The Urgency of Now – Understanding the Threats of Climate Change, by the Numbers

As COP26 gets underway in Glasgow, the system signalling unprecedented threats to the planet is blinking red. The UN World Meteorological Organization (WMO) announced yesterday that record greenhouse (GHG) concentrations and associated heat "have propelled the planet into uncharted territory, with far reaching repercussions for current and future generations." In its State of Global Climate 2021 Provisional Report, released today concurrently with the opening of COP26, the WMO concludes that the past seven years are on track to be the seven warmest on record and that global sea level rise accelerated since 2013 to a new high in 2021, with continued ocean warming and ocean acidification. WMO Secretary-General Professor Petteri Taalas warns that "[a]t the current rate of increase in greenhouse gas concentrations, we will see a temperature increase by the end of this century far in excess of the Paris Agreement targets of 1.5 to 2 degrees Celsius above pre-industrial levels. COP26 is a make-or-break opportunity to put us back on track."

The break-glass urgency flows from the fact that, left to its own devices, nature would take literally ages to get levels of CO_2 concentrations back to pre-industrial levels, which at 413 parts per million (ppm) currently are around 50% higher than pre-industrial levels (of around 280 ppm). Levels of methane and nitrous oxide in 2020 were 262% and 123% of pre-industrial levels. The increases continue.

As the Intergovernmental Panel on Climate Change (IPCC) concluded in August in its Sixth Assessment Report, it is unequivocal that human influence has warmed the atmosphere, ocean and land, resulting in widespread and rapid changes in the atmosphere, ocean, cryosphere (the portion of the planet where water is seasonally or continuously frozen as snow or ice) and biosphere. The scale of the changes are unprecedented. Human-induced climate change is affecting weather and climate extremes in every region across the globe, including heatwaves, heavy precipitation, droughts and tropical cyclones. Many changes in climate are exacerbated by global warming, including increases in the frequency and severity of hot extremes, marine heatwaves and heavy precipitation; agricultural and ecological droughts in some regions; and reductions in Arctic sea ice, snow cover and permafrost.

The IPCC warns that global warming of 1.5°C and 2°C will be exceeded by 2100 unless there are deep reductions in CO_2 and other GHG emissions in the coming decades. With further global warming, every region will experience concurrent and multiple changes in climatic-impact drivers. Changes in several such drivers would be more widespread at 2°C compared to 1.5°C global warming and even more widespread and/or pronounced at higher warming levels. The IPCC concludes that limiting human-induced global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least net zero CO_2 emissions (when most or all of CO_2 is removed by natural or human processes), along with strong reductions in other GHG emissions.

Climate scientists and others have been pleading with us for years to take action to address the looming threat. Is part of our collective problem in accepting the urgency of reducing GHG emissions that time horizons of 2030 or 2050 simply are too remote to grasp? Or is the challenge that thinking in 1.5°C or 2°C increments of global warming somehow minimizes the problem, allowing us to change the subject? Or is it simply the enormity of the climate undertaking and the complexity of the solutions?

I turned to the IPCC Special Report (2018) to try to put 1.5°C and 2°C into context, and the takeaways are sobering:

- Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate. (Global warming is defined by the IPCC as an increase over a 30-year period in global mean surface temperature which is the estimated global average of near-surface air temperatures over land and sea ice, and sea surface temperatures over ice-free regions. Generally, warming is expressed relative to the period 1850–1900, used as an approximation of pre-industrial temperatures.)

