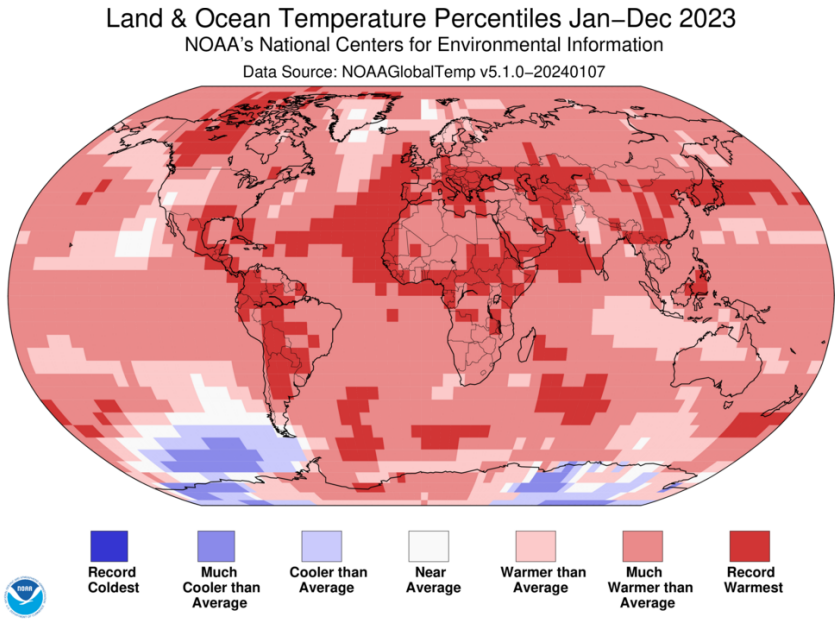
CLIMATE CHANGE: ITS STATUS & TRAJECTORY IN 2024



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This briefing aims to draw attention to the growing concerns that the decade 2028-2038 could witness a devastating deterioration in the world environment. It will highly likely be caused by a very recent acceleration in human-induced global heating.

Background

Over the past 35 years, the international scientific community has warned about the causes and trajectory of climate change. But the year 2028 may be the forerunner of a decade that could set a catastrophic path for life on the planet.

Heightening concerns is the analysis by the World Meteorological Organization *i*n March 2024, suggesting that the planet's heating may be accelerating faster than was expected by the United Nations in its latest global climate change assessment in 2023.

The years 2022, 2023, and now 2024, are hotter than any previous period on record. In fact, the planet now has its highest surface temperature in 2000 years.

- A consequence is that extreme heat events over the past year exposed tens of millions of people to life-threatening heat exhaustion. So far in 2024, more than a dozen countries in multiple regions have sweltered through temperatures of 48-52 degrees Centigrade, often with night-time temperatures staying above 35 degrees.

The evidence establishes that there is now sufficient energy in the lower atmosphere to underpin future extreme climate impacts that will be abrupt, non-linear, widespread, and potentially irreversible within this century.

Of equal concern is the realisation that the opportunity to prevent this global threat has gone. The combined plans of all of the Member States of the United Nations to take appropriate action, as published in late 2023, fail badly to provide a viable response *(UN COP 28).*

Emerging and highly challenging international conflicts in places like Ukraine and the Middle East are further challenging the capacity of nations to act in concert to implement the measures needed.

Human-Induced Global Heating: The Concept

Climate change, or more appropriately "human-induced global heating," is now firmly established as one of the greatest threats to our planet's environment. The dangers it creates are increasing in frequency, severity, spread and destructive potential, with its dominant impact being expressed as extreme heat *(WEF, Jan 24).*

The primary cause of Earth's heating is the build-up of energy at its surface, which is destabilising the wind and rainfall patterns that have underpinned civilisation for thousands of years.

Vital systems such as biodiversity, freshwater management, food production, global communications and population migration trends, are already being disrupted by these changes.

The UN International Panel on Climate Change has developed a well-characterised relationship between energy growth and temperature increase at Earth's surface from 1900 onwards *(IPCC, AR6 2023 - T5.3.2).* From 1900 to 2023, the heat gain increased the surface temperature by 1.3°C (*WMO,2024; EU Copernicus 2024; WWA).*

The energy build up is being driven by human activities that release certain gases which trap heat at the planet's surface. Some gases exist transiently in the atmosphere while others accumulate and persist indefinitely.

The levels of greenhouse gases in the atmosphere are higher now than at any time in the past 2 million years. Most human-induced emissions were after 1980.

