more, sharing not selfishness, community not division.” — The Story of Stuff

Focusing on life’s simple pleasures — spending time in nature, being with loved ones, making a difference to others — provides more purpose, belonging and happiness than buying and consuming. Sharing, making, fixing, upcycling, repurposing and composting are all good places to start.

Fire up your commitment to the people and places you love by acting every day on the understanding that we are one with nature.

8. Invest in renewables and divest from fossil fuels

Even if you can’t install solar panels or a wind turbine, you can still be a part of the clean-energy economy. Search online for local renewable energy co-ops to join. As a member, you’ll own part of the co-op’s renewable energy projects and will receive a return on your investment. You can also speak to your financial adviser about clean energy/technology investments.

Let industry know you care about climate change by meeting with your bank or investment adviser to make sure your investments do not include fossil fuels. And make sure your workplace, pension fund or university doesn’t invest in fossil fuels either. If they do, join or start a divestment campaign.

Learn more about why it’s important to divest from damage and invest in a healthier future.
9. Help put a price on pollution

A price on carbon is one of the most important pillars of a strong climate policy. Carbon pricing helps make polluting activities more expensive and green solutions relatively more affordable, allowing your energy-efficient business and/or household to save money!

Most market economists agree that pricing carbon is an efficient and business-friendly way to reduce emissions. The federal government is working with the provinces and territories to put a national price on carbon, but they need your support.

10. Get politically active and vote

Although it’s important to take action to reduce our individual carbon footprints, we also need to focus on changing the larger system. That’s where we have the greatest opportunity to reduce emissions.

Vote for leaders at all levels of government who take climate change seriously. They should commit to setting science-based targets to reduce harmful carbon emissions, implementing clear plans to reach those targets, adapting to climate change and shifting to a clean-energy economy.

Make sure you are registered to vote and then get informed for all elections — not just the ones that get the most media attention. Candidates’ positions on climate change vary widely, so research the parties, ask questions about climate change at town halls or debates and let your candidates know you are voting for the climate. Know that your vote really matters.

If you’re too young to vote, encourage your class or school to join a Student Vote program, which provides students the opportunity to experience participation in the election process. You can also talk to your parents about the importance of voting for climate action.
Pollution, greenhouse gasses, plastic production, microplastic, and more have turned out to be a sickly concoction for the Earth. This has resulted in melting glaciers, rising seas, global warming, superstorms, extinction of species, and many other horrific natural consequences.

In addition to squandering the beautiful nature around us, climate change has directly impacted the lives of families across the globe. Climate change causes dangerous, extreme weather, health hazards, and economic instability. Without major changes and quick action, these consequences will only worsen over time.

**How Does Climate Change Affect Families**

According to Climate Council, there are three major ways that climate change can affect families now and in the future. Each one of these impacts has the potential to negatively change families’ lives, and they can cause chain reactions to each other. Preventing or even helping to decrease climate change can spare families from catastrophic events that will stem from these impacts.

**Ecological Effects**

The first are physical and ecological impacts, which include heat waves, droughts, fires, and supercharged storms. While the coined phrase “global warming” implies that climate changes will be comprised exclusively of higher temperatures, climate change can actually manifest as any major change in climate patterns.

Some examples of major climate change in the U.S. include the rising temperatures in the east, more frequent and intense storms in the midwest, and outrageous wildfires burning through the west. These changes arise directly from the worldwide pollution that not only contributes to climate change, but it affects human health negatively.
Human Health Impacts

This brings us to the next major way that climate change affects families: human health impacts. This encompasses infectious diseases, decreasing nutrition, injuries, damage to infrastructure, and job loss.

Recently, scientists have caught on to one of the first major diseases caused by climate change. In South America, there has been a surge of chronic kidney disease cases that have been linked to climate change. This is primarily due to farmers working under the hot sun without access to water. Some rely on soda for hydration, which results in kidney stones and chronic damage. Scientists have found impacts of the same disease from the same cause in regions of India, Southeast Asia, and the southern U.S.

