Framework Convention on
Climate Change

Summary report on the second meeting of the structured expert dialogue on the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it

Report by the co-facilitators

18 May 2022

Contents

Page

	Abbreviations and acronyms	3
I.	Introduction	4
	A. Mandate	4
	B. Objective of and general approach to the second meeting of the SED	4
	C. Summary of proceedings	5
II.	Summary of discussions	6
	A. Long-term global goal and scenarios towards achieving it	6
	B. Assessing the overall aggregated effect of the steps taken by Parties	26
	C. Challenges and opportunities	32
III.	Reflections	36

Abbreviations and acronyms

AR	Assessment Report of the Intergovernmental Panel on Climate Change
CMIP6	World Climate Research Programme Coupled Model Intercomparison Project Phase 6
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
COP	Conference of the Parties
COVID-19	coronavirus disease 2019
ESCWA	Economic and Social Commission for Western Asia
G20	Group of 20
GDP	gross domestic product
GHG	greenhouse gas
IEA	International Energy Agency
IPAC	International Programme for Action on Climate of the Organisation for Economic Co-operation and Development
IPCC	Intergovernmental Panel on Climate Change
LDC	least developed country
NDC	nationally determined contribution
OECD	Organisation for Economic Co-operation and Development
SCF	Standing Committee on Finance
SED2	structured expert dialogue under the second periodic review of the long-term global goal
SIDS	small island developing State(s)
SOFF	Systematic Observations Finance Facility
SR1.5	Intergovernmental Panel on Climate Change Special Report on Global Warming of 1.5 °C
SSP	shared socioeconomic pathways
UNEP	United Nations Environment Programme
WG I	Working Group I of the Intergovernmental Panel on Climate Change
WMO	World Meteorological Organization
WMO-RCC	Regional Climate Centre of the World Meteorological Organization

I. Introduction

A. Mandate

1. COP 25 decided that the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it shall start in the second half of 2020 and conclude in 2022, with SED2 held in conjunction with sessions of the subsidiary bodies, starting at their fifty-third sessions (November 2020) and being completed at their fifty-fifth sessions (November 2021).[1]

2. COP 25 agreed that the outcome of the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it will not lead to an alteration or redefinition of the long-term global goal stated in decision 10/CP.21, and decided that the review itself should, in accordance with the relevant principles and provisions of the Convention and on the basis of the best available science:

(a) Enhance Parties' understanding of:

(i) The long-term global goal and scenarios towards achieving it in the light of the ultimate objective of the Convention;

(ii) Progress made in relation to addressing information and knowledge gaps, including with regard to scenarios to achieve the long-term global goal and the range of associated impacts, since the completion of the 2013–2015 review;

(iii) Challenges and opportunities for achieving the long-term global goal with a view to ensuring the effective implementation of the Convention.

(b) Assess the overall aggregated effect of the steps taken by Parties in order to achieve the long-term global goal in the light of the ultimate objective of the Convention.[2]

B. Objective of and general approach to the second meeting of the structured expert dialogue

3. As mandated by COP 25, three meetings of SED2 will be held and will consider a range of sources of information, as they become available, on both themes of the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it. The final summary report of SED2 will consolidate all aspects considered at each of the three planned meetings in a comprehensive manner. Parties nominated Tara Shine (Ireland) and Xiang Gao (China) to co-facilitate SED2.

4. The objective of SED2 is identified in paragraph 2 above. Information sources for the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it include the ARs, special reports and technical papers of the IPCC; submissions and information from Parties; other relevant reports of United Nations agencies and other international organizations; and information from regional and subregional agencies. The first periodic review[3] identified other processes that would be relevant to the review, without prejudice to any further discussions that Parties might have on the identification of these processes.[4] The SED2 co-facilitators followed the precedent of the first periodic review and added processes that had been established after 2015, such as the Facilitative Working Group of Local Communities and Indigenous Peoples Platform and the Katowice Committee of Experts for the Impacts of the Implementation of Response Measures.[5]

1 Decision 5/CP.25, para. 7.

2 Decision 5/CP.25, paras. 4–5.

3 The first periodic review took place from 2013 to 2015 and is available at https://unfccc.int/topics/science/workstreams/periodic-review#eq-1.

4 FCCC/SB/2014/INF.3, para. 6.

5 See presentation by the SED2 co-facilitators, available at https://unfccc.int/sites/default/files/resource/1.per cent20Overarchingper cent20presentationper cent20byper cent20theper cent20SEDper cent20CFsper cent20v02.pdf.

5. In line with the periodic review modality to consider information as it becomes available, discussions at the second meeting of SED2 were primarily informed by the content of the WG I contribution to AR6, the Fourth Biennial Assessment and Overview of Climate Finance Flows of the SCF, the UNEP Emissions Gap Report,[6] the first regional State of the Climate 2020 reports of WMO, and other recently published reports by OECD and the Third World Network. In addition, to complement the discussions at the second meeting of SED2, a virtual poster session was organized and accessible throughout the Conference.

6. Building on the approach adopted at previous SED meetings, the second meeting of SED2 was organized to facilitate the exchange of views between experts and Parties. Provisions were made to enable virtual participation for delegates unable to travel to Glasgow owing to the COVID-19 pandemic.

7. The presentations, posters and discussions at the meeting were guided by the following questions:

(a) What new knowledge has your organization or agency gathered regarding the scenarios towards achieving the long-term global goal in the light of the ultimate objective of the Convention?

(b) What progress has your organization or agency made in relation to addressing information and knowledge gaps, including with regard to scenarios to achieve the long-term global goal and the range of associated impacts, since the completion of the 2013–2015 review?

(c) What challenges and opportunities have your organization or agency identified for achieving the long-term global goal, with a view to ensuring the effective implementation of the Convention?

(d) What assessments does your organization or agency have of the overall aggregated effect of the steps taken by Parties in order to achieve the long-term global goal in the light of the ultimate objective of the Convention?

C. Summary of proceedings

8. The second meeting of SED2 took place on 1 and 2 November 2021, during the United Nations Climate Change Conference in Glasgow. The meeting was held in two sessions: session 1 from 3 p.m. until 6 p.m. on 1 November 2021, focusing on global aspects, and session 2 from 3 p.m. until 6 p.m. on 2 November 2021, reflecting regional perspectives. Prior to each session, a virtual poster question and answer session was held from 1.15 p.m. to 2.45 p.m. for poster authors to interact with delegates. At each session, brief presentations by experts were followed by a facilitated dialogue among Parties and experts to clarify possible interpretations of the findings presented and their policy implications. Considering the rich content of the WG I report, a team of WG I authors[7] joined the SED plenary to support the WG I Co-Chairs in responding to questions and comments on aspects of the WG I report from Parties and observers. All presentations delivered by invited experts at the meeting, together with the posters and the video recording of the plenary proceedings, are available on the SED2 web page.[8]

9. The two sessions consisted of presentations by experts on findings relevant to the two themes of the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it. Based on the modalities of the periodic review, the co-facilitators strove to ensure a balance in terms of gender of experts invited, as well as the regions of their origin. The co-facilitators made arrangements to ensure a balance of time allocated to each of the two themes of the period review, although it was noted the interactions among Parties and experts on the first theme attracted relatively more interest. In response to requests from Parties following the first meeting of SED2 for more time dedicated to open discussion, two hours (of the total three hours) within each session of the second meeting of SED2 were allocated for open dialogue among Parties

[6] The UNEP Adaptation Gap Report 2021 was launched on 4 November 2021, so not presented at the second meeting of SED2 but shall be considered at the third meeting.

[7] The following WG I authors joined SED as experts and responded to questions from Parties and observers: Pep Canadell, Piers Forster, Helene Hewitt, June-Yi Lee, Joeri Rogelj, Sophie Szopa, and Peter Thorne on 1 November, and Erika Coppola, Richard Jones, Izidine Pinto, Alex Ruane and Sonia Seneviratne on 2 November.

[8] See https://unfccc.int/event/second-meeting-of-the-structured-expert-dialogue-of-the-second-periodic-review.

and experts. Organizations and agencies invited to present at one session were also invited to participate in the discussions at the other session. This ensured a richer exchange and the participation of a wider range of experts on both themes. In particular, the majority of the IPCC experts participated in both sessions, thereby ensuring the scientific integrity of the dialogue.

10. Structured around the key topics of the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it, this report provides a summary of the presentations and discussions from the second meeting of SED2. The report does not aim to present an exhaustive assessment of the issues pertinent to the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it, as it documents the dialogue held in a thematic rather than chronological way. Furthermore, the views expressed by experts during the dialogue and captured here should not be seen as taking precedence over the findings of WG I contribution to AR6 or the reports from other organizations considered at the meeting.

II. Summary of discussions

11. Discussions at the second meeting of SED2 are summarized below under the two themes of the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it.