Carbon dioxide, which accumulates over very long periods, is now the greatest contributor to the heating process. It constituted 87% of the net 40 billion tonnes of greenhouse gases emitted from Earth in 2023, and is released by burning coal, natural gas, and oil - the fossil fuels. (*WES, Jun 24).*

The stickiness of fossil fuels

Although there is a strong push to exit the burning of fossil fuels as quickly as possible, renewable sources met only 18% of the total demand for energy at the end of 2023.

They are not expected to be more than 30% by 2050, although this rises to 50% for electricity generation when nuclear power is added in *(WES, 2024)*.

The international energy industry reports that a full conversion to a carbon-emissions-free world is unlikely to occur before 2070 *(IEA)*.

The goal of a full transition away from fossil fuels is becoming very difficult due to factors such as:

- Record global subsidies of US$7 trillion paid annually from public sources. They present as financial incentives for new production facilities or subsidies for consumers to help them afford fossil fuel market prices *(Black; Global Subsidies Initiative)*.
- Investment in 2025 is projected to be US$2,000 billion by large and medium-sized oil gas and coal companies maintaining and expanding intensive carbon fuel supplies *(McKinsey)* .

  Coal power generation remains controversial. Coal has the highest carbon emissions intensity of the three fuels but has been in decline for a decade, It provided only 27% of the global energy used in 2023 *(WES)*.

Nevertheless, while the G7 countries agreed in May 2024 to phase out coal power plants by 2035, 69 billion Watts of new coal power capacity came online in 2023 while only 21 was retired. China was responsible for two-thirds.

The global decarbonisation strategy is heavily influenced by the needs and appetite of the different industry sectors for specific energy types. Until recently the tertiary industry sector was less intensive in its demands.

But electricity and gas producers are now trying to come to grips with the enormous and rapid changes occurring in the energy demands by this sector.

Growth over the past 5-7 years in new activities such as video streaming, bitcoin transactions, EV charging, online shopping and work-from-home arrangements is driving the construction of massive data storage centres that operate continuously.

A study in the US published in March 2024 estimated that by 2030, electricity demand by data centres in that country could triple, using the same power as 40 million homes (*Plumer&Popovich)*.

The current shortfall in renewable energy, as well as transmission systems to connect the various sources, mean natural gas could underpin electricity generation in the tertiary sector for years.

This demand growth has not yet been factored into the projections for global carbon emissions in 2030.

Calibrating the planet's deterioration

The *UN Paris Agreement on Climate Change (2015)* is the dominant treaty governing responses to the threats from global heating.

It identified the maximum acceptable surface temperature as +1.5°C. It also stated that exceeding +2.0°C would set the planet on a trajectory that could eventually render it uninhabitable.

Statistically, the two temperature points are not truly discrete. Expectations for reaching +1.5°C are quoted at a 50% confidence level, while the modelling for +2.0°C applies a 67% confidence level. This implies a non-linear timing of the worst environmental impacts at different regions across the planet, during the time between them.

A logical approach therefore is to focus on the implications of the planet reaching +1.7°C. This is supported by the view that each additional 0.1°C increase will create a new and disproportionately higher threat-level requiring novel adaptation measures

Likely adverse outcomes will include an acceleration of the loss of polar and glacier ice masses; millions of people will die from heat stress annually; agriculture and freshwater loss will cause food insecurity; and by 2050, rising seas will inundate low lying coastal communities across multiple regions (*WEF; Swiss Re)*.

The carbon budget

Widely accepted scientific projections about the pace of extreme climate change have centred on one key variable: the sensitivity of the increase in the lower atmosphere's temperature to the addition of the next tonne of greenhouse gases released from Earth.

A review published in March 2024 demonstrated that by the end of 2024, only a further 200 billion tonnes of carbon dioxide can be emitted before the +1.5^{0}C level is reached *(Forster)*.

Given that annual emissions will still unavoidably exceed 40 billion tonnes until after 2030, the authors conclude that there is a 50% chance that this will occur before then.

The same modelling for +1.7°C and +2.0°C showed that the carbon budget would expire after the emissions of the next 450 billion tonnes and 900 billion tonnes respectively (*post 2024, and at the 67% level of confidence)*.

These calculations cause alarm because of one overriding consideration: the UN is clear that future emissions must be reduced below 20 billion tonnes annually, by 2030, for the planet to stay below +1.5°C across the century *(IPCC, 2018)*.

The environmental impacts

It appears that the planet's temperature is now +1.3^{0}C.