Social and Economic Effects

Lastly, there are social and economic impacts, such as conflict, war, displacement, damage to infrastructure, and job loss. One example is the refugee crisis in Syria. The worst drought on record in the country, lasting from 2006 to 2011, contributed to the situation, causing a food shortage and exacerbating rising tensions.

Now, although some Syrians are starting to reenter the country, projections show that the country will lose over half of its agricultural capacity in the next 30 years. By now, climate change is impacting almost everyone in the world in some way. Even those who are not directly impacted by extreme climate change may be paying tens of thousands of dollars in their lifetime due to its effects. This is money that not all families can afford, and money that could otherwise be put to other means like housing, healthcare, and so on.

Action to Protect Families

The effects of climate change will only intensify dramatically, potentially displacing many families, harming children’s health, or destroying their homes. It can be scary to think of the future with such catastrophic projections in sight, but it’s not too late to make the necessary changes to save the planet. While people can collectively work to adopt more environmentally-friendly habits, change needs to happen at a higher level.
For example, the Carbon Majors Report found that only 100 companies are responsible for over 70 percent of greenhouse gas emissions since 1988. While this data is alarming, it points in the direction of where we need to take action. If major businesses were more strictly regulated for their pollution emissions, greenhouse gas could be significantly cut down.

For this to happen, politicians across the world would have to ban together to protect the planet and enforce comparatively strict regulations to large businesses.

In addition, political administrators face the responsibility of making positive changes to reverse some of the effects of climate change. According to the University of Reno, Nevada, there are many possibilities for change that public administrators can embrace to face climate change:

Whether it’s working to reinforce public infrastructure to deal with widespread disease outbreaks, chronic conditions like allergies or Lyme or food and water shortages, public health is positioned to become an ever more vital occupation, at the crossroads of human development in response to environmental challenges.

Another industry that is positioned to affect mass change is the tech industry. For instance, advances in civil engineering can provide solutions to provide clean water. Projections for water shortages show that by 2050, 71 percent of counties in the U.S. could be in a water shortage.

Civil engineers are working to find solutions for these future problems, including:

- Desalination: the process of taking salt water and turning it into drinkable water.
- Waste water: recycling wastewater into drinking water.
- Upgrading the water infrastructure: Investing in water and wastewater treatment and infrastructure.
- Agricultural irrigation: using precision technology to increase efficiency.
While many of these technological advances are important for water efficiency, it is important to work on preventing water emergencies where possible. As with other climate change issues, we should spend more time and energy on **fixing current problems**, as well as preventing and minimizing future issues. This is the only way we can begin make changes to slow climate change and protect the future for our children.

With about half of the country still suffering from extreme drought, farmers and businesses in the Western United States are looking at another hot, dry summer.

And the country’s water risk is a lot worse than most assessments suggest, according to a recent study from the Columbia University Water Center.

Taking into account past patterns of drought and water use, the Columbia study reveals that several major metro areas, including New York City, Washington, D.C., and Los Angeles, are at high risk for water scarcity, along with the Great Plains agricultural belt extending from North and South Dakota down to North Texas.
Global Hunger Is Threatening Families Because of Climate Change

By Siddharth Chatterjee
Inter Press Service

Siddharth Chatterjee is the United Nations Resident Coordinator to Kenya

NAIROBI, Kenya, May 15 2019 (IPS) - There is barely a corner of human life that will not be affected by climate change, and some of its impacts are already being felt. Consider this, 821 million people are now hungry and over 150 million children stunted, putting the hunger eradication goal, SDG 2, at risk. Today 15 May, is the United Nations International Day of Families and the theme for this year is, ‘Families and Climate Action’.

The wellbeing of families is central to healthy societies, but is threatened by climate change, especially in the poorest parts of the world.

Across the world what we understand by ‘family’ takes many forms, but it remains the fundamental unit of society. It is where from our earliest days we learn to share, to love, to reason, to consider others, to stand up for ourselves and to take responsibility.

But families face challenges on many fronts and – particularly in the developing world – climate change is perhaps the greatest of these as it is exacerbating hunger and food insecurity.

