

Climate Indicators

STRATEGIC INTELLIGENCE BRIEFING

Curated with World Meteorological Organization (WMO)

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Executive summary



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online

Despite the adoption of the Paris Agreement on climate change and the establishment of the 2030 United Nations Sustainable Development Goals, significant gaps remain between the scientific and political communities when it comes to understanding how climate change risks cascade through environmental, social, and economic systems. The World Meteorological Organization has established seven climate indicators to provide a holistic picture of the global climate system, and the risks posed by altering it. The ultimate aim of the indicators is to improve our collective understanding of the complex ways climate change threatens sustainable development - and encourage more drastic and immediate climate action.

This briefing is based on the views of a wide range of experts from the World Economic Forum's Expert Network and is curated in partnership with Omar Baddour, Head of Climate Monitoring and Policy Services Division, Nirina Ravalitera, Scientific Officer, and Valentine Haran and Claire Ransom, Visiting Scientists, at the World Meteorological Organization.

The key issues shaping and influencing Climate Indicators are as follows:

CO2 Concentration

Rising levels of human-caused carbon dioxide emissions are triggering cascading effects around the world

Sea Level Rise

Rising sea levels pose significant risks to coastal populations, food systems and ecosystems

Glacier Mass Balance

Glaciers provide freshwater to millions of people around the world, and their fate is tied to the changing climate

Sea Ice Extent

This critical indicator impacts weather patterns, marine ecosystems, and food chains

Ocean Heat Content

The ocean's central role in Earth's climate system means temperature changes pose serious risks

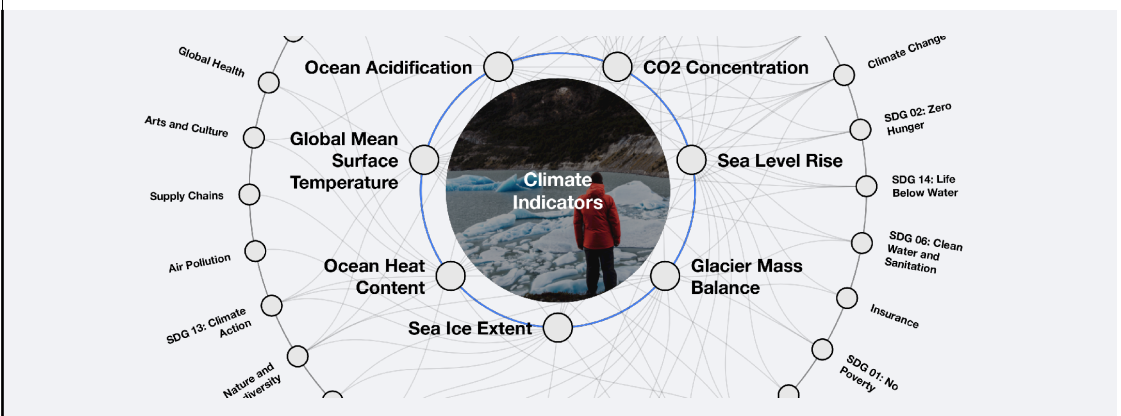
Global Mean Surface Temperature

Temperature drives extreme events and biodiversity loss with serious consequences for sustainable development

Ocean Acidification

As the ocean absorbs higher concentrations of CO₂, it puts marine ecosystems and human life at risk

Below is an excerpt from the transformation map for Climate Indicators, with key issues shown at the centre and related topics around the perimeter. You can find the full map later in this briefing.



1

Latest insights

A synthesis of the most recent expert analysis.

Below are your latest updates on the topic of Climate Indicators spanning 13 different sources.

1.1 Current perspectives



EOS
**Meltwater from Antarctic
Glaciers Is Slowing
Deep-Ocean Currents**

26 July 2023

Part of Earth's deep-ocean conveyor belt is slowing, and melting ice is to blame, according to new research.

When the sea freezes around Antarctica's fringes in winter, the ice expels salt into the water below. Trillions of metric tons of this briny, supercooled, heavy water cascade down Antarctica's continental slope, dropping into the deep ocean in submarine waterfalls.

As these waters sink from the Antarctic shelf, they spread north through the Southern Ocean, driving abyssal circulation—the lower limb of the global ocean overturning circulation. They are the densest water masses in the world's oceans and the engine room of a current system that conveys heat, dissolved gases, and nutrients around the world.



RAND Corporation
**Aging and Emotional
Well-Being After Disasters**

21 July 2023

We investigated age differences in well-being among U.S. Gulf Coast-residing adults. Older age was associated with fewer depression and PTSD symptoms, and this association was stronger for those who experienced hurricane-related adversities.