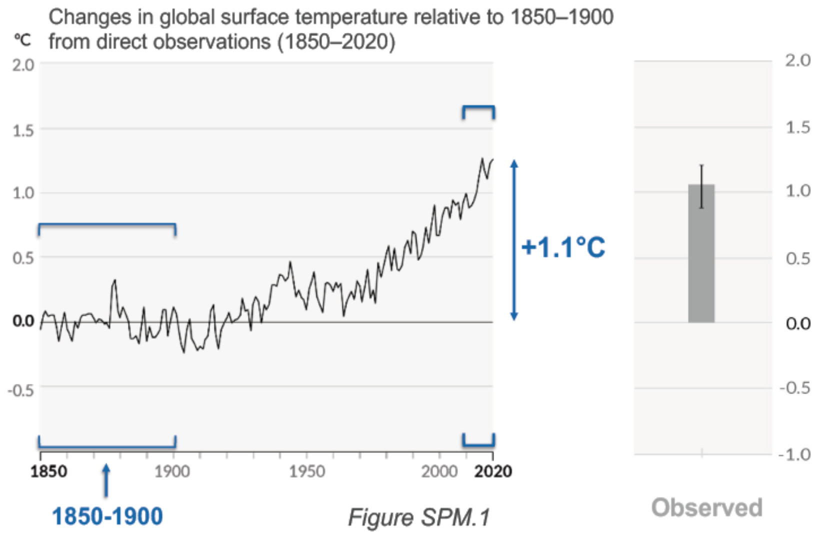
A. Long-term global goal and scenarios towards achieving it

1. Understanding of observed changes in and human influence on the climate system

12. The Co-Chairs of WG I presented the key findings of the WG I contribution to AR6. Published in August 2021, the WG I contribution focuses on the physical science basis for climate change and the key finding of the report is that the scale of the widespread and rapid changes observed in the atmosphere, ocean, cryosphere and biosphere and across the climate system as a whole is unprecedented in many centuries to many thousands of years; and human influence on the climate system is unquestionable.

13. As shown in figure 1 below, global surface temperature warming has reached 1.1 °C relative to 1850–1900 in the past 10 years. Methodological advances and new data sets contributed approximately 0.1 °C to the updated estimate of warming, compared with that stated in AR5. Further warming has been recorded since 2003–2012, adding around 0.19 °C to the warming reported in AR5.

Figure 1: **Observed changes in global surface temperature relative to 1850–1900**



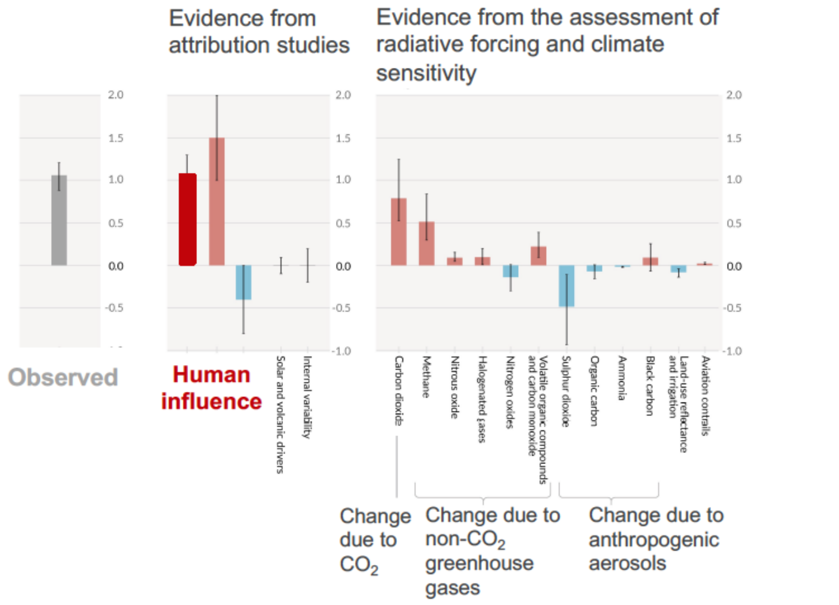
Source: slide 2 of Part 1 presentation by WG I Co-Chairs.

14. Regarding the contribution of human activities to observed warming, figure 2 below shows that observed warming is driven by emissions from human activities. Warming resulting from GHG emissions is slightly masked by aerosol cooling. While natural variability plays no role in centennial global warming, it has a large effect at regional and decadal scales. The understanding of the IPCC regarding human influence on observed warming has been strengthened by combining two lines of evidence from attribution studies, as well as the assessment of radiative forcing and climate sensitivity.

15. Since 2013, human-caused radiative forcing has increased by around 20 per cent, driven by the increase in atmospheric concentration in GHGs and the recent decrease in the global cooling effect of pollution particles and aerosols. Warming to date has primarily been driven by emissions of CO_2, which also drive ocean acidification. Methane emissions, which have both direct and indirect heat-trapping effects, also play a large role. The aerosol cooling effect is dominated by emissions of sulfur dioxide, which peaked at the global scale in the late twentieth century, with varying regional patterns.

16. In addition to the information on global aspects, regional information makes up one-third of the WG I contribution to AR6. Human-induced climate change is already affecting every region on Earth, with human influence contributing to many observed changes in weather and climate extremes. The changes experienced will increase with further warming.

Figure 2: **Contribution of human activities to observed warming**



Source: Slide 4 of part 1 presentation by WG I co-chairs, adapted from WG I contribution to AR6, figure SPM.2, which shows assessed contributions to observed warming in 2010–2019 relative to 1850–1900. Left panel: observed global warming (increase in global surface temperature). Whiskers show the very likely range. Middle panel: evidence from attribution studies, which synthesize information from climate models and observations. The panel shows temperature change attributed to human influence (total human influence; changes in well-mixed GHG concentrations; other human drivers due to aerosols, ozone and land-use change [land-use reflectance]); solar and volcanic drivers; and internal climate variability. Whiskers show likely ranges. Right panel: evidence from the assessment of radiative forcing and climate sensitivity. The panel shows temperature changes from individual components of human influence: emissions of GHGs, aerosols and their precursors; land-use changes (land-use reflectance and irrigation); and aviation contrails. Whiskers show very likely ranges. Estimates account for both direct emissions into the atmosphere and their effect, if any, on other climate drivers. For aerosols, both direct effects (through radiation) and indirect effects (through interactions with clouds) are considered.

17. Complementing key findings from the WG I contribution to AR6, regionally observed patterns in key climatic variables, as reported in the first edition of the WMO regional State of the Climate series, were also presented by representatives of the five WMO-RCCs, namely Andre Kamga Foamouhoue for Africa, Atsushi Goto for Asia, Stefan Rösner for Europe, José Marengo for Latin America and the Caribbean, and Blair Trewin for South-West Pacific. Table 1 below provides a summary of regional information presented at the plenary and in the posters. As highlighted by Andre Kamga Foamouhoue, regional information is critically important, as globally obtained information is often inadequate in capturing regional climate features.

18. Parties discussed the extent to which data and information provided by WMO-RCCs have been used to support action and steps taken by Parties towards achieving the long-term global goal. Stefan Rösner explained that, typically, WMO-RCCs collect and share data, provide climate monitoring and prediction, and enable their members, through national meteorological services, to serve their users at the national level without interfering with the operations of individual national meteorological services. On an exceptional basis, however, some WMO-RCCs also provide value added products and services such as fire weather forecasts to members in their regions. For example, WMO-RCC Africa offers three levels of service: advisory information to raise awareness, watches to alert people to get ready, and warnings to urge people to act. Further, Parties discussed with experts the contributions that WMO-RCCs could make to attribution science. It was noted that, although attribution analysis is not yet carried out routinely by WMO-RCCs, data collected at regional level would contribute to attribution studies, including through the provision of better access to observational data at a regional scale. Given the limited research capacity in many national meteorological services, WMO-RCCs are critical for building a strong original research capacity by tapping into expertise available in member countries and then supporting national meteorological services, which provide the basis and advice for Parties' actions and steps taken to achieve the long-term global goal.