The focus on families and climate has most resonance in Africa, where it is estimated that climate change could reduce yields from rain-fed agriculture by 50 percent by 2020, jeopardizing the welfare of seven in ten people who depend on farming for a living.
“Environment is the foundation of development,” said Kenya’s President, Uhuru Kenyatta when he launched the government’s 1.8 billion tree-planting campaign in May 2018.

When crops are wiped out by flood or drought, families are robbed of livelihoods and food security. Parents who are already financially vulnerable then struggle to meet the costs of housing, feeding and schooling their children, and of paying for medicines when they are sick.

The greatest killers of children – malnutrition, diarrhoeal disease and malaria – will worsen because of climate change. Children living in developing countries face the greatest risks of all, not always because climate change effects will be worse there than in other countries, but because poverty limits their ability to respond.

Nowhere is this truer than in Bangladesh, with its overwhelmingly young population and almost unparalleled vulnerability to the repercussions of a changing climate. A recent report by UNICEF looked at the impact of climate change on families and children in Bangladesh.

“Climate change is deepening the environmental threat faced by families in Bangladesh’s poorest communities, leaving them unable to keep their children properly housed, fed, healthy and educated,” said UNICEF Executive Director Henrietta Fore, who visited Bangladesh in early March 2019.

Increased competition for dwindling natural resources results in political instability, social upheaval, conflicts, forced migration and displacements and once again, children are the main victims. Forced from their homes, many are denied an education, further denting their prospects and threatening social and economic development in some of the poorest areas of the world.

An FAO study says that almost 57% of Kenya’s population lives in poverty, particularly female headed households who are largely reliant on climate-sensitive economic activities including rain fed subsistence or smallholder agriculture.
With Kenya’s considerable advances in mobile technology penetration, important information can be delivered to agricultural actors along the value chain, including weather information and availability and prices of inputs.

With proper investments and policy, Kenya’s youth can spur the transformation of agriculture from subsistence, hit-or-miss propositions to robust commercial operations that can withstand the effects of climate change.

Africa’s biggest threat from climate change will remain the inter-generational downward spiral into deeper poverty that is brought on by decreased farm yields.

Increasing resilience to climate-related shocks in Africa’s agriculture will result in a rise in farm productivity. It will mean women, who make up the largest share of the continent’s small-holder farmers, will have better incomes. Women allocate more of their income to food, health and education for their families, therefore it would also translate into greater gains for children and future generations.

An initiative from the Anglican Development Services-Eastern and the Alliance for a Green Revolution in Africa is encouraging farmers to diversify to drought-tolerant crops such as millet, sorghum and green grams.

Ending hunger and poverty is the prime mission of the UN’s Sustainable Development Goals, and will demand dramatic shifts in what and how we consume, and above all it will demand cooperation and collaboration on a regional and global scale.

It will not be easy, but for the sake of every family, everywhere, we cannot fail.
Climate change is an ever-looming topic in the news. It can be hard to go a week without hearing reports of droughts, fires, natural disasters and extreme weather patterns, all of which scientists and meteorologists attribute to the growing effects of climate change. From rising sea levels and melting ice caps to increased storms around the globe, the impacts of global warming are constantly before our eyes.

Climate change affects more than just the weather around us. While climate change begins by causing massive shifts in global weather patterns, these shifts have ripple effects throughout other facets of our lives and the natural world. These weather patterns influence the growth of crops and can cause crop losses, which in turn can affect food supplies. Rising sea levels can affect coastal cities, which can lead to huge numbers of displaced people. But did you know that another of climate change’s far-flung effects is the impact these fluctuating weather patterns have on the pests in your home and yard?

Today, we want to explain how global warming and the growing effects of climate change are causing massive shifts in the insect world, and how these changes may already be affecting you.

It’s easy to see how things like temperature, sea level and abnormal weather patterns are the result of global warming. What’s less immediately clear is how these weather-based phenomena might have an impact on the insect population. Let’s take this opportunity to break it all down. What is the impact of global warming on pests?

Most pests are more prevalent in warm climates. Whether we’re talking about ticks, ants or cockroaches, one thing they all have in common is that they love higher temperatures. Because insects can’t control their own body temperature, their internal temperature mirrors that of the environment around them. For their own survival, they tend to seek out warmer climates and avoid those with cold weather. This means that in the past, there have been plenty of regions around the world that most pests simply avoided, as they were too cold to make a comfortable insect habitat.