**London School of Economics and
Political Science**

**Chasing a Dying River: The
Yamuna in Delhi**

17 July 2023

Rivers are lifelines; in India, they are sacred, holy and worshipped by millions. Yet, it is the people and their actions that, over decades, is polluting these sacred rivers. Souzeina Mushtaq and Praveen K. Chaudhry have been visiting the Yamuna river at Ghat 24 in Delhi for several years, and discuss some of the issues — and hopes — in this final 'India at 75' post.

Throughout history, rivers have been crucial to the birth of civilisations. In the Indian subcontinent, the mighty civilisations of Mohenjo-Daro and Harappa came up along the Indus, Sutlej, and the riverbanks of the ancient Saraswati rivers in the north; in southern India, they developed around the Godavari, Krishna, and Kaveri rivers.



The New Yorker
**Will Record Temperatures
Finally Force Political
Change?**

12 July 2023

Tuesday, July 4th, was the hottest day ever recorded on earth. That is just one of many heat-related records that have been broken this summer. Historically high temperatures have been recorded around the planet, causing fires, floods, and other extreme weather events.

Earth Faces Hottest Day Ever Recorded— Three Days in a Row

06 July 2023

Researchers attribute the sweltering heat to a combination of human-caused climate change and El Niño, which has a global warming effect

The Earth has set back-to-back records this week for the hottest days ever documented, first on Monday, then again on Tuesday and Wednesday. Researchers attribute these three days in a row of sweltering heat to a combination of human-caused climate change and El Niño, a weather pattern that has a global warming effect.



How Tuvalu is using technology to adapt to rising sea levels

25 July 2023

How Tuvalu is using technology to adapt to rising sea levels

Tuvalu is leading the way in adapting to sea level rise and is an example for other countries facing the same threat. Image: Wikimedia Commons/Gabriella Jacobi

Dr Arthur Webb Coastal Adaptation Specialist, CTA Tuvalu Coastal Adaptation Project, UNDP

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As jobs law stalls, Philippines struggles to green economy

01 August 2023

Eight years ago, the Philippine government built an ultra-modern Green Technology Centre in the city of Taguig to spearhead a national drive for jobs to help combat climate change and protect the environment.

These days, however, the two-storey building of 1,000-square metres (10,800 sq ft) stands almost empty - and with only nine staff - after an innovative green jobs law stalled.

Around the world, countries are increasingly passing legislation to fight climate change, safeguard nature and cut pollution, but the UN Environment Programme says new laws often suffer from a lack of enforcement.

The Philippines centre in Taguig, near Manila, was built to teach greener, less-polluting techniques to workers in jobs ranging from construction to car mechanics, under the National Institute for Technical Education and Skills development.

It is intended to play a key role in implementing the Philippine Green Jobs Act of 2016 — the first and only legislation of its kind in Asia — which would promote micro, small and medium enterprises that create green jobs through tax deductions and tax-free imports of capital equipment.



One of 2023's most extreme heatwaves is happening in the middle of winter

04 August 2023

Temperatures in parts of Chile and northern Argentina have soared to 10°C-20°C above average over the last few days. Towns in the Andes mountains have reached 38°C or more, while Argentina's capital, Buenos Aires, saw temperatures above 30°C – breaking its previous August record by more than 5°C. Temperatures peaked at 39°C in the town of Rivadavia.

Bear in mind it's mid-winter in this part of the world. It's far south enough that seasonal variations have a substantial impact on temperatures.



Vanessa Nakate on how the climate crisis impacts girls | UNICEF

21 July 2023

Before, during and after humanitarian emergencies, UNICEF is on the ground, bringing lifesaving help and hope to children and families. Non-political and impartial, we are never neutral when it comes to defending children's rights and safeguarding their lives and futures.



Awareness Raising Educational Game on Climate and Development - Climate Challenge

15 July 2023

Gender inequality and the climate crisis are two of the greatest challenges of our time. They pose threats to ways of life, livelihoods, health, safety and security for women and girls around the world.



Present and future flooding and erosion along the NW Spanish Mediterranean Coast

07 July 2023

Coastal flooding and erosion caused by extreme events are the main factors responsible for beach hazards. This effect will be exacerbated by the sea level rise induced by climate change. The present work determines the vulnerability to erosion and flooding along 55 beaches grouped in different coastal archetypes, representative of the Catalan coast.