- Temperature change is not uniform across the globe. In many regions warming has already exceeded 1.5°C. Most land regions are experiencing greater warming than the global average, while most ocean regions are warming at a slower rate. Depending on the temperature dataset considered, 20–40% of the global human population live in regions that, by 2006–2015, had already experienced warming of more than 1.5°C above pre-industrial levels in at least one season.
- Past emissions alone are unlikely to raise global-mean temperature to 1.5°C above pre-industrial levels, but past emissions do give rise to other changes, such as sea level rise. In other words, warming greater than 1.5°C is not geophysically unavoidable. Whether it can be avoided, depends on future rates of reductions in emissions. In short, ambitious mitigation actions are indispensable to limit warming to 1.5°C while achieving sustainable development and poverty eradication.
- Under emissions in line with current pledges under the Paris Agreement (known as Nationally Determined Contributions, or NDCs), global warming is expected to exceed 1.5°C above pre-industrial levels, even if pledges are supplemented by increases in the scale and ambition of mitigation after 2030.
- In comparison to a 2°C limit, the transformation required to limit warming to 1.5°C is similar but more pronounced and rapid over the next decades. Limiting warming to 1.5°C implies reaching net zero CO_2 emissions globally around 2050 and concurrent significant reductions in emissions of "non-CO_2 forcers," such as methane. Limiting warming to 1.5°C depends on greenhouse gas (GHG) emissions over the next decades, where lower GHG emissions in 2030 lead to a higher likelihood of keeping peak warming to 1.5°C.
- Exposure to multiple and compound climate-related risks is projected to increase between 1.5°C and 2°C of global warming with more people both exposed, and susceptible, to poverty in Africa and Asia. From 1.5°C to 2°C, energy, food and water threats could overlap in time and location, creating new, and exacerbating existing, vulnerabilities that affect increasing numbers of people and areas of the world.
- Limiting global warming to 1.5°C compared to 2°C would:
  - limit risks of increases in heavy precipitation events on a global scale and in several regions;
  - substantially reduce the probability of extreme drought, precipitation deficits and risks associated with water availability (i.e., water stress) in some regions; and
  - reduce risks to natural and human systems.
- Ocean ecosystems are already experiencing large-scale changes, and critical thresholds are expected to be reached at 1.5°C and higher levels of global warming.

Higher temperatures

- The strongest warming of extreme temperatures is likely to occur in central and eastern North America, central and southern Europe, the Mediterranean region (including southern Europe, northern Africa and the Near East), western and central Asia, and southern Africa. The number of exceptionally hot days are expected to increase the most in the tropics, where inter-annual temperature variability is lowest; extreme heatwaves are likely to emerge earliest in these regions, and are expected to be widespread there at 1.5°C warming. At 1.5°C warming, 13.8% of the world's population would be exposed to "extreme heatwaves" at least once every five years, and at 2°C warming the percentage increases to 36.9%, corresponding to a difference of about 1.7 billion people. Limiting global warming to 1.5°C instead of 2°C could result in about 420 million fewer people being frequently exposed to extreme heatwaves, and about 65 million fewer people being exposed to "exceptional heatwaves," assuming constant vulnerability.

- At mid-latitudes, the hottest days will be up to 3°C hotter at 1.5°C warming and up to 4°C hotter at 2°C warming. The warmest extreme temperatures will be in Central and Eastern North America, Central and Southern Europe, the Mediterranean (including Southern Europe, Northern Africa and the near-East), Western and Central Asia and Southern Africa.
- At warming above 1.5°C, twice as many megacities (such as Lagos and Shanghai) are likely to become heat stressed, potentially exposing 350 million more people by 2050. In the absence of adaptation strategies, at 2°C warming, the heatwaves India and Pakistan experienced in 2015 could occur annually and the risk of heatwaves in China's urban areas will increase. Stabilizing at 1.5°C instead of 2°C could decrease mortality from extreme temperatures in key European cities.

Drought

- Limiting global warming to 1.5°C compared to 2°C would reduce the risk of drought, and 60.% million fewer people may be exposed to severe drought with 1.5°C warming compared to 2°C warming.

Water scarcity

- Depending on future socio-economic conditions, limiting global warming to 1.5°C compared to 2°C may reduce by up to 50% the proportion of the world population exposed to climate change-induced increases in water stress. People inhabiting river basins, particularly in the Middle East and Near East, are projected to become newly exposed to chronic water scarcity even if global warming does not exceed 2°C. Depending on the scenario (Shared Socioeconomic Pathways), exposure to the increase in water scarcity in 2050 could impact 184–270 million fewer people at 1.5°C warming compared to 2°C.

Heavy Precipitation

- Limiting warming to 1.5°C would limit risks of increases in heavy precipitation events on a global scale and in several regions compared to conditions at 2°C warming. The regions with the largest increases in heavy precipitation events for 1.5°C to 2°C global warming include: several high-latitude regions (e.g. Alaska/western Canada, eastern Canada/Greenland/Iceland, northern Europe and northern Asia); mountainous regions (e.g., Tibetan Plateau); eastern Asia (including China and Japan); and eastern North America.