Table 1: **Key trends in regional climate and associated impacts in 2020**

	Climate Indicators	*Climate Extremes*	*Impacts*
Africa	• Land surface temperature: average near-surface (2 m) air temperature across the continent was between 0.45 °C and 0.86 °C above the 1981–2010 average, making it between the third and eighth warmest year on record; • Sea surface temperature: sea surface temperature over the equatorial central Pacific region was close to El Niño thresholds in early 2020 but reached moderate La Niña conditions in October, conditions typically associated with above average summer precipitation over the Sahel; • Rainfall: many parts of the continent experienced heavy rainfall, causing the bursting of the Congo River and the Mayo Palar. Other lakes and rivers reached record high levels, including Lake Victoria and the Niger River at Niamey and the Blue Nile at Khartoum; • Glacier mass balance: if current retreat rates prevail, the African mountains will be deglaciated by the 2040s and Mount Kenya might be deglaciated by the 2030s, making it one of the first entire mountain ranges to lose its glaciers due to anthropogenic climate change; • Sea level: regional trends around the African continent show that the rates of sea level rise on the Atlantic side of Africa are uniform and close to the global average, and slightly higher than average on the Indian Ocean side.	• Heat waves: anomalies of monthly mean temperature reached +3.5 °C in Algeria and +4.0 °C in Morocco. In Tunisia, it was the third hottest year since 1950, after 2016 and 2014, with an average temperature of 20.2 °C and an anomaly of +0.9 °C; • Tropic cyclones: Tropical Cyclone Gati became the strongest storm ever to hit Somalia. The storm brought heavy rain to the region, with at least nine people killed, tens of thousands displaced and thousands of properties destroyed; • Floods: flooding was extensive across many parts of East Africa, with the Sudan and Kenya the worst affected, 285 deaths reported in Kenya, and 155 deaths and over 800,000 people affected recorded in the Sudan; • Drought: long-term drought continued to persist in parts of Southern Africa, particularly the Northern and Eastern Cape Provinces. In Morocco, dry conditions persisted and the rainy season was one of the four driest years since 1981.	• Food security and socioeconomic development: nearly half of the population in sub-Saharan Africa live below the poverty line and depend on weather-sensitive activities, such as rain-fed agriculture, herding and fishing, for their livelihoods. Approximately 98 million people suffered from acute food insecurity and needed humanitarian assistance in Africa, almost a 40 per cent increase from 2019; • Displacement: An estimated 1.25 million people were displaced in Burkina Faso, Mali and Niger, which were all already facing conflict and food insecurity, as well as forced internal and cross-border population movements.
Asia	• Land surface temperature: the average land surface air temperature across Asia was approximately 1.39 °C above the 1981–2010 average, making it the highest on record; • Sea surface temperature and ocean heat content: the Asian oceanic area showed an overall warming trend. The rates of surface ocean warming for areas of the Kuroshio Current, the Arabian Sea, the southern part of the Barents Sea, the Kara Sea and the south-eastern part of the Laptev Sea were three times higher than the global rate; • Precipitation: an unusual wet spell persisted in the summer over the regions from the Yangtze River basin, the Republic of Korea to western and eastern Japan, associated with the persistent East Asian summer monsoon. In China, the cumulative monsoon rainfall over the affected region was the highest since records began in 1961;	• Heat waves: many parts of Asia and surrounding oceans experienced heat events, with temperatures reaching 38.0 °C at Verkhoyansk on 20 June, provisionally the highest known temperature anywhere north of the Arctic Circle; • Tropical cyclones: Cyclone Amphan, one of the strongest cyclones ever recorded, hit densely populated coastal areas in Bangladesh and India during the rapid spread of COVID-19 in May; • Floods: floods and storms affected approximately 50 million people, including over 5,000 lives lost in the region. In Karachi, a devastating urban flooding event occurred, affecting millions of people and inflicting widespread infrastructure damage;	• Food security: 48.8 million people in South-East Asia, 305.7 million in South Asia and 42.3 million in West Asia are estimated to have been undernourished. Extreme events contributed to a worsening food insecurity situation in many countries already afflicted by conflict and COVID-19; • Displacement: climate and weather events had major and diverse impacts on population movements and on the vulnerability of people on the move in Asia. Cyclone Amphan displaced 2.4 million people in India, and 2.5 million people in Bangladesh. During monsoon season, torrential rainfall and ensuing

	Climate Indicators	*Climate Extremes*	*Impacts*
	• Glacier mass balance: in the past 40 years, all four glaciers with relative long-term observations in the High-Mountain Asia region experienced mass loss, with an accelerating trend in the twenty-first century; • Sea ice extent: in the summer, the Eurasian shelf seas and the Northern Sea Route were completely ice-free and the 3.9 million km^2 minimum sea ice extent reached in September was the second lowest minimum sea ice extent since 1979; • Sea level: in Asia, the North Indian Ocean (3.70 +/- 0.1 mm/year) and the north-west Pacific Ocean (3.68 +/- 0.1 mm/year), the rates of sea level change were significantly higher than the global mean rise.	• Sandstorms: Saudi Arabia experienced major sand and dust storms from 9 to 10 May, with winds exceeding 56 km/h. The strongest sand and dust storm occurred in north-western China from 8 to 10 March, affecting agricultural facilities, aircraft shipping and air pollution levels.	flooding and landslides through the Rohingya refugee settlements in Cox's Bazar, Bangladesh, forced refugees living there to move once again; • Socioeconomic development: extreme events such as tropical cyclones, floods and droughts caused an estimated average annual loss of several hundred billion dollars.
Europe	• Sea level: the mean sea level has been rising, albeit unevenly, in the region. For the North-West Shelf, the mean sea level rose at a rate of 2.9±0.83 mm/year between 1993 and 2020.	• Heatwaves: 17 of the top 23, including 9 of the top 10, heatwave events of 1950–2021 have occurred since 2000.	
Latin America and the Caribbean	• Land surface temperature: it was one of the three warmest years on record for Mexico, Central America and the Caribbean, and the second warmest year for South America. Temperatures were 1.0 ℃, 0.8 ℃ and 0.6 ℃ above the 1981–2010 average, respectively; • Precipitation: lower than average rainfall was observed in Mexico and many countries in Central America, including Belize, Guatemala, Nicaragua and Panama. There was above average rainfall in South Paraguay, parts of Peru and the semi-arid region of North-East Brazil, on the Pacific coast of Costa Rica, El Salvador and in Jalisco in Mexico; • Sea surface temperature in the tropical North Atlantic Ocean was significantly warmer than usual throughout the year. In the Caribbean, it was the year with the highest positive anomalies on record; • Glacier mass balance: in the Chilean and Argentine Andes, glaciers have been retreating during the last decades. Ice mass loss has accelerated since 2010, in line with an increase in seasonal and annual temperatures and a significant reduction in annual precipitation in the region; • Sea level rise in the region is not uniform. The trend is rising at a higher rate than the global average along the Atlantic coast of South America, as well as in the Caribbean Sea and Gulf of Mexico.	• Heatwaves: a series of heatwaves and extreme temperatures affected several places in South America and induced favourable weather conditions for wildfires, in particular in the Amazonian Forest; • Cold waves: in August, a cold wave affected most of Brazil, reaching as far as western Amazonia. A high-pressure blocking pattern over southern Patagonia led to extremely low temperatures and produced significant accumulation of snow depth; • Tropical cyclones: Hurricanes Eta and Iota reached category 4 intensity and made landfall in the same region in quick succession; they followed identical paths across Nicaragua and Honduras, affecting the same areas and exacerbating related impacts; • Floods: heavy rains and related floods, flash floods and landslides affected Bolivia (Plurinational State of), Brazil, Colombia, Ecuador, Peru and Uruguay, destroying infrastructure, affecting thousands of people and claiming lives; • Drought: widespread drought across the Latin America and the Caribbean region has had a significant impact on inland shipping routes,	• Food security: extreme weather events affected over 8 million people across Central America, exacerbating food insecurity in countries already crippled by economic shocks, COVID-19 restrictions and conflict. Drought conditions had a significant impact on crop yields, with almost 80 per cent of maize grown in Guatemala's highland region lost. In Mexico, the Cerritos municipality suffered a 50 per cent drop in cultivated crops owing to the drought, including for sorghum, sunflower and corn; • Infrastructure loss and damage: Hurricanes Eta and Iota, two category 4 hurricanes, were among the most destructive events of the year for Latin America and the Caribbean. In Nicaragua alone, 1.8 million people were affected, including damages to 220,000 ha of cultivated land and losses of 43,667 livestock animals. Material damages were estimated to be approximately USD 172 million, while immediate