World Economic Forum

Why we urgently need new approaches to monitoring biodiversity in the sea

25 July 2023

For the sea, climate change may play a more important role than for the land since many sea species are very sensitive to changes in temperature. Where we can have the fastest and most direct positive impact on the sea is on the loss of habitat and overexploitation. By providing long-term, accurate data on fish populations, we can make informed decisions about conservation and management strategies that will help protect and restore the biodiversity of aquatic ecosystems.



The Conversation

Antarctica is missing a chunk of sea ice bigger than Greenland – what’s going on?

31 July 2023

Deadly heatwaves, raging wildfires and record global temperatures are upon us. Far from the flames, at the southernmost tip of the planet, something just as shocking is unfolding.

It’s Antarctic winter, a time when the area of floating sea ice around the continent should be rapidly expanding. This year though, the freeze-up has been happening in slow motion.

After reaching a record low minimum extent this summer there is now an area of open ocean bigger than Greenland.



The Science Breaker

Of Microbes and Megastorms

18 July 2023

The earliest ecosystems we know of were built entirely by microscopic lifeforms. Similar ecosystems that exist today help us understand the history of life on our planet. We set out to investigate their sensitivity to sea level change, but the occurrence of an extreme hurricane redirected our study and illustrated how climate change outcomes can impact life in surprising ways.



Frontiers

Communicating carbon removal

06 July 2023

Removing carbon dioxide from the atmosphere is “unavoidable” if net zero emissions are to be achieved, and is fast rising up the climate policy agenda. Research, development, demonstration, and deployment of various methods has begun, but

technical advances alone will not guarantee a role for them in tackling climate change. For those engrossed in carbon removal debates, it is easy to forget that most people have never heard of these strategies. Public perception of carbon removal is therefore particularly sensitive to framings—the ways in which scientists, entrepreneurs, activists, politicians, the media, and others choose to organize and communicate it. In this perspective, we highlight four aspects of carbon removal for which their framing will play a decisive role in whether—and how—different methods are taken forward. First, the use of analogies can be helpful in guiding mental models, but can also inadvertently imply processes or outcomes that do not apply in the new example. Second, a taxonomic split between “nature-based” and “technological” methods threatens to divert attention from the actual qualities of different methods and constrain our policy options. Third, people are likely to overestimate the emissions-reduction potential of carbon removal, but this misperception can be corrected. Fourth, communications...



Scientific American

Climate Change Could Stump AI Weather Prediction

12 July 2023

CLIMATEWIRE | For decades, morning weather reports have relied on the same kinds of conventional models. Now, weather forecasting is poised to join the ranks of industries revolutionized by artificial intelligence.

A pair of papers, published Wednesday in the scientific journal Nature, touts the potential of two new AI forecasting approaches — systems that could yield faster and more accurate results than traditional models, researchers say.

They’re part of a new wave of AI models sweeping the meteorology community worldwide. They have potential to transform the forecasting industry.



Eco-Business

China and Mongolia team up to fight sandstorms

24 July 2023

Battsengel, 50, lives in the south of Mongolia, in Khanbogd district, Ömnögovi province, just over the border from China’s Inner Mongolia. He has made a living herding livestock since he was 20. Sandstorms of increasing frequency are making things very tough.

“Precipitation started to fall off in 2004. By 2015, we were seeing long periods without rain and shorter intervals between droughts.