As the planet heats up and more parts of the globe become temperate regions or even heat zones, this creates more places for insects to live and reproduce. This changing climate results in insect species overrunning areas they might previously never have visited, extra generations being born during the long hot seasons and insects that grow larger due to the more favorable conditions. All of these factors contribute to the growing problem — that the populations of many insects and pests are rapidly increasing as a result of climate change.
Here are just a few of the effects of climate change on insects that we’ve begun to experience that factor into this population growth.

**High Winter Survival Rates:** While temperature fluctuations may lead to harsh winters in certain locations, the overwhelming trend across the planet is toward milder winters. These lower temperatures and warmer conditions create a climate that allows far more insects to survive over the winter. This means that while winter has traditionally represented a season-long respite from insect pests, this is no longer true. Now, some insects are known to survive the winter with little difficulty, allowing them to live longer and cause trouble all year round.

**Spread Towards Previously Cooler Climates:** As traditionally colder climates begin to warm up, bugs start to flood into these areas. These migration patterns present a problem not only because they lead to wider insect populations worldwide, but also because they introduce new species into areas that may not be equipped to deal with them.

**Worsened Impact on the Crops and Human Population:** As bugs move into previously untapped areas, they discover new crops — and can devastate entire fields. Similarly, these bugs may be more likely to infest buildings, yards and vehicles as they encroach upon new territory.

**Increased Size Due to Favorable Conditions:** In years past, bugs have typically died off before they ever had the chance to grow to significant sizes. Now, the current conditions are ideal for allowing bugs to grow larger than perhaps ever before. Insects love the warmer temperatures since these conditions help them live longer, eat more and stay healthier, all of which increase the odds that these pests will grow to reach unusually large sizes.

**Increased Resistance to Insecticides:** As warmer temperatures increase insect populations, insects’ natural ability to resist insecticides grows, too. Combine this with the migration of insects into areas unprepared to deal with them, and it’s a recipe for the spread of insects along with fewer effective ways to control them.

**More Generations Born:** The longer the warm seasons last, the more opportunities insects will have to breed, leading to increased populations worldwide. These additional generations, in turn, create more additional generations, leading to an insect population that continues to increase exponentially.

The increased insect population is not the end of the story, however. While most of us would see this as an unpleasant reality in and of itself, there are farther-reaching consequences of this growing trend. As insect populations rise, so too does the extent of the diseases they spread. Lyme disease, for instance, which is a condition spread by ticks, has tripled in the number of reported cases in the U.S. since the late 1990s.

In addition to the spread of disease, crops are suffering worldwide as insects spread into areas that previously had no encounters with the bugs in question. Even in regions that are used to dealing with a specific pest, the increasing numbers of the pests means they can still destroy crops and cause damage in many different industries.

**Which Pests Are Affected by Climate Change?**

Not every single insect is enjoying the effects of climate change. Bees, for instance, have received plenty of news coverage regarding their declining populations and the problems that will result from their dwindling numbers. Nevertheless, there are still plenty of insects, pests and bugs that are thriving as they experience the results of climate change.
These are just a few of the major pests that are spreading and thriving due to climate change.

1. **Mosquitoes**

   Mosquitoes are a nuisance under the best of circumstances. Even if they aren’t spreading disease, they’re busy buzzing in your ears and leaving itchy bites on your arms and legs. But they’re also capable of much worse. Mosquitoes are known spreaders of multiple dangerous and deadly diseases, including but not limited to yellow fever, West Nile, Zika, dengue viruses and malaria. While these diseases are a problem in any climate, they’re particularly severe in urban areas where mosquitoes thrive with no natural predators and an abundance of food sources.

   Mosquitoes love warm and wet climates, meaning that climate change is creating excellent conditions for this pest to rapidly spread and reproduce. Female mosquitoes lay their eggs in stagnant water, where they eventually hatch and feed on the organic material found in the water. Once they reach adulthood, these mosquitoes may live for no more than a week in less-than-ideal conditions. When presented with conditions like those created by climate change, they can live up to several months, during which time they lay eggs every several days. This increased lifespan leads to an exponential increase in the global mosquito population.