	Climate Indicators	*Climate Extremes*	*Impacts*
		crop yields and food production, leading to worsening food insecurity in many areas; Wildfires: the fire season over the Pantanal was the most catastrophic yet, with burned area over more than 26 per cent of the region, four times larger than the long-term average observed between 2001 and 2019.	restoration costs were around USD 36.4 million.
South-West Pacific	• Land surface temperature: it was the second or third warmest year on record in the region. Depending on the data set used, average near-surface land and ocean temperatures across the region were about 0.37–0.44 ℃ above the 1981–2010 average; • Sea surface temperature and ocean heat content: the ocean area shows overall warming from 1982 to 2020, in particular in the Tasman Sea, the Indian and Pacific Oceans and in the west of the Timor Sea, where rates of warming are three times faster than the global rate; • Precipitation: it was a relatively wet year over many parts of Indonesia, extending south-east into Fiji, parts of Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu. Pago Pago, American Samoa and Pekoa, Vanuatu both had their wettest years on record; • Glacier mass balance: the glaciers near Puncak Jaya are remnants of glaciers that have existed for around 5,000 years and have been retreating since approximately 1850 CE. Models predict that total ice loss can be expected between 2024 and 2026 if current retreat rates continue; • Sea level: in the North Indian Ocean and in the western part of the tropical Pacific Ocean, the rates of sea level rise are substantially higher than the global mean, with significant implications for SIDS.	• Marine heat waves: in February, high temperatures affected the entire Great Barrier Reef region of Australia. Widespread coral bleaching was reported, the third mass bleaching event in the past five years; • Tropical cyclones: Tropical Cyclones Harold and Yasa and Typhoon Goni caused extensive damage in Fiji, the Philippines, Solomon Islands, Tonga and Vanuatu. Typhoon Goni (Super Typhoon Rolly) had one of the most intense landfalls of any tropical cyclone on record; • Floods affected the far south of New Zealand in early February. A total of 509 mm fell on 3 February in Milford Sound, while the inland town of Lauder had its wettest day on record, causing numerous evacuations; • Wildfires: the unprecedented 2019–2020 wildfire season in eastern Australia led to heavy loss of life and property and severe smoke pollution, with direct fire impacts, and contamination of rivers by ash and debris, also leading to major losses of wildlife.	• Food insecurity and socioeconomic development: extreme weather events led to significant disruption across various sectors, including agricultural, with significant consequences for approximately 2.7 million people who were estimated to have been undernourished in the region. In Vanuatu, Cyclone Harold damaged between 22 and 66 per cent of crops and caused approximately 19.6 billion vatu (USD 177 million) of damage to the agriculture sector. In Fiji, Tropical Cyclone Yasa affected an area of predominantly subsistence agriculture, damaging approximately 83 per cent of total cropland; • Displacement: climate and weather events had major and diverse impacts on population movements and on the vulnerability of people on the move in the region throughout the year. The Philippines was the most affected country, recording 4.4 million new displacements. Vanuatu was also hard-hit, particularly relative to its population size, with Cyclone Harold causing 80,000 new displacements, accounting for nearly a quarter of the population.

Source: Posters and presentations by representatives of WMO-RCCs for Africa, Asia, Latin America and the Caribbean, and South-West Pacific, and presentation by the representative of the WMO-RCC for Europe.

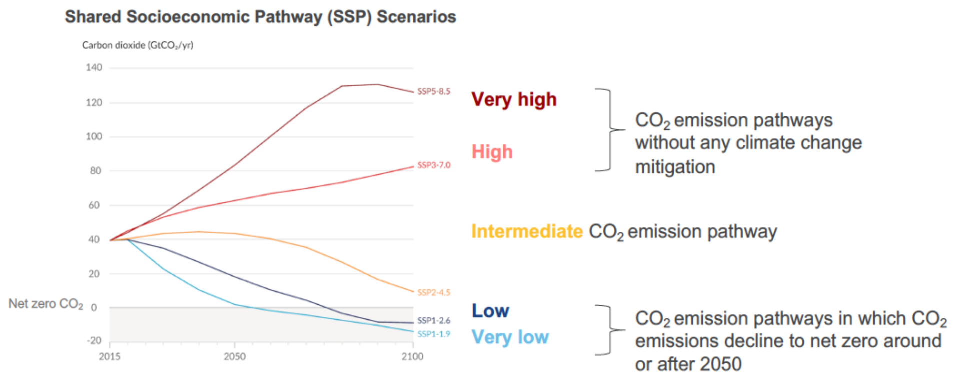
19. Parties inquired about the discrepancies between observed changes in temperature reported by the IPCC and some WMO-RCCs. WMO-RCC experts explained that, although the ARs and the WMO regional State of the Climate reports are based on the same global databases, regional observed changes in WMO reports are estimated using slightly different baseline periods and lengths of data series. For example, some regional assessments tend to use the more recent data series (e.g. the past 20 or 30 years) which are more complete and of better quality in general. In addition, a WG I expert noted that, given that the WMO regional State of the Climate reports are a relatively new initiative, it is important to ensure that there is sufficient coordination between the IPCC and WMO on these activities in the future.

20. In response to a Party's query over the information pertinent to small islands in the WG I report, an IPCC expert noted that small islands feature in various parts of the WG I report and outreach products, including chapters on observed changes, the water cycle and tropical cyclones, Atlas.10 on small islands, cross-chapter box Atlas.2, the interactive atlas, and the fact sheet for small islands.

2. Understanding of emissions scenarios and climate futures

21. To understand possible future global surface temperature trends, the WG I report uses a core set of illustrative scenarios, SSP1–1.9, SSP1–2.6, SSP2–4.5, SSP3–7.0 and SSP5–8.5, to explore the climate response to a broad range of GHG, land-use and air pollutant futures (figure 3 below). They span a broader range of GHG and air pollutant futures than those assessed in AR5. High (SSP3–7.0) and very high (SSP5–8.5) CO_2 emissions scenarios do not include climate change mitigation, with CO_2 emissions doubling from current levels by 2100 and 2050, respectively. The likelihood of the very high emissions scenario is considered low in the light of recent developments in the energy sector. In the intermediate CO_2 emission pathway (SSP2–4.5), CO_2 emissions remain close to today's levels for several decades before slowly declining. The low (SSP1–2.6) and very low (SSP1–1.9) CO_2 emissions scenarios correspond to fast and very fast declines in global CO_2 emissions, to net zero CO_2 around or after 2050, followed by varying levels of net negative CO_2 emissions, as well as fast declines in other GHG emissions. These scenarios include a wide span of future air pollution control measures. The scenarios account for solar activity variability and background volcanic activity but do not include the unpredictable (but likely) occurrence of a major volcanic eruption.

Figure 3: **Illustrative scenarios for exploring climate responses to emission futures**

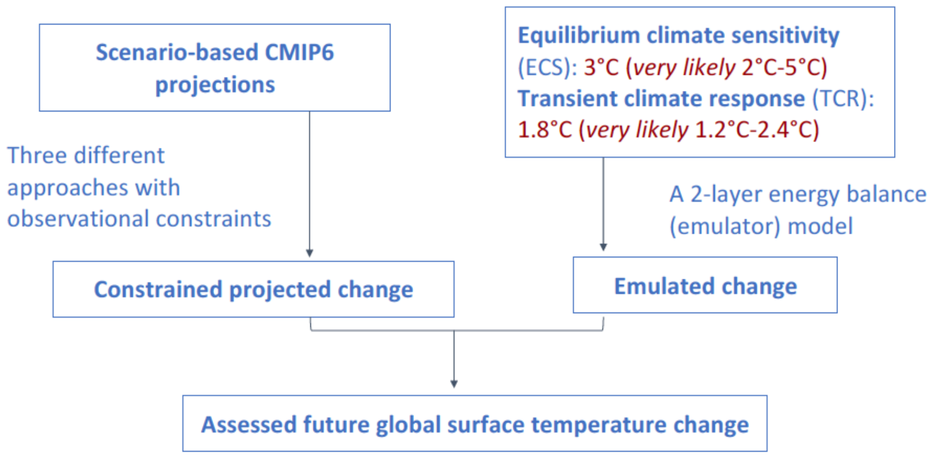


Source: Slide 5 of Part 1 presentation by WG I Co-Chairs, adapted from WG I contribution to AR6, Panel (a) of Box SPM.1 Figure SPM.4 which shows annual anthropogenic emissions for 2015–2100. Emissions trajectories are shown for CO_2 from all sectors (Gt CO_2/year).

22. As shown in figure 4 below, for the first time in an IPCC report, the assessment of future change in global surface temperature consistently combines scenario-based projections with three different approaches based on observational constraints, as well as the updated assessment of equilibrium climate sensitivity and transient climate response.

23. A major scientific advance reflected in the WG I report is the reduction of the long-standing uncertainty ranges for climate sensitivity. This arises from the broad agreement across multiple lines of evidence, including paleoclimate information, as well as climate feedbacks and their dependence on climate state.

Figure 4: **Multiple lines of evidence to assess future global surface temperature trends**

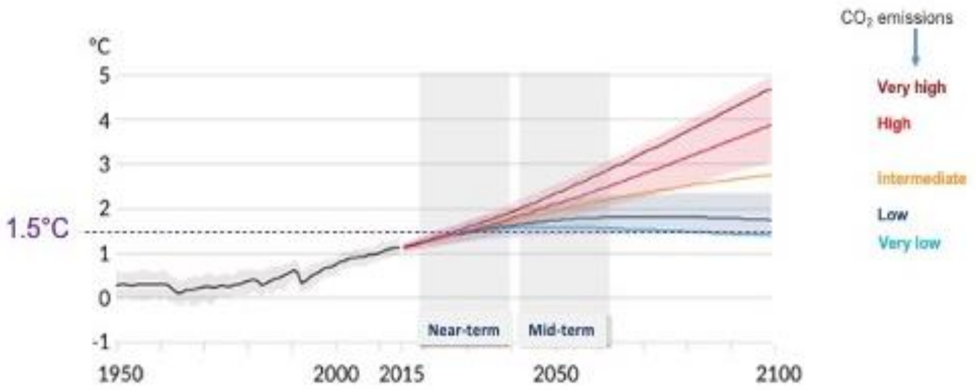


Source: Slide 6 of Part 1 presentation by WG I Co-Chairs.