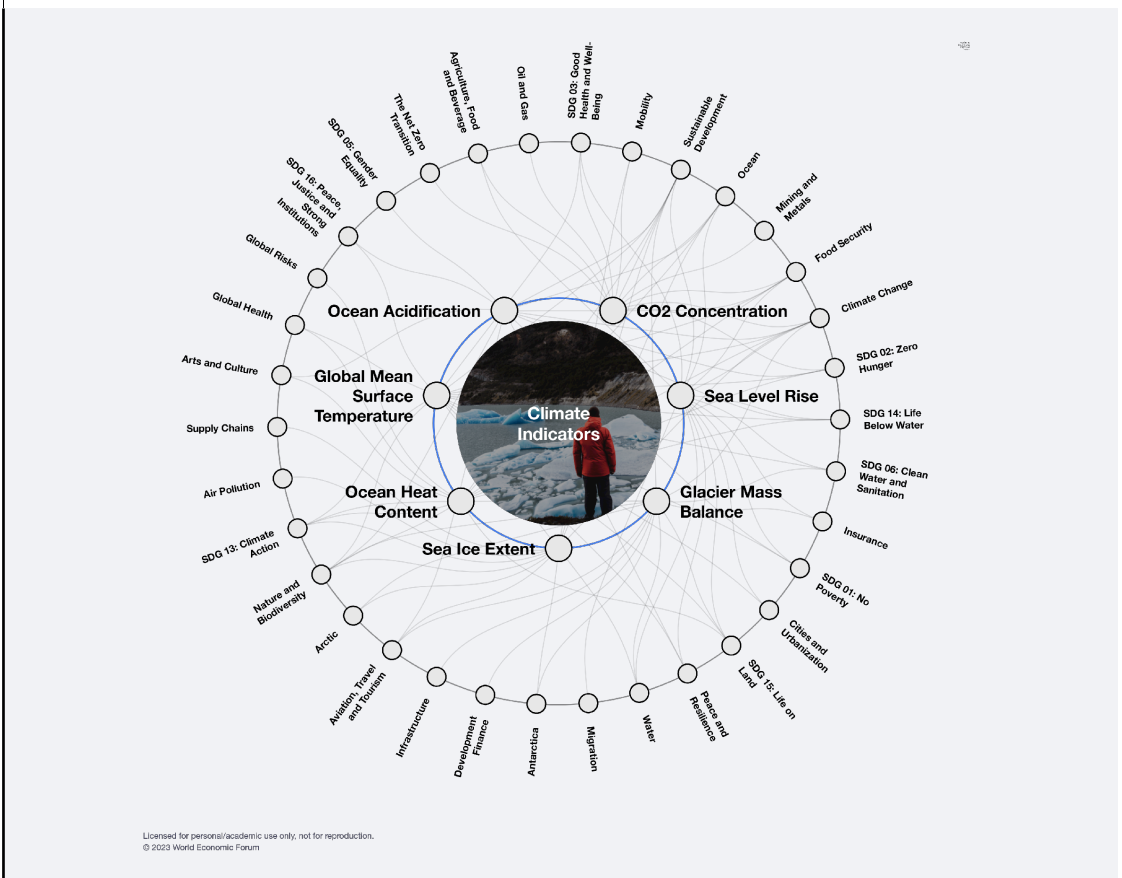
2

Strategic context

The key issues shaping Climate Indicators.

The following key issues represent the most strategic trends shaping the topic of Climate Indicators. These key issues are also influenced by the other topics depicted on the outer ring of the transformation map.

FIGURE 1 Transformation map for Climate Indicators



2.1 CO2 Concentration

Rising levels of human-caused carbon dioxide emissions are triggering cascading effects around the world

The atmospheric concentration of carbon dioxide is a key indicator of the state of the global climate (a US scientific agency reported monthly average atmospheric CO₂ for May 2021 at the highest level since accurate measurement had begun 63 years earlier). The ultimate concentration level is the result of exchanges between the atmosphere, the biosphere, and the ocean - and reflects a balance between sources like human-caused emissions, and the sinks that absorb them. One of Earth's biggest carbon sinks is the ocean, which captures between 25% and 30% of all CO₂ emissions. The CO₂ that is not absorbed by natural carbon sinks remains in the atmosphere; as its concentration rises alongside other greenhouse

gases, it perpetuates the “greenhouse effect” and accelerates warming processes. Earth warming is measured through “radiative forcing,” a measure defined by the Intergovernmental Panel on Climate Change (IPCC) as a balance between “positive forcing” such as the greenhouse effect, which contributes to the warming of Earth’s surface, and “negative forcing” that cools the surface. Because human-caused emissions of greenhouse gases are skyrocketing, it is boosting “positive forcing” and energy accumulation on Earth.

CO₂ is responsible for 82% of the increase in radiative forcing over the past decade, and the greenhouse effect threatens to undermine the necessary climate action outlined in UN Sustainable Development Goal 13. 1% of this energy accumulation warms the atmosphere, 3% dissipates into the ground, 3% melts sea ice, ice sheets, and glaciers, and 93% is trapped by the ocean. As CO₂ dissolves into the ocean it turns into acid ions and reduces pH, which threatens marine ecosystems (the success of efforts to minimize this is a key indicator of progress on SDG 14, “Life Below Water”). As CO₂ concentrations increase, photosynthesis processes speed up - producing agricultural yields in less time. This results in a reduction of grain protein concentration that threatens food security (as outlined in SDG 2, “Zero Hunger”). Recent studies have also demonstrated that there may be health risks related to increased exposure to high levels of atmospheric CO₂ - threatening progress made on SDG 3, “Ensure Healthy Lives.” In fact, CO₂ concentration is at least indirectly related to risks outlined in nearly all 17 of the SDGs, and reducing emissions is therefore necessary to achieve the goals.