2. **Ticks**

   Ticks may not be as irritating in the moment as a mosquito, which constantly makes itself known through buzzing and biting. By contrast, ticks are so small and unobtrusive that it isn’t uncommon for people to not even realize one has latched on. This unobtrusiveness is part of what makes them so dangerous. Ticks spread detrimental illnesses like Lyme disease and tick-borne spotted fever, all without you ever realizing they were there in the first place.

   Ticks will live for about four years before they complete their life cycle, although in typical cases, not many ticks reach their full adulthood. This is because ticks need to find a host before grow into each new phase of life. As many ticks fail to locate the required hosts, they die off. This naturally keeps the tick population under control. But as rising temperatures allow ticks to move into previously uninhabitable regions, the chance to find hosts increases — which leads to higher populations of ticks and greater spread of these tick-carried diseases.
3. Cockroaches

No one wants cockroaches in their home. Not only are these pests frightening, but they’re also unhygienic and have been known to spread conditions such as salmonella. These insects are extremely tough, however, as they come with a built-in defense mechanism that helps them survive virtually anything the natural world can throw at them. They love a warm, dry climate, so climate change is creating the perfect environment for these insects to grow and thrive.

Cockroaches can reproduce multiple times throughout their life cycle, so the longer they live, the more eggs they’re likely to lay. By extension, this means that the better conditions become for cockroach populations, the greater the population will increase, leading to more infestations worldwide.

4. Ants

There are so many different species of ants that it can be difficult to speak about them as a collective, as each sub-species has its own characteristics. It’s worth noting, however, that they’re present in almost every climate on the globe. How do they achieve this? It has to do with how resilient they are and how good they are at filling ecological gaps. As other species die out, ants increase in population since there are more resources for them to consume.

In addition to their ability to survive in virtually every climate on earth, one of the reasons ants are so resilient is because of the sheer numbers with which they reproduce. Therefore, it should come as no surprise that the farther ants spread and the fewer natural predators they encounter, the greater their numbers will continue to grow over time.
5. Bed Bugs

Bed bugs don’t spread disease in the same way that ticks or mosquitoes do. But they will bite, leaving itchy sores that can grow infected and that are extremely unpleasant to deal with. They’re also tricky to get rid of once they’ve decided they want to live in your home. It typically takes a pest control specialist to do the job. How are they being affected by climate change? It’s simple. Bed bugs thrive in warm weather. As winters grow milder and shorter and warm seasons stretch on for longer, this inevitably means the bed bugs are going to be enjoying longer and longer reproductive seasons. Where a typical year can produce as many three generations, longer summers mean this number grows even larger, leading to higher bed bug populations worldwide.

As the effects of global warming and climate change become more apparent with every passing day, the odds of insect infestations in homes and businesses are always increasing. Have you recently noticed ants or bedbugs in your home? Are you dealing with cockroaches or other pests? If so, then you’re not alone.

"GOODNIGHT, SLEEP TIGHT, DON'T LET... OH, YOU KNOW THE REST."
Some 540 million people depend on fisheries and aquaculture as a source of protein and income. For 400 million of the poorest of these, fish provides half or more of their animal protein and dietary minerals. Yet, more must be done to understand and prepare for the impacts that climate change will have on world fisheries and aquatic ecosystems.
The plethora of effects related to climate change involving, besides climate, oceans, coasts and freshwater ecosystems, are bound to affect fisheries and habitats together with the composition and location of production and will have major impacts on aquaculture productivity and security.

Climate change imperils the structure and function of already stressed coastal aquatic ecosystems. Estuaries, coral reefs, mangroves and sea grass beds are critical for production of wild fish. In freshwater systems, ecosystem health and productivity is linked to water quality and flow and the health of wetlands.

Small wild fish like anchovies and sardines are sensitive to changes in ocean conditions. They are found in schools in the ocean and are also processed into fishmeal used to feed other fish (aquaculture) as well as poultry and pigs.