24. Based on the broader set of emissions scenarios and the multiple lines of evidence, figure 5 below presents the likely global surface temperature trends relative to 1850–1900. In all scenarios, the best estimate is that rise in global surface temperature will reach 1.5 °C on average across 2021–2040. This implies that, by the 2030s, every single year has a 50 per cent chance of having an annual global surface temperature above 1.5 °C, compared with the 1850–1900 average. Under the intermediate scenario, the best estimate is that global surface temperature on average across 20 years will reach 2 °C in around 2050, and around 2.7 °C (with a 66 per cent range from 2.1 to 3.5 °C) by 2100. The last time the Earth's global surface temperature was sustained at or above 2.5 °C higher than the 1850–1900 average was over 3 million years ago.

25. However, if deep reductions in CO_2 and other GHG emissions occur in the coming years and continue over the coming decades (as reflected in the illustrative low and very low emissions scenarios), warming can remain well below 2 °C and close to 1.5 °C.

Figure 5: **Global surface temperature trends relative to those of 1850–1900**



Source: Slide 7 of Part 1 presentation by WG I Co-Chairs, adapted from WG I contribution to AR6, panel (a) of figure SPM.8. The projections for each of the five scenarios are shown in colour. Shades represent uncertainty ranges. The black curves represent the historical simulations. Historical values are included to provide context for the projected future changes.

26. With every increment of global warming, the pattern of temperature trends intensifies in every region. The land surface will continue to warm 1.4 to 1.7 times more than the ocean surface, and the Arctic at more than twice the rate of the global average.

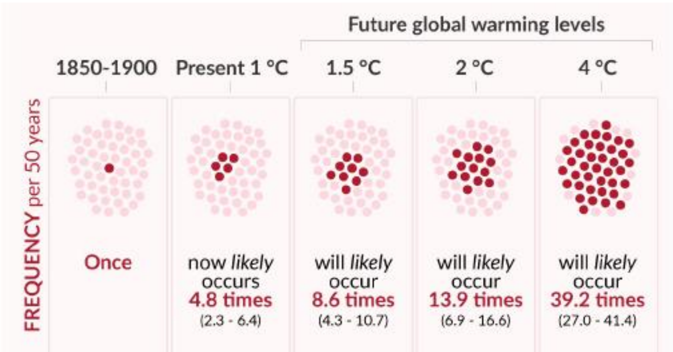
27. With every increment of global warming, annual mean precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and some areas in the tropics. Changes in soil moisture are affected by changes in precipitation and the increased evapotranspiration in a warmer climate, leading to increased aridity

in several regions. Continued warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation, and the severity of wet and dry events and seasons.

28. Changes in the climate system become larger in direct relation to the level of global warming. Every increment of global warming causes increases in the intensity and frequency of hot extremes, including heatwaves (see figure 6 below for an example of projected changes in hot extremes), and heavy precipitation, as well as agricultural and ecological droughts in some regions. Snow cover, Arctic sea ice and surface permafrost diminish with further global warming.

29. Anthropogenic global warming has already set in motion the slow component of the climate system. Glaciers are committed to continue melting for decades or centuries. Changes are irreversible on centennial and millennial timescales in global ocean temperature, deep ocean acidification and deoxygenation.

Figure 6: **Number of days with extreme hot condition**



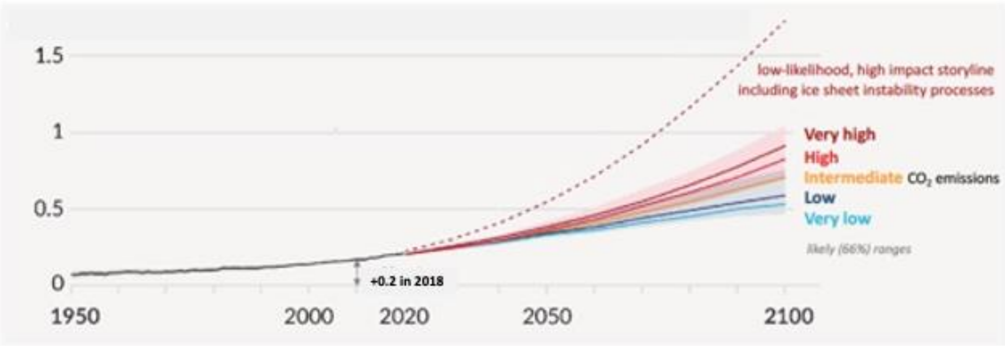
Source: Slide 11 of Part 1 presentation by WG I Co-Chairs, adapted from WG I contribution to AR6, the top right portion of figure SPM.6 which shows projected changes in intensity and frequency of 50-year hot temperature extremes over land. Projected changes are shown at global warming levels of 1 °C, 1.5 °C, 2 °C, and 4 °C and are relative to 1850–1900, representing a climate without human influence. Hot temperature extremes are defined as the daily maximum temperatures over land that were exceeded on average once in 50 years during the 1850–1900 reference period.

30. With regard to global sea level, for the first time in an IPCC report, the assessed future change in global mean sea level rise consistently combines climate, ice sheet and glacier simulations, with the assessed climate sensitivity. Figure 7 below presents the projected global sea level rise up until the end of the century. Global sea level is set to rise by 15–30 cm above the present-day level by 2050.

31. After 2050, the sea level will continue to rise, but with a rate and magnitude dependent on future GHG emissions. Reducing GHG emissions and limiting the level of future global warming increases the chance of avoiding the triggering of irreversible instabilities in the ice sheets that could substantially increase sea level rise. Deep uncertainty is associated with specific Antarctic ice sheet instability processes. For high emissions and high warming levels, the low probability outcome where rapid ice sheet loss could lead to a 2 m sea level rise by the end of this century cannot be ruled out.

32. As for the global sea level beyond the twenty-first century, low GHG emissions would lead to a sea level rise of around 0.5–3 m by 2300, while very high GHG emissions could lead to a 2–7 m rise, and potentially many metres more when accounting for ice sheet instability processes. Reducing GHG emissions provides time to reduce the magnitude of changes and allow more time for coastal responses. For instance, a level of 1 m above the current level would be reached by the middle of next century with intermediate emissions, but around 40 years later with low emissions.

Figure 7: **Global sea level rise relative to 1900 (in m)**



Source: Slide 13 of Part 1 presentation by WGI Co-Chairs, adapted from WG I contribution to AR6, Panel (d) of figure SPM.8. The projections for each of the five scenarios are shown in colour. Shades represent uncertainty ranges. The black curves represent the historical observations. Historical values are included in all graphs to provide context for the projected future changes.

33. To facilitate the exploration of climate trends assessed in the WG I contribution to the AR6 for different levels of warming, time horizons, reference periods and scenarios, the IPCC has made available an interactive atlas.[9] In addition, two-page fact sheets are available for the six continents, small islands, Polar regions, mountains, and ocean and urban areas.[10]

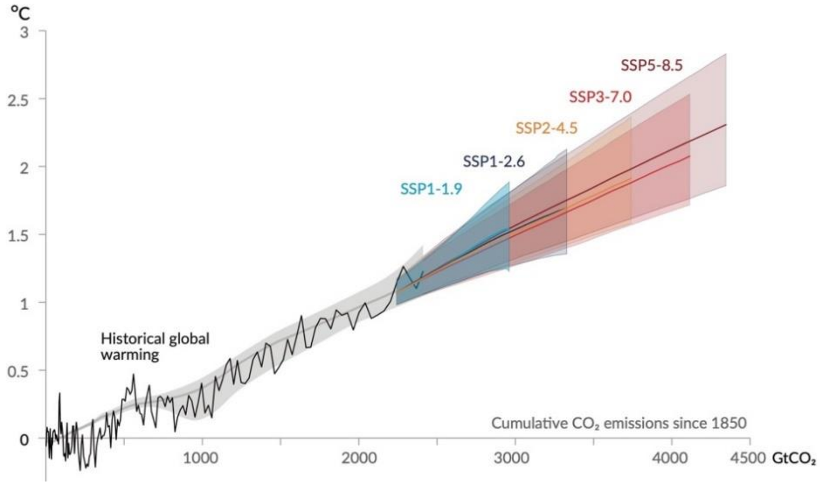
34. The multiple observed changes in every region will continue with further warming. Some changes can be slowed and others can be stopped by limiting warming. The WG I report reaffirms, with high confidence, that there is a near-linear relationship between cumulative anthropogenic CO_2 emissions and the global warming they cause (figure 8 below). This relationship implies that reaching net zero anthropogenic CO_2 emissions is a requirement to stabilize human-induced global temperature increase at any level, but that limiting global temperature increase to a specific level would imply limiting cumulative CO_2 emissions to within a carbon budget.[11]

[9] The interactive atlas can be accessed at http://interactive-atlas.ipcc.ch.