Related topics: [Sustainable Development](#), [Agriculture, Food and Beverage](#), [The Net Zero Transition](#), [SDG 02: Zero Hunger](#), [Mining and Metals](#), [Food Security](#), [Ocean](#), [SDG 03: Good Health and Well-Being](#), [Mobility](#), [Climate Change](#), [Oil and Gas](#)

2.2 Sea Level Rise

Rising sea levels pose significant risks to coastal populations, food systems and ecosystems

Sea level rise is one of the most important climate indicators, because it reflects many different changing components of the climate system and their interaction. Over the past few decades, global mean sea level has risen approximately 3.2 millimetres per year. As sea levels rise, extreme events and coastal flooding are more likely to occur - and are likely to be further exacerbated by projected increases in tropical cyclone intensity and precipitation. This can endanger ecosystems, as water temperature and salinity are altered, amounts of available light change, and plants and animals potentially drown in ways that undermine progress made on UN Sustainable Development Goals 14 (“Life Below Water”) and 15 (“Life on Land”). While vegetated coastal ecosystems can often protect coastlines from storms and erosion, and help buffer the impacts of sea level rise, nearly half of all coastal wetlands have actually been lost over the past century, as a result of the combined effects of localized pressure caused by human activity, rising sea levels, warming, and increasingly prevalent extreme weather events.

These extreme events can damage infrastructure, put lives at risk, cause significant economic losses, and hamper progress made on multiple SDGs. Sea level rise can also displace populations, impoverish them, and fracture them politically. Coastal flooding can cause the salinization of ground water, and result in soil becoming inundated with salt water - contaminating it and harming crops in ways that threaten yields and damage farmers’ livelihoods and food security (SDG 1 targets poverty, while SDG 2 targets hunger, and both may be undermined). The increased risk of water contamination during flooding as a result of sea level rise can undermine progress made on SDG 3, “Good Health and Well-Being,” and on SDG 6, “Clean Water and Sanitation.” This threatened state of access to clean water along with diminished food security and livelihoods create an increased risk of local conflict - potentially further raising the risk of population displacement. As always, it should be noted that many of the risks posed by sea level rise will be felt disproportionately around by those people around the world already faced with socioeconomic and gender inequalities.

Related topics: [Climate Change](#), [Migration](#), [Peace and Resilience](#), [Agriculture, Food and Beverage](#), [SDG 14: Life Below Water](#), [Ocean](#), [Food Security](#), [Sustainable Development](#), [Insurance](#), [Water](#), [SDG 06: Clean Water and Sanitation](#), [SDG 15: Life on Land, Cities and Urbanization](#), [SDG 03: Good Health and Well-Being](#), [SDG 01: No Poverty](#)

2.3 Glacier Mass Balance

Glaciers provide freshwater to millions of people around the world, and their fate is tied to the changing climate

Glaciers are distributed across the planet, with concentrations in the high mountain ranges of Asia, and in both North America and South America. Glacial mass balance is defined as the sum of all gains and losses in ice mass - and preliminary data show that 2020 marked the 33rd consecutive year of recording a negative result. Glaciers have a significant impact on the global climate. In the past decade alone, glacial mass loss (particularly ice sheets in Greenland and the Antarctic) has accounted for nearly a third of the total sea-level rise now being recorded. As cold glacial water melts into the ocean, it also disrupts the current thermohaline circulation - which in turn reduces the ocean's capacity to absorb carbon dioxide. Combined with thawing permafrost throughout the Arctic that releases million tons of carbon per year into the atmosphere, glacial mass loss perpetuates climate change and undermines progress made towards UN Sustainable Development Goal 13 - "Climate Action." In addition, changing ocean circulation could significantly alter weather patterns around the world, putting habitats and ecosystems at risk and hindering SDG 15, "Life on Land."

Biodiversity in particular is at greater risk, as plants and animals are forced to move and establish habitats in new areas as glaciers recede and the snow-free seasons lengthen. Glaciers are now melting so quickly that they pose an increased risk of floods and contaminated water, hindering SDG 6 ("Clean Water and Sanitation"). Landslides, mudslides and avalanches can also occur, putting lives at risk and threatening infrastructure including homes and businesses, disrupting transportation, exacting significant economic losses and causing development setbacks, and undermining a number of SDGs. These disruptions also risk agricultural yields, threatening the livelihoods of people who depend on them and undermining food security in ways that also hinder efforts related to the SDGs. Longer term, reduced glacial snowmelt and runoff threaten reliable access to safe, clean, drinking water - and the tourism centred on glaciers, in addition to related cultural services, will be increasingly threatened. It is important to note that many of the risks posed by changing glacial mass will be experienced differently around the world - and will no doubt fall disproportionately on those already suffering from socioeconomic and gender inequalities.