Though precise consequences cannot yet be forecast, climate change is likely to affect fisheries and aquaculture, their dependent communities and related economic activities along three main pathways:

1. indirect wider socio-economic effects (e.g. fresh water use conflicts affect all food production systems, adaptation and mitigation strategies in other sectors impact aquatic systems in general or fisheries and aquaculture directly);
2. biological and ecological responses to physical changes (e.g. productivity, species abundance, ecosystem stability, stock locations, pathogen levels and impacts); and
3. direct physical effects (e.g. sea level change, flooding, storm impacts).
Fishers, fish farmers and coastal inhabitants will bear the full force of these impacts through less stable livelihoods, changes in the availability and quality of fish for food, and rising risks to their health, safety and homes. Many fisheries-dependent communities already live a precarious and vulnerable existence because of poverty, lack of social services and essential infrastructure. The fragility of these communities is further undermined by overexploited fishery resources and degraded ecosystems. The implications of climate change for food security and livelihoods in small island states and many developing countries are profound.

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*Climate change will drive species northward.*
Introduction

Thanks very much for the introduction. I am honoured to be here today, speaking to two of North America’s most progressive museum associations and to be able to share in the collective intelligence, knowledge and experience assembled in this room.

You might well be wondering why I am so concerned about climate change and museums. For that, I must look back over 45 years, when I was a graduate student doing archaeological research in Canada’s remote Subarctic. As part of that work, I spent six months living with a band of Dene hunters. Their culture is thousands of years old, and is based on intimate knowledge of one of the most unforgiving environments in the world. It is there that I learned firsthand the meaning of social ecology - that social and environmental issues are intertwined and both must be considered simultaneously.¹

This inescapable truth – that our lives are inextricably linked with the natural world – inspires my belief that the global museum community must now take a stand on climate change. This is a moral imperative for museums, as climate change is no longer just about science or politics – it is also about social justice.

The Elephant in the Room

I’ll not go into the science of climate change and how it is throwing our civilization into chaos – it is a dire emergency by any definition. Suffice it to say that levels of carbon dioxide have now reached levels unmatched in the last four million years. The oceans are acidifying; coral reefs are bleaching, sea levels are rising, and extreme weather events and wildfires are now commonplace. We must reduce our carbon emissions by 80% by 2050, to forestall the worst impacts of climate disruption. This also means that 80% of the fossil fuels currently on the corporate books will have to remain in the ground.²

I fully concede that museums are not intended to resolve climate change, but I cannot emphasize enough that the sustainability of museums cannot be separated from the sustainability of the biosphere. Yet, I note that 20 pages of a Google search did not reveal a single reference to museums responding to the 2015 Paris Agreement on Climate Change.³
What is the Problem Here?

With a 97 per cent scientific consensus on the human causes of climate change, what is the problem? Why are we not confronting climate change with our collective will and resources? One explanation is that climate change is a taboo subject – not to be talked about with family, friends and colleagues.

In fact, the most important thing we can do to bring about climate action is to talk about climate change and its solutions with everyone we know. There are two essential lessons that we can learn from the LGBTQ community. The first is the need to have conversations about uncomfortable subjects, like queer rights and climate change, and the second is the need to focus on the *immorality of inaction*. We are living a massive lie about the impending catastrophe of climate change and it must not be avoided as a topic of discussion.

A second challenge is the widely-held belief that museums must protect their neutrality, lest they fall prey to bias and special interest groups. The unspoken argument is that museums cannot risk doing anything that might alienate their audiences or sponsors, real or potential. This claim of neutrality underlies the belief that museums may abstain from addressing societal issues, because they have complex histories and unique missions which absolve them from greater accountability.

A third obstacle in addressing climate change concerns our personal agency, meaning the capacity of individual museum workers, not just their leaders and managers, to take action in the world. Museum workers are as insightful and motivated as any other human beings, yet they often shy away from expressing their values and assuming their personal agency in the museum – likely for fear of losing their jobs or their friends. This fear is exaggerated, however, especially by those in authority. Take your concerns about climate change into the workplace and see what happens.