[10] These fact sheets are available at www.ipcc.ch/report/ar6/WGI/#Regional.

[11] The term 'carbon budget' refers to the maximum amount of cumulative net global anthropogenic CO_2 emissions that would result in limiting global warming to a given level with a given probability, taking into account the effect of other anthropogenic climate forcers. This is referred to as the total carbon budget when expressed starting from the pre-industrial period, and as the remaining carbon budget when expressed from a recent specified date. Historical cumulative CO_2 emissions determine to a large degree warming to date, while future emissions cause future additional warming. The remaining carbon budget indicates how much CO_2 could still be emitted while keeping warming below a specific temperature level (Source: footnote 43 of the Summary for policymakers, WG I contribution to AR6: www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf).

Figure 8: **Global surface temperature increase since 1900 as a function of cumulative carbon dioxide emissions**



Source: Slide 17 of Part 1 presentation by WG I Co-Chairs, adapted from WG I contribution to AR6, top panel of figure SPM.10 which shows near-linear relationship between cumulative CO_2 emissions and the increase in global surface temperature. Historical data (thin black line) shows observed global surface temperature increase in centigrade since 1850–1900 as a function of historical cumulative CO_2 emissions in Gt CO_2 from 1850 to 2019. The grey range with its central line shows a corresponding estimate of the historical human-caused surface warming. Coloured areas show the assessed very likely range of global surface temperature projections, and thick coloured central lines show the median estimate as a function of cumulative CO_2 emissions for 2020–2050 for the set of illustrative scenarios (SSP1–1.9, SSP1–2.6, SSP2–4.5, SSP3–7.0 and SSP5–8.5). Projections use the cumulative CO_2 emissions of each respective scenario and the projected global warming includes the contribution from all anthropogenic forcers. The relationship is illustrated over the domain of cumulative CO_2 emissions for which there is high confidence that the transient climate response to cumulative CO_2 emissions remains constant, and for 1850–2050, over which period global CO_2 emissions remain net positive under all illustrative scenarios, as there is limited evidence supporting the quantitative application of transient climate response to cumulative CO_2 emissions to estimate temperature evolution under net negative CO_2 emissions.

35. In response to a comment made by a Party on the uncertainties in projected changes in global temperature and sea level associated with assumptions and parameterization of climate models, WG I Co-Chair explained that the WG I report assessed the results from all available climate models, and is therefore not limited to the choice of an individual climate model. For example, the statement that intensity of extreme precipitation increases by around 7 per cent with each degree of global warming is strongly grounded in scientists’ understanding of the ability of a warmer atmosphere to hold more moisture.

36. A Party inquired about the difference between the values for global surface temperature change and global warming used in the WG I report. A WG I expert explained that the combination of assessed global surface temperature change and global warming level approach is an important advance in AR6. The WG I assessment used both scenario-based projections and other evidence, in particular the updated climate sensitivity (from chapter seven of the WG I report), to provide the comprehensive assessment for future changes in global surface temperature, ocean warming and sea level, whereas it used the global warming level for a fully consistent assessment of changes in different climate variables (including climatic impact drivers). In other words, the IPCC used the assessed global surface temperature change to bridge the gap between regional climate response patterns and physical climatic impacts to different levels of global warming.

3. Understanding of remaining carbon budgets and mitigation pathways for limiting global warming to specific levels

37. From a physical science perspective, limiting human-induced global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least net zero CO_2 emissions, along with strong reductions in other GHG emissions.

38. During 1850–2019, a total of 2390 ± 240 Gt CO_2 of anthropogenic CO_2 was emitted. The remaining carbon budgets have been estimated for several global temperature limits and various levels of probability. The remaining carbon budgets are shown in table 2 below.

39. These budgets are based on the estimated value of the transient climate response to cumulative CO_2 emissions and its narrower uncertainty, updated estimates of historical warming,

variations in projected warming from non-CO_2 emissions, climate system feedbacks such as CO_2 emissions from thawing permafrost, and the global surface temperature change after global anthropogenic CO_2 emissions reach net zero. Several factors that determine estimates of the remaining carbon budget have been reassessed in AR6, and updates to these factors since SR1.5 are small. When adjusted for emissions since previous reports, estimates of remaining carbon budgets are of similar magnitude to those of SR1.5.

Table 2: **Historic cumulative carbon dioxide emissions and remaining carbon budgets from 2020 for a range of global temperature limits of levels of probability**

Global warming between 1850–1900 and 2010–2019 *(°C)*	Historical cumulative CO_2 emissions from 1850 to 2019 *($GtCO_2$)*
1.07 (0.8–1.3; *likely* range)	2390 (± 240; *likely* range)

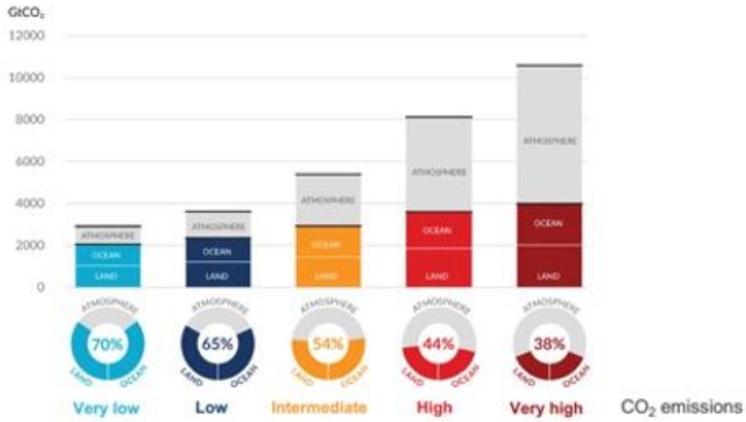
Approximate global warming relative to 1850–1900 until temperature limit *(°C)**(1)	Additional global warming relative to 2010–2019 until temperature limit *(°C)*	Estimated remaining carbon budgets from the beginning of 2020 *($GtCO_2$)* *Likelihood of limiting global warming to temperature limit*(2)*					Variations in reductions in non-CO_2 emissions*(3)
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

Source: Slide 18 of Part 1 presentation by WG I Co-Chairs.

40. A Party enquired about the role of rapid reduction in methane emissions in achieving the long-term global goal. A WG I expert explained that deep reduction in methane emissions is already assumed in estimating the remaining carbon budget for limiting warming to various levels. Therefore, if deep reductions in methane are not achieved globally, the remaining carbon budget for a specific warming target would be even smaller. As shown in table 2 above, depending on the degree of global success in cutting non-CO_2 (including methane) emissions, the remaining carbon budgets can vary by 220 Gt CO_2 or more.

41. While natural land and ocean carbon sinks are projected to take up, in absolute terms, a progressively larger amount of CO_2 under higher CO_2 emissions scenarios, they become less effective the higher the level of CO_2. The proportion of emissions taken up by land and ocean decrease with increasing cumulative CO_2 emissions (figure 9 below). This results in a higher proportion of emitted CO_2 remaining in the atmosphere. The magnitude of feedbacks between climate change and the carbon cycle becomes larger and more uncertain in high CO_2 emissions scenarios. Additional ecosystem responses to warming not yet fully included in climate models, such as CO_2 and methane fluxes from wetlands, permafrost thaw and wildfires, would further increase concentrations of these gases in the atmosphere. By contrast, under the very low and low GHG emissions scenarios, where CO_2 concentrations peak and decline during the twenty-first century, land and oceans begin to take up less carbon in response to declining atmospheric CO_2 concentrations.