Related topics: [Nature and Biodiversity](#), [Aviation, Travel and Tourism](#), [Water](#), [SDG 13: Climate Action](#), [Infrastructure](#), [Sustainable Development](#), [Insurance](#), [SDG 15: Life on Land](#), [Arctic](#), [Climate Change](#), [Development Finance](#), [Antarctica](#), [SDG 06: Clean Water and Sanitation](#)

2.4 Sea Ice Extent

This critical indicator impacts weather patterns, marine ecosystems, and food chains

Sea ice extent, or areas where ice concentration is greater than 15%, is the most widely used climate indicator to assess long-term changes in the Arctic and Antarctic regions. There is still much that is unknown about sea ice behaviour at the two poles, though what we do know is not reassuring: annual minimum sea-ice extent in the Arctic was the second lowest on record in 2020, with record low sea-ice extents observed in July and October. Changing sea ice extent impacts the global climate system through the polar jet stream, which is a type of thermal wind that arises due to a strong contrast between cold, polar air and warm, tropical air. As the Arctic warms, the temperature differential between that pole and the tropics is reduced, weakening the jet stream and causing warm air to creep north and cold air to plunge south. Another significant impact of sea ice extent on the global climate is reduced surface "albedo," or reflectivity, which causes faster local warming. As light surfaces like sea ice become more reflective, more solar radiation bounces back into the atmosphere.

The flip side of that is that as sea ice melts, the amount of light surface is reduced and the darker melt water and ocean below absorb more solar radiation. The result is that sea temperatures and surface air increase, further accelerating warming and the melting of sea ice in a feedback loop. As this change in surface albedo speeds up warming, it undermines progress made on UN Sustainable Development Goal 13, "Climate Action." In addition, as sea ice melts the species that depend on it - including algae, zooplankton, polar bears and wolves - are placed at risk. Given the connections across marine ecosystems, changes in Arctic and Antarctic sea ice could have global repercussions, threatening biodiversity in ways that can affect livelihoods, increase poverty, decrease food security for those depending on fishing yields, and undermine several SDGs. And, as ice melts and creates fewer blockages, new routes for transportation are becoming available - increasing commercial traffic and possibly further exacerbating pollution in ways that hurt marine life and potentially fuel conflict.

Related topics: [Sustainable Development](#), [SDG 13: Climate Action](#), [Supply Chains](#), [Mobility](#), [Climate Change](#), [Antarctica](#), [Arctic](#), [Aviation, Travel and Tourism](#), [Nature and Biodiversity](#), [Ocean](#), [Air Pollution](#)

2.5 Ocean Heat Content

The ocean's central role in Earth's climate system means temperature changes pose serious risks

The ocean covers more than 70% of Earth's surface and has an incredible capacity to store heat - lending it a central role in stabilizing the global climate system. Ocean heat content reached record levels in 2019. As water warms, its volume increases - and thermal expansion is responsible for between 30% and 55% of sea level rise during the 21st century. Temperature changes also lead to shifting densities of surface and deep water, reducing ventilation and causing stratification. This reduces the ocean's ability to absorb carbon. In addition, rising ocean temperatures can cause melting hydrates to release methane (another potent greenhouse gas) into the atmosphere. Increasing ocean heat content therefore directly threatens to undermine any efforts made in line with the UN's Sustainable Development Goal 13, "Climate Action." Changes in ocean heat dynamics are also responsible for Atlantic Meridional Overturning Circulation weakening, which is projected to have a significant impact on weather patterns. Changing weather patterns may cause cascading impacts on ecosystem structure and functioning, affecting species on land and hindering SDG 15, "Life on Land."

Ocean circulation slowdown is also a threat to SDG 14 ("Life Below Water"), as it hinders the movement of nutrient content and oxygen to marine organisms. In fact, there has already been as much as a 3.3% oxygen loss since 1970, and oxygen minimum zones have extended by as much as 8%. Warming, particularly during marine heatwaves and deoxygenation, can also contribute to an increased risk of harmful algae blooms that cause significant impacts to both marine biodiversity and human health. Higher temperatures can negatively impact keystone species like coral reefs, for example - and as these reefs are damaged, so too are natural heritage sites, tourism opportunities, and the many livelihoods that depend on them, in ways that undermine multiple different SDGs. Ultimately, changes in marine biodiversity can lead to reduced fishing yields, and further threaten livelihoods while expanding poverty, threatening food security, and potentially leading to conflict over increasingly scarce resources. It is important to note that these impacts will have significantly worse implications for those people already affected by socioeconomic and gender systemic inequalities.