An increase of this small level over a 123 year period from 1900 seems trivial. The scepticism could be valid if it were not for its impacts already including:

- A global temperature increase faster in the past 50 years than at any time in the past 2,000 years. (*Rockstrom)*
- The frequency of extreme wildfires across the globe more than doubled during the past 20 years, with devastating and widespread incidents occurring in Australia, Siberia, Canada and California. The latter includes July 2024
    - *Munich Re,* one of the world's largest re-insurers, estimates that the loss and damage these fires caused between 2018 and 2022 alone, exceeded US$69 billion.
- Destructive flooding in Australia, Florida, Pakistan, China, and Europe. Many were on a scale and intensity never before experienced.
- Extreme droughts, such in the western USA that has persisted for decades and represents the most severe drought in 1,200 years.

Ocean threats

There have been widespread, severe and in many circumstances, irreversible impacts on the world's oceans.

- 90% of the excess energy created by humans since 1900 has been absorbed by the top 2,000 meters of the world's oceans. This prevented a planetary temperature-hike that could have eliminated all life, but interestingly, the deterioration of the oceans was not publicised until a decade ago.
- The impacts have included:
    - More frequent and severe ocean heatwaves that have destroyed marine habitats and subsistence seafood industries.
    - Violent storm driven surges of waves that were not only destructive but which also inundated even elevated coastal zones.
    - The most recent mass bleaching on the World Heritage-listed Great Barrier Reef in 2023–24, is the fifth since 2016. Previous events have hit the northern sections of the reef hard, but this time the impact has been all along of the GBR's entire 2300km length. Up to 75% of the 3000 individual reefs in that area have been affected to some extent (*GBRMPA, April 2024)*.
    - An increased loss of ice from glaciers and the polar ice caps. The Greenland ice sheet in the Arctic Circle is warming at four times the rate of the rest of the planet, and the Antarctic continent at twice the rate. As a result:
        - Each year since 2002, the two polar ice caps have been losing a total of 420 billion tonnes of ice.
        - The world's glaciers are melting with a loss of 335 billion tonnes each year. *(Cryosphere)*

The melting ice together with the expansion of the global oceans caused by their warming, is accelerating sea level rise faster than during any other century in the last 3,000 years (*Cryosphere)*.

Grave concerns are now held for the inhabitants of many low lying Pacific Islands; heavily populated deltas such as on the coast of Bangladesh; and major cities such as Shanghai and the Manhattan area of New York.

Predicting the exact number of cities affected by sea level rise by 2040 - 2050 is difficult due to variations in factors like land elevation and coastal protection systems. But 40% of the world's population lives within 100 km of the coast,

If the current carbon emissions profile persists, 340 million people will be living on land that is below their projected annual flood levels by 2050. This rises to one billion people who now occupy land that is less than 10 metres above current high tide lines.

Carbon Offsets

The transition from a carbon-intensive world to one with low carbon emissions rests on reducing fossil fuel consumption.

Current approaches focus on achieving higher energy efficiency in urban and industrial settings, and fully utilising low-carbon electricity generation from renewable sources linked to storage systems such as lithium batteries and pumped hydro.

Other means, such as replacing fossil fuels with hydrogen from "green energy" may eventually be available to industry. But so far less than 5000 tonnes of hydrogen has been produced globally, of which only 150 are from green sources *(Brown, S)*.

On the other hand, new generation and safe nuclear energy technologies may be available for large scale production after 2040. But it will then take a further decade before their output can make a meaningful contribution to resolving the climate threat *(CSIRO)*. This is far too late to be considered as an option.

However, two highly contentious approaches are being debated that escape fossil fuel reductions. Instead they purport to compensate for substantial ongoing emissions by offsetting them with one of:

- Carbon capture and underground storage *(CCUS or geosequestration)*, where carbon dioxide emissions are buried underground.
- Biosequestration, where vegetation and soil are used to extract the gas from the atmosphere and incorporate it into their living and growing matrix.

There is extensive literature on the pros and cons of each, but essentially:

- CCUS has not yet worked at a relevant scale, despite trials over 20 years at great expense. Only 375 million tonnes of carbon dioxide were captured over the past decade, during which 375 *billion* tonnes were released to the atmosphere (ie 0.1%)

Biosequestration faces other issues.

Although the greening of the planet profits from the uptake of carbon by vegetation and soil, the terrestrial environment is not an efficient means for reducing greenhouse gases.