Museums Are Already Empowered

Despite these obstacles, I firmly believe that museums are already empowered to play a key role in addressing climate change, because they have several unique characteristics that distinguish them from any other contemporary, social organization. In addition to their deep view of time, museums are ably qualified to embrace climate change because:

- They are grounded in their communities and are expressions of locality;
- They are a bridge between science and culture;
- They bear witness by assembling evidence and knowledge, and making things known;
- They are seed banks of sustainable living practices that have guided our species for millennia;
- They are skilled at making learning accessible, engaging and fun.
- They are some of the most free and creative work environments in the world.

In short, there are no other organizations with this singular combination of historical consciousness, public accessibility, and unprecedented public trust. How, then, can these precious qualities translate into concrete action to address climate change? Here are several suggestions:

1. Begin by revisiting your vision and mission and start by asking some big questions, such as *why* does your museum exist, *what* changes are you trying to effect, *what* solutions will you generate, and *what* are your non-negotiable values?
2. Second, tell stories and educate – Museums tell the stories of the natural and cultural world – tell your visitors how climate change and disruption came to be.

3. Third, museums, as public forums, are ideally positioned to form alliances with science museums and environmental advocacy groups to help their communities understand what they need to do to move toward climate solutions - without pessimism and defeatism.

4. Fourth, with thoughtless consumption as the cause of climate change, it is imperative that we reduce our household consumption, as well as that of museums. Museums can readily assist with this task through information, dialogue and advocacy.

5. A fifth suggestion is to develop an Advocacy Policy for your museum, which would delineate what issues are important and how your museum will respond when confronted with moral and civic challenges, such as climate change.⁴

6. Last, I encourage you to join the Coalition of Museums for Climate Justice.⁴ It is a digital network of museum workers and organizations with over 350 members. We aim to unite and cultivate our collective intelligence to promote collaborative initiatives - involving individuals, museums, other sectors, in any combination, and for any length of time. The key is the Coalition’s shared purpose – confronting climate change through awareness, mitigation and resilience.

Conclusion

In conclusion, humanity needs a new story; museums need a new story.⁴ We must move beyond the doomed economy of industrial growth based on fossil fuels, to the recognition that the connection between individuals, communities, and nature is the key to our well-being. We must reconnect with the web of life by exercising our personal and organizational agency. Contrary to what you may be feeling, the climate change crisis is not a catastrophe yet, it is an enormous opportunity – an enormous opportunity for museums to step forward as key intellectual and civic resources. We must now mobilize the resources of the global museum community, and engage in collective political action and solutions.

As Zen teacher and former monk, Norman Fischer, wrote (Quote):

“If you have a spirituality that is grounded in concern and love for others you realize that politics is important. Politics is people interacting with one another over how we live together. In political discourse, you are making a case… There’s really no place for hatred or the demonizing of enemies.⁴ (End Quote)

In conclusion, I want to acknowledge the courage and foresight of the Alberta Museums Association for partnering with the Coalition of Museums for Climate Justice and Shadow Light Productions to produce a video on museums and climate change. I’m delighted to conclude my remarks with the premier showing of the trailer for this video.

Thank you very much for inviting me here today, and all the best with your important work. The trailer, please….
References:


2 Monbiot, G. “Why leaving fossil fuels in the ground is good for everyone.” Available online: https://www.theguardian.com/environment/georgemonbiot/2015/jan/07/why-leaving-fossil-fuels-in-ground-good-for-everyone


11 See: https://www.facebook.com/groups/MuseumsforClimateJustice/ https://coalitionofmuseumsforclimatejustice.wordpress.com/


13 See One Earth Sangha. Available online: https://oneearthsangha.org/articles/climate-change-is-making-us-crazy/
The Coalition of Museums for Climate Justice: An Overview

Robert R. Janes

The Challenge

Climate change is clearly our civilization’s most serious challenge. We have now passed the milestone level of 400 parts per million of climate-warming carbon in the atmosphere. The 400ppm threshold is a dire wake-up call, and our profound, global challenge is to reduce our carbon emissions by 50% by 2030, in order to forestall the worst impacts of climate disruption. This also means that 80% of the fossil fuels currently on the corporate books will have to remain in the ground.¹ Judging by the results so far, we are failing miserably. As expected, 2018 was the fourth-hottest year on record globally.