Related topics: [Sustainable Development](#), [SDG 02: Zero Hunger](#), [Global Health](#), [Ocean](#), [Nature and Biodiversity](#), [Food Security](#), [SDG 15: Life on Land](#), [Climate Change](#), [Global Risks](#), [SDG 13: Climate Action](#), [Arts and Culture](#), [Climate Indicators](#), [SDG 14: Life Below Water](#)

2.6 Global Mean Surface Temperature

Temperature drives extreme events and biodiversity loss with serious consequences for sustainable development

Global mean surface temperature (GMST) is the international standard for climate change policy. By 2020, warming was already 1.2°C above pre-industrial levels. GMST has a significant influence on the extreme weather events that have become more common; the exchange of energy, momentum, and gases between the ocean and atmosphere causes more severe tropical cyclones and storms and the intensification of El Niño events, leading to drought and floods. GMST also affects the pressure gradient - and therefore wind patterns, jet streams and storm tracks, leading to more frequent and intense cold and heat waves. Such extreme events will profoundly affect life on land and in the sea, primarily in the form of habitat loss, migratory shifts, and "trophic cascades" (shifts among predators and prey that alter food chains). Biodiversity loss, combined with increased temperatures, extreme events, and water scarcity all put agricultural and fishing yields at risk, undermining livelihoods and food security (with implications for the first two UN Sustainable Development Goals - eliminating poverty and hunger). Temperature rise and extreme events also distort rainfall, snowmelt, river flows, and groundwater, with implications for SDG 6 - "Clean Water and Sanitation."

Extreme events also threaten infrastructure in ways that put health at risk, damage property and communities, disrupt transportation, cause economic loss and hinder development - potentially undermining multiple SDGs. SDG 3, "Good Health and Well-Being," is placed at risk, for example, due to social and environmental disruption that can enable disease to spread more easily, and cause significant trauma that impacts mental health. The combination of extreme events, health issues, water scarcity, and food insecurity increases the risk of short- and long-term displacement, undermining work on establishing land rights and promoting social and economic inclusion and labour rights. The increased risk of displacement, water scarcity and food security can in turn increase the likelihood of conflict, undermining SDG 16 - "Peace, Justice, and Strong Institutions." A warming planet also causes permafrost and glacial melt, further

undermining infrastructure and releasing greenhouse gases into the atmosphere. This feedback loop undermines any governmental action on climate (SDG 13 is “Climate Action”). It is important to note that these impacts on food security, water scarcity, health, and livelihoods will not be equally felt - those already affected by systemic racism and gender and socioeconomic inequalities will be more significantly affected.

Related topics: [Peace and Resilience](#), [Global Health](#), [SDG 16: Peace, Justice and Strong Institutions](#), [SDG 13: Climate Action](#), [SDG 14: Life Below Water](#), [SDG 02: Zero Hunger](#), [SDG 03: Good Health and Well-Being](#), [SDG 06: Clean Water and Sanitation](#), [Food Security](#), [Climate Change](#), [SDG 15: Life on Land, Nature and Biodiversity](#), [Sustainable Development](#), [SDG 01: No Poverty](#), [Water](#), [Cities and Urbanization](#)

2.7 Ocean Acidification




















As the ocean absorbs higher concentrations of CO₂, it puts marine ecosystems and human life at risk

The international community has become increasingly aware of the dangers of ocean acidification in recent years. Approximately 25% to 30% of all CO₂ emissions are captured by the ocean - and whenever CO₂ dissolves in water, it turns into acid ions. The acidification of the ocean causes a decrease in carbonate ion concentration, which is necessary for marine organisms like coral to form shells and essential skeletal material. Because these organisms form the fundamental basis for many complex marine ecosystems, any threat to their ability to form in turn threatens many other species. In recent decades, ocean acidification has been occurring 100 times faster than in the past 55 million years. In fact, the process of ocean acidification is unique in that it is the only climate indicator that merits designated space within one of the UN's Sustainable Development Goals - within SDG 14, the third target spells out the need to minimize and address the impact of ocean acidification, including through enhanced scientific cooperation “at all levels.” There is good reason for this, as the impacts of acidification are far reaching.