- The dynamic between land and the atmosphere resulted in a net 4 billion tonnes being emitted in 2023 - and not sequestered (*Global Carbon Project)*.
- Manipulation of this dynamic is ineffective over the mid-to- longer term because *(Doolan):*
  - measurable capture and retention can take a decade after planting a crop, during which fossil fuel combustion continues unabated.
  - biosequestration effectiveness can be fickle. Factors contributing to this include variable microclimates; sporadic threats like bushfires, alien species invasion, and floods;
  - the suitability of nominated plant species and their gene-pools for the site selected for planting, may be inappropriate over the longer term and especially in the face of a changing climate;
  - the validity of sequestration performance audits has been found to be highly questionable of late.

However, *t*he debate over the relative strengths and weaknesses of carbon offsets became serious when 140 countries, covering 88% of global emissions, joined the *UN Net Zero Coalition* and committed to achieve net zero by 2050. Both CCUS and biosequestration will be fundamental to this, so the validity of the movement has been questioned**.**

Many private organizations have also replaced their efforts to reduce their emissions through offsets, including by trading in offshore voluntary carbon markets that issue unregulated credits. The credibility of many is stretched notwithstanding the efforts of The Integrity Council set up to improve it *(ICVCM)*.

Together these arrangements seriously challenge not only the imperative for the world to halve current emissions by 2030 to contain global heating, but also to achieve *negative* emissions after 2050 for the planet to remain habitable *(IPCC, 2018)*.

Exactly how negative emissions will be achieved if fossil fuel burning is happening at the same time, is very unclear.

Socio-economic implications

This analysis does not address the enormous social and economic issues already being faced across the globe because of the warmer climate. The list is long but features:

- competition and potential conflicts for dwindling fresh water supplies
- threats to food security from both drought and floods
- large numbers of refugees needing to be relocated from coastal areas that have either been submerged, experienced frequent flooding, or have lost their subsistence food industries

But it is clear from negotiations at recent meetings of UN bodies that there will also be increasing inequality in the capacity of different population groups to adapt to the climate changes as they progress.

Only those with the capital to invest in technologies that protect against extreme heat impacts, or to move to less hostile lands, will escape the worst of the outcomes.

There is also one other economic influence over the growing risk, and that is the disposition of the insurance industry worldwide.

The industry has the option of using differential pricing for climate risks based on the location of an applicant for an insurance policy, or the nature of the hazard expected to be experienced there. Or an insurance firm can choose not to offer risk cover anywhere that it considers to be unprofitable (and is doing so already).

Global re-insurers such as Munich Re and Swiss Re are fundamental to the financial sustainability of the world's insurance industry. Each has developed a sophisticated scientific platform for their continual monitoring of the threat and its expected trajectory, and to determine which of the risks they will be prepared to cover.

It is very clear that how they, and their individual insurance company clients, handle the emerging extreme threats will have a major influence on both the short and longer term economic performance of the many countries highly exposed to one or more of the risks.

Comment

A comprehensive climate impact surveillance program is in place across the planet that utilises a fleet of satellites to monitor the progress of global heating in the oceans, lower atmosphere, and on the land.

The data generated in real-time is integrated through collaboration between research centres in over a dozen countries, and coordinated by scientific entities within the United Nations and European Union.

The present threat level for all climate-related risks must factor in the reality that the environment changed only gradually between 1900 and 1980. The acceleration that followed now provides a far more hostile baseline for future climate risks, enhancing both their unpredictability and consolidating their inevitability.

While the world focuses on the implications of the +1.5°C and +2.0°C thresholds, the sensitivity of the global system is such that each additional +0.1°C increase in the Earth's temperature will create its own new hazard level.

In turn, this increases the variability in the data underpinning the climate risk analysis that has already lost some of the luxury of avoiding abrupt impacts. But now the response to even minor temperature changes will be heightened as well.

The total risk becomes acute however, when a wild-card is factored into the story: There are 'low probability of occurrence' scenarios but seriously high impacts that are not built into the international climate trajectory projections, and which could occur abruptly.

The scale of the potential loss associated with each could dwarf the progressive deterioration of the world climate as currently understood, and exert its effects rapidly.

Examples include:

- the loss of the Arctic Circle permafrost that will release an enormous mass of greenhouse gases over a short time period;
- the collapse of the Atlantic Meridional Overturning Circulation (AMOC). This will block the movement of the currents across the Atlantic Ocean that stabilise ambient temperatures across the Northern Hemisphere ;
- the collapse of the Thwaites Glacier in the western region of the Antarctic. Massive volumes of water will be released and have a rapid and significant impact on the height of the worlds oceans *(Bradley and Hewitt, 2024)*
- a die-off of the Amazon old growth forests. The biological destruction would be catastrophic, and climatic patterns would be destabilised far away.

The period 2028-2038 is therefore primed to determine the fate of the survival of life on the planet.

An optimistic outcome is difficult to picture.

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