Museums are uniquely qualified to contribute to climate change awareness and mitigation, as they have several unique characteristics:¹

- They are expressions of community and locality;
- They are a bridge between science and culture;
- They bear witness by assembling evidence based on knowledge and they make things known;
- They are seed banks of sustainable living practices that have guided our species for millennia;
- They are some of the most free and creative work environments in the world.
- They enjoy an unprecedented degree of public trust
- They are skilled at making learning accessible, engaging and fun.

In short, museums are key intellectual and civic resources that are largely untapped and unacknowledged, and they are civil society spaces where substantive issues can be aired, discussed, and acted upon. These unique qualities must now be put to work in combating the spectre of climate change and its impact on the biosphere.

In the words of Stephen Weil, the renown, museum scholar-practitioner:

“Unless museums can, and do, play some role relative to the real problems of real people’s lives – then what is the point.”
The Coalition of Museums for Climate Justice

With this in mind, Robert R. Janes founded the Coalition of Museums for Climate Justice (CMCJ) in June of 2016. It began with invitations to 70 museum colleagues and now includes around 1800 participants – the majority of whom are Canadians. Much has been accomplished through the efforts of a national Advisory Group and the Coalition’s participants. Highlights include:

1. The CMCJ has established a strong online presence, including a website, a blog, a monthly newsletter, a Facebook group, a Twitter account and YouTube videos. See:

   https://coalitionofmuseumsforclimatejustice.wordpress.com/
   https://www.facebook.com/groups/MuseumsforClimateJustice/
   https://twitter.com/Museums4Climate?lang=en
   https://www.youtube.com/channel/UCy2nQdhaUQfkp9WAKU7WKyQ
   Email: museums4climate@gmail.com

2. The CMCJ has organized and conducted conference sessions on museums and climate change at the Canadian Museums Association, the Alberta Museums Association, the Western Museums Association, the British Columbia Museums Association, and the Ontario Museums Association (a webinar).

3. The CMCJ developed a seven-part video series on museums and climate change in conjunction with the Alberta Museums Association and Shadow Light Productions. The videos are available free of charge. See: Taking Action on Climate Change Video Series: Vimeo page

4. The CMCJ continues to publish articles and commentaries. Examples include an interview in the BCMA publication Round Up, an interview in the Museum of Anthropology’s Magazine, an article for Germany’s BEAM, an article in the journal Curator, an article in the UK Museums Association’s Newsletter, and an interview on the CBC’s Current (radio, 2018) and an interview in Canadian Art (2019).
   Members of the CMCJ’s Advisory Group have also appeared by video in conferences and museum studies programs in Canada, the US, the UK, Norway, Poland, Iceland, the Netherlands and Italy.

5. The CMCJ developed and hosted a climate justice workshop for the Greater Toronto Area Museum Educators and fifty museum educators enrolled in the 2018 workshop.

6. The CMCJ issued a call to action to museum studies departments in Canada in 2019 – encouraging them engage in climate change awareness and adaptation. The results included student blogs on the CMCJ’s website and a video seminar with museology graduate students at the University of Quebec/Montreal.

The CMCJ welcomes participation from all interested and concerned museum workers.

Note

1 Monbiot, G. “Why leaving fossil fuels in the ground is good for everyone.” Available online: https://www.theguardian.com/environment/georgemonbiot/2015/jan/07/why-leaving-fossil-fuels-in-ground-good-for-everyone

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- Interpretive training core curriculum development,
Korea National Arboretum.
- Interpretive Planning. Korea (several projects).
- 8th Annual Seminar of Latin American Museology,
Mexico City, October 22nd - 24th, sponsored by the School
of Conservation, Restauration and Museography/National
Institute of Anthropology and History. Invited
Speaker and historic site interp. consultations.
- International Conference on Interpretation of Natural
Heritage, sponsored by the Punjab Heritage and Tourism
Promotion Board, Department of Tourism, Punjab, India.
John Veverka was an invited keynote speaker.
- Interpretive training and consulting services. Malta Tourism.
- Interpretive training, Xcaret Resort, Cancun, Mexico.

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