When organisms sensitive to changes in acidity like mussels, crustaceans, and corals are in danger, so are other species along the food chain that depend on them. That undermines the overarching goal of SDG 14, which is to conserve and sustainably use the ocean and seas. Many coral reefs have value beyond their ecosystem services and have been declared UNESCO World Heritage sites. Their demise would be both a significant cultural and economic loss (due to declines in tourism), with implications for many SDGs, not least SDG 11, “Sustainable Cities and Communities.” In addition, significant changes or losses in marine biodiversity can reduce fishing yields, which can lead to reduced or diminished livelihoods (SDG 1 is to end poverty) and cause food insecurity (SDG 2 is to achieve zero hunger) - particularly in low-income and rural areas. Risks to food security and livelihoods can also have significantly different implications based on gender, potentially undermining work done towards gender equality (SDG 5). Ultimately, food insecurity and loss of livelihood can also drive conflict, particularly disputes over territory and resources, with implications for SDG 16 (“Peace, Justice, and Strong Institutions”).

Related topics: [Nature and Biodiversity](#), [Sustainable Development](#), [SDG 16: Peace, Justice and Strong Institutions](#), [SDG 05: Gender Equality](#), [Food Security](#), [SDG 14: Life Below Water](#), [SDG 02: Zero Hunger](#), [Aviation](#), [Travel and Tourism](#), [SDG 01: No Poverty](#), [Climate Change](#), [Ocean](#), [Arts and Culture](#), [Peace and Resilience](#)

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About Strategic Intelligence

Our approach

In today's world, it can be difficult to keep up with the latest trends or to make sense of the countless transformations taking place. How can you decipher the potential impact of rapidly unfolding changes when you're flooded with information - some of it misleading or unreliable? How do you continuously adapt your vision and strategy within a fast-evolving global context? We need new tools to help us make better strategic decisions in an increasingly complex and uncertain environment.

This live briefing on Climate Indicators, harnesses the World Economic Forum's [Strategic Intelligence](#) platform to bring you the very latest knowledge, data and context from our 300+ high quality knowledge sources. Its aim is to help you understand the global forces at play in relation to Climate Indicators and make more informed decisions in the future.

Each day, our Strategic Intelligence platform aggregates, distills and synthesizes thousands of articles from around the world. We blend the best of human curation with the power of machine learning to surface high-quality content on over [two hundred global issues](#) to our one million users globally. Our hand-picked network of [content partners](#) from around the world means that we automatically exclude much of the noisy clickbait, fake news, and poor quality content that plague the Internet at large. We work with hundreds of think tanks, universities, research institutions and independent publishers in all major regions of the world to provide a truly global perspective and we are confident that our data are well positioned when it comes to the intrinsic biases inherent to open text analysis on uncurated content from the Internet. For further context on our approach, you may be interested to read [Strategic trend forecasting: anticipating the future with artificial intelligence](#) and [These Are The 3 Ways Knowledge Can Provide Strategic Advantage](#).

↓ A leading expert presenting a transformation map at our Davos Annual Meeting



Transformation maps

Our [Transformation Maps](#) are dynamic knowledge visualisations. They help users to explore and make sense of the complex and interlinked forces that are transforming economies, industries and global issues. The maps present insights written by experts along with machine-curated content. Together, this allows users to visualise and understand more than 250 topics and the connections and inter-dependencies between them, helping in turn to support more informed decision-making by leaders.

The maps harness the Forum network's collective intelligence as well as the knowledge and insights generated through our activities, communities and events. And because the Transformation Maps are interlinked, they provide a single place for users to understand each topic from multiple perspectives. Each of the maps has a feed with the latest research and analysis drawn from leading research institutions and media outlets around the world.

At the centre of each map is the topic itself. This is surrounded by its "key issues", the forces which are driving transformation in relation to the topic. Surrounding the key issues are the related topics which are also affected by them. By surfacing these connections, the map facilitates exploration of the topic and the landscape within which it sits.

Continue online

Our suite of Strategic Intelligence tools are available to help you keep up to date across over 300 topics.

On the web

Visit [Strategic Intelligence](#) on your desktop or laptop. All modern browsers supported.



In the app stores

You can find our [Strategic IQ app](#) on the Apple App Store, Google Play Store or Huawei App Gallery.



You can also follow Strategic Intelligence [on Twitter](#).

Go further with our Pro offering

Our Pro membership allows you to create unlimited custom transformation maps and the ability to collaborate on them with your colleagues. You also get the ability to export transformation maps images and Powerpoint presentations. As a Pro user, you also gain access to a range of hypothetical scenarios that have the potential to impact developments in the near future; enabling you to think through and anticipate potential opportunities and risks.

To learn more, [visit our membership site](#).

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World Economic Forum



COMMITTED TO
IMPROVING THE STATE
OF THE WORLD

The World Economic Forum, committed to improving the state of the world, is the International Organization for Public-Private Cooperation.

The Forum engages the foremost political, business and other leaders of society to shape global, regional and industry agendas.

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