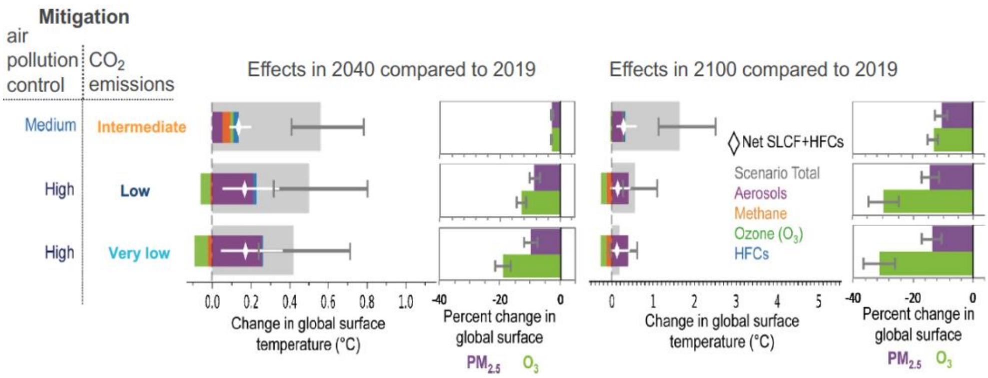
Figure 9: **Total cumulative carbon dioxide emissions taken up by land and oceans and remaining in the atmosphere from 1850 to 2100**



Source: Slide 19 of Part 1 presentation by WG I co-chairs, adapted from WG I contribution to AR6, figure SPM.7 which shows cumulative anthropogenic CO_2 emissions taken up by land and ocean sinks by 2100 under the five illustrative scenarios (SSP1–1.9,SSP1–2.6, SSP2–4.5, SSP3–7.0 and SSP5–8.5), as simulated from 1850 to 2100 by CMIP6 climate models in the concentration-driven simulations. Land and ocean carbon sinks respond to past, current and future emissions, therefore cumulative sinks from 1850 to 2100 are presented here. During the historical period (1850–2019) the observed land and ocean sink took up 1,430 Gt CO_2 (59 per cent of emissions).

42. With regards to other GHGs, the WG I report concludes that strong, rapid and sustained reductions in methane emissions would also limit the warming effect from declining aerosol pollution and would improve air quality. As shown in figure 10 below, there are differences between the intermediate, low and very low emissions scenarios in terms of air quality and temperature effects in 2040 and 2100, compared with 2019. In the low and very low GHG emissions scenarios, assumed reductions in anthropogenic aerosol emissions lead to a net warming, while reductions in methane and other ozone precursor emissions lead to a net cooling. Because of the short lifetime of both methane and aerosols, these climate effects partially counterbalance each other. Reductions in methane emissions also contribute to improved air quality by reducing global surface ozone. In the long term, the net warming is lower in scenarios that assume the adoption of air pollution controls combined with strong and sustained methane emission reductions.

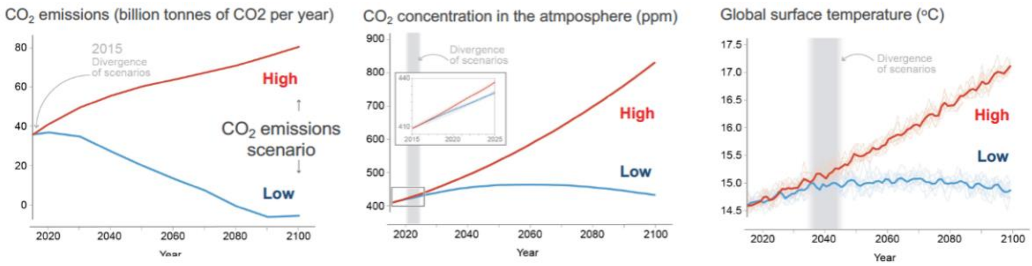
Figure 10: **Impacts of mitigation levels on global surface temperature change**



Source: Slide 20 of Part 1 presentation by WG I Co-Chairs, adapted from WG I contribution to AR6, Box TS.7, figure 1 which shows the effects of short-lived climate forcers on global surface temperature and air pollution across the WG1 core set of SSPs. The figure shows the climate and air quality (surface ozone and $PM_{2.5}$) response to short-lived climate forcers in the SSP scenarios for near- and long-term. Effects of net aerosols, tropospheric ozone, hydrofluorocarbons (with lifetimes less than 50 years), and methane are compared with those of total anthropogenic forcing for 2040 and 2100 relative to 2019. The global surface temperature changes are based on historical and future evolution of effective radiative forcing, as assessed in chapter 7 of the WG I contribution to AR6. The temperature responses to the effective radiative forcing are calculated using a common impulse response function for the climate response, consistent with the metric calculations in chapter 7 (box 7.1). The common impulse response function has an equilibrium climate sensitivity of 3.0°C for a doubling of atmospheric CO_2 concentration (feedback parameter of -1.31 W m^{-2} °C^{-1}). The scenario total (grey bar) includes all anthropogenic forcings (long- and short-lived climate forcers, and land-use changes). Uncertainties are 5–95 per cent ranges. The global changes in air pollutant concentrations (ozone and $PM_{2.5}$) are based on multi-model CMIP6 simulations and represent changes in five-year mean surface continental concentrations for 2040 and 2098 relative to 2019. Uncertainty bars represent inter-model ±1 standard deviation.

43. Regarding the timescale over which the benefits of emission reduction can be realized, scenarios with very low or low GHG emissions lead within years to discernible effects on GHG and aerosol concentrations and air quality, relative to high and very high GHG emissions scenarios. For global surface temperature, differences in 20-year trends would likely emerge during the near term under a very low GHG emissions scenario, relative to a high or very high GHG emissions scenario (figure 11 below). The response of many other climate variables would emerge from natural variability at different times later in the twenty-first century.

Figure 11: **Trends in carbon dioxide emissions, atmospheric carbon dioxide concentrations and global surface temperature for the remainder of the twenty-first century**



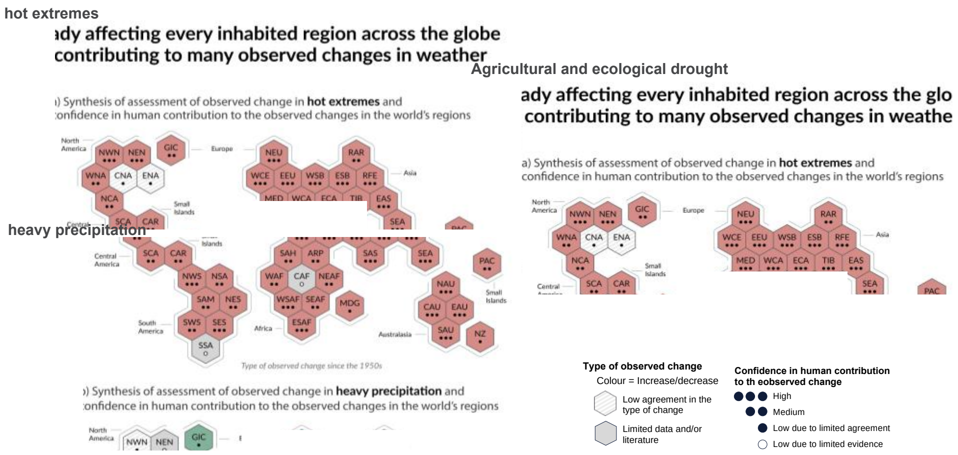
Source: Slide 21 of Part 1 presentation by WG I Co-Chairs, adapted from WG I contribution to AR6, FAQ 4.2, figure 1 which shows the benefits of emission reductions. The charts show CO_2 emissions, CO_2 concentration in the atmosphere and the effect on global surface temperature for two scenarios: a low emissions scenario (SSP1–2.6, blue) and a high emissions scenario (SSP3–7.0, red). In the low emissions scenario, CO_2 emissions begin to decrease in 2020, whereas they keep increasing throughout the twenty-first century in the high emissions scenario. The thick lines are the average of the 10 individual simulations (thin line) for each scenario. Differences between individual simulations reflect natural variability.

44. As noted by the OECD representative, although it is encouraging to see so many net zero targets, there is still a need to ramp up the level of ambition. Moreover, increased ambitions and net zero pledges need to be turned into action now if the goal of the Paris Agreement is to be met.

4. Current and future climate change impacts and risks

45. Climate change information is increasingly available and robust at regional scale for impact and risk assessments. As highlighted by the IPCC WG I presentation, climate change is already affecting every region of the globe, with human influence contributing to many observed changes in weather and climate extremes. Figure 12 below illustrates observed changes in hot extremes, heavy precipitation events and drought.