Sea Level Rise/Oceans

- Sea level rise and other oceanic climate changes have led to salinization, flooding and erosion and, in the future, are projected to affect human and ecological systems, including health, heritage, freshwater availability, biodiversity, agriculture, fisheries and other services, with different effects globally.
- Global mean sea level rise is projected to be around 0.1 meter less by 2100 with 1.5°C warming than 2°C warming. A smaller sea level rise could mean 10.4 million fewer people would be exposed to sea level rise, assuming no adaptation. With a 1.5°C stabilization scenario in 2100, 62.7 million people per year are at risk from flooding. Coastal flooding is projected to cost trillions of dollars annually. A slower rate of sea level rise should increase

the likelihood of adaptation. Both Greenland and Antarctic ice sheets are vulnerable, which could result in multi-meter sea level rises over time horizons of century to millennia, and could be triggered at warming of 1.5°C or 2°C.

- Ocean warming and acidification caused by absorption of about 30% of anthropogenic carbon dioxide, corresponding to 1.5°C warming, would impact a wide range of marine organisms and ecosystems. Larger risks are expected for many regions and systems for global warming at 1.5°C, as compared to today, with adaptation required now and up to 1.5°C. However, risks would be greater at 2°C warming and yet greater efforts would be needed for adaptation at that level.
- The probability of a sea ice-free Arctic Ocean during summer is substantially higher at 2°C (projected at once a decade) compared to 1.5°C (projected at once a century) of global warming.
- 1.5°C warming is projected to shift the ranges of many marine species to higher latitudes, increase the amount of damage to many ecosystems and drive the loss of coastal resources and reduction of productivity of fisheries and aquaculture (especially at low latitudes). Coral reefs are projected to decline by a further 70–90% at 1.5°C with larger losses (>99%) at 2°C. The risk of irreversible loss of many marine and coastal ecosystems increases with global warming, especially at 2°C or more.

Impact on human beings

- Climate-related risks to health, livelihoods, food security, water supply, human security and economic growth are projected to increase with 1.5°C warming and increase further with 2°C warming. Regions such as Arctic ecosystems, dryland regions, small island developing states and least developed countries are at higher risk. Poverty is expected to increase in some populations as global warming increases; limiting global warming to 1.5°C, compared with 2°C, could reduce the number of people both exposed to climate-related risks and susceptible to poverty by up to several hundred million by 2050.
- At warming of 2°C, compared to 1.5°C, there are higher levels of heat-related morbidity and mortality, as well as higher reductions in yields of maize, rice, wheat and potentially other cereal crops, particularly in sub-Saharan Africa, Southeast Asia and Central and South America. The same is true for food availability in the Sahel, southern Africa, the Mediterranean, central Europe and the Amazon, and for livestock. Risks increase for some vector-borne diseases such as malaria and dengue fever.
- Economic growth will suffer to a greater extent with 2°C warming particularly in low-income countries (Africa, Southeast Asia, India, Brazil and Mexico). Tourism has already been affected by global warming, and certain geographic regions and seasonal tourism will experience further reductions at 1.5°C warming. Risks to coastal tourism in subtropical and tropical regions will increase with temperature-induced degradation and/or loss of beach and coral reef assets.
- Sea level rise and changes to salinity of coastal groundwater, increased flooding and damage to infrastructure will affect vulnerable environments such as small islands, low-lying coasts and deltas.

What this all means

There is an endless supply of studies and reports that get us to the same place. The threats to the planet are real, and concerted action across policy-makers and legislators, across businesses and across society is necessary to avert a catastrophic result. If there is one motivation to act for those still unsure and for whom the fact that it rained rather than snowed for the first time ever at the peak of the Greenland ice sheet, glaciers in Canada are melting, heatwaves in parts of the United States and Canada pushed temperatures up to unprecedented levels, devasting fires accompanied exceptional heat in the Mediterranean region, a month of rainfall fell during a few hours in China and severe floods ravaged parts of Europe – all this year, are unconnected, it should be the realization that the science is real and that meeting the 1.5/2.0°C targets is existential. The delta between impacts of 1.5°C versus 2.0°C warming is itself alarming, and it is not hard to extrapolate from the data the likely impact if the world is unable to limit warming to 2.0°C.

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