Figure 12: **Synthesis of assessment of observed changes in hot extremes, heavy precipitation events and drought**



Source: Slide 2 of Part 2 presentation by WG I co-chairs, adapted from WG I contribution to AR6, figure SPM.3 which presents a synthesis of assessed observed and attributable regional changes. The world's inhabited regions as adopted by IPCC AR6 WG I are displayed as hexagons with identical size in their approximate geographical location (see legend below for regional acronyms). All assessments are made for each region as a whole and for the 1950s to the present day. Assessments made on different timescales or more local spatial scales might differ from what is shown in the figure. The colours in each panel represent the four outcomes of the assessment on observed changes. Striped hexagons (white and light grey) are used where there is low agreement in the type of change for the region as a whole, and grey hexagons are used when there are limited data or literature that prevent an assessment of the region as a whole. Other colours indicate at least medium confidence in the observed change. The confidence level for the human influence on these observed changes is based on assessing trend detection and attribution and event attribution literature, and it is indicated by the number of dots: three dots for high confidence, two dots for medium confidence and one dot for low confidence (single, filled dot: limited agreement; single, empty dot: limited evidence). For hot extremes, the evidence is mostly drawn from changes in metrics based on daily maximum temperatures; regional studies using other indices (heatwave duration, frequency and intensity) are used in addition. Red hexagons indicate regions where there is at least medium confidence in an observed increase in hot extremes. For heavy precipitation, the evidence is mostly drawn from changes in indices based on one- or five-day precipitation amounts using global and regional studies. Green hexagons indicate regions where there is at least medium confidence in an observed increase in heavy precipitation. Agricultural and ecological droughts are assessed on the basis of observed and simulated changes in total column soil moisture, complemented by evidence on changes in surface soil moisture, water balance (precipitation minus evapotranspiration) and indices driven by precipitation and atmospheric evaporative demand. Yellow hexagons indicate regions where there is at least medium confidence in an observed increase in this type of drought, and green hexagons indicate regions where there is at least medium confidence in an observed decrease in agricultural and ecological drought. IPCC AR6 WGI reference regions: North America: NWN (North-Western North America), NEN (North-Eastern North America), WNA (Western North America), CNA (Central North America), ENA (Eastern North America), Central America: NCA (Northern Central America), SCA (Southern Central America), CAR (Caribbean), South America: NWS (North-Western South America), NSA (Northern South America), NES (North-Eastern South America), SAM (South American Monsoon), SWS (South-Western South America), SES (South-Eastern South America),SSA (Southern South America), Europe: GIC (Greenland and Iceland), NEU (Northern Europe), WCE (Western and Central Europe), EEU (Eastern Europe), MED (Mediterranean), Africa: MED (Mediterranean), SAH (Sahara), WAF (Western Africa), CAF (Central Africa), NEAF (North-Eastern Africa), SEAF (South-Eastern Africa), WSAF (West Southern Africa), ESAF (East Southern Africa), MDG (Madagascar), Asia: RAR (Russian Arctic), WSB (Western Siberia), ESB (Eastern Siberia), RFE (Russian Far East), WCA (West Central Asia), ECA (East Central Asia), TIB (Tibetan Plateau), EAS (East Asia), ARP (Arabian peninsula), SAS (South Asia), SEA (South-East Asia), Australasia: NAU (Northern Australia), CAU (Central Australia), EAU (Eastern Australia), SAU (Southern Australia), NZ (New Zealand), small islands: CAR (Caribbean), PAC (Pacific small islands).

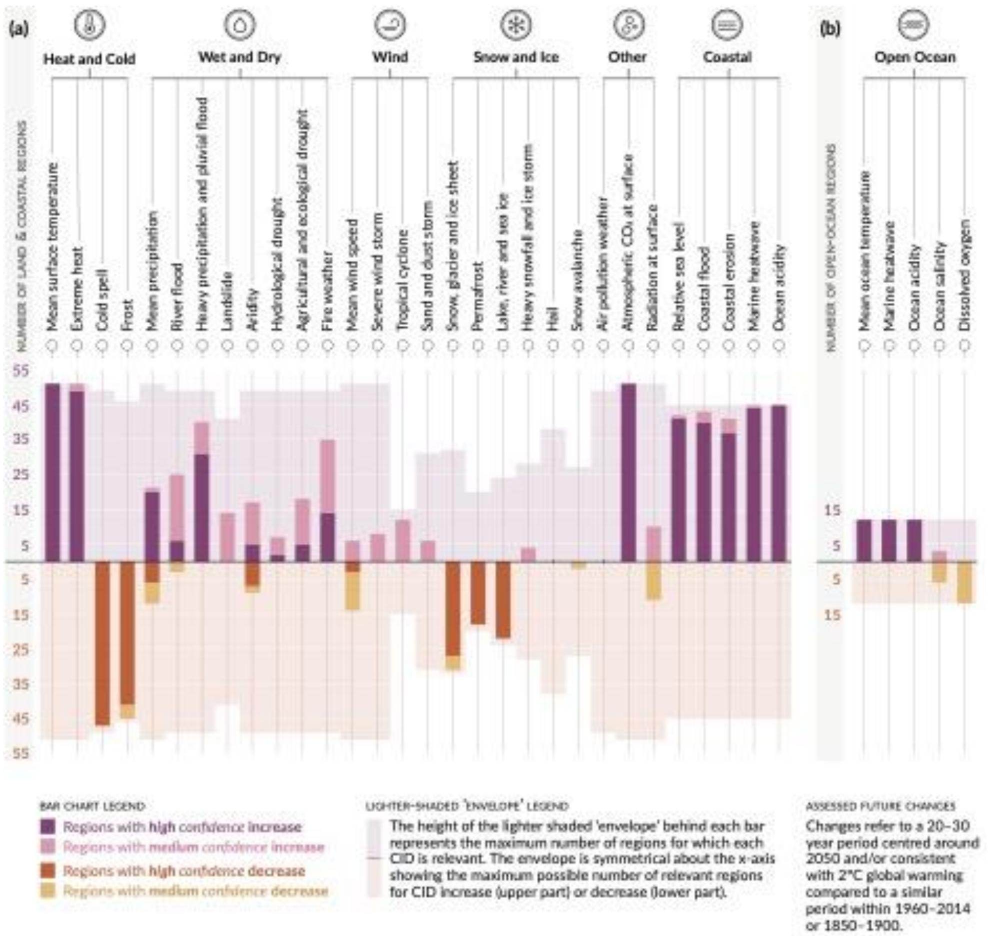
46. A Party asked about the low level of confidence in some of the attribution of human contributions to observed changes due to climate change, particularly for heavy precipitation and drought, as shown in figure 12 above. A WG I expert clarified that attribution is more challenging on a regional scale, because of stronger background noise, a lack of available long-term records at sufficient resolution to be able to perform robust statistical trend analysis, and a lack of attribution studies in some regions. As a result, even though there may be medium or high confidence in an observed trend, there may not always be medium or high confidence in attribution. Nevertheless, there is high confidence that human activities have led to an increase in heavy precipitation in most regions with sufficient observations. As for agricultural and ecological drought, there is medium confidence that human emissions have led to an increase of those types of droughts in certain regions due to increased evapotranspiration.

47. As an innovative aspect of the WG I contribution to AR6, a framework of over 30 different climatic impact drivers is used to assess the characteristics of the physical climate through trends,

extremes or specific indices that are known to drive impacts on societal and ecological systems under different levels of warming. These climatic impact drivers are based on impact and vulnerability studies and are related to land, coastal areas or ocean. Depending on the system tolerance, these climatic impact drivers and their changes can be beneficial, neutral, detrimental or a combination of these across interacting system elements and regions (see figure 13 below).

48. Human-induced climate change has already altered the profiles of climatic impact drivers and resulted in shifting magnitude, frequency, duration, seasonality and spatial extent of the associated indices in various regions. With further global warming, every region is projected increasingly to experience concurrent and multiple changes that are region-specific in those climatic impact drivers.

Figure 13: **Number of land and coastal regions (a) and open-ocean regions (b) where each climatic impact driver is projected to increase or decrease with high confidence (dark shade) or medium confidence (light shade)**

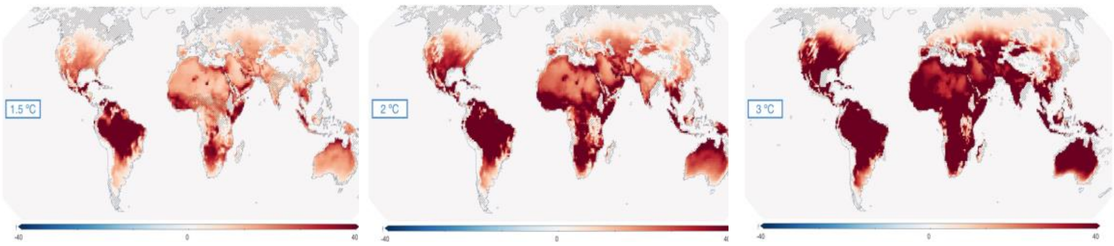


Source: adapted from WG I contribution to AR6, figure SPM.9. A total of 35 climatic impact drivers grouped into seven types are shown: heat and cold; wet and dry; wind; snow and ice; coastal; open ocean; and other. For each climatic impact drivers, the bar in the graph below displays the number of AR6 WG I reference regions where it is projected to change. The colours represent the direction of change and the level of confidence in the change: Purple indicates an increase while brown indicates a decrease; darker and lighter shades refer to high and medium confidence, respectively. Lighter background colours represent the maximum number of regions for which each climatic impact driver is broadly relevant. Panel (a) shows the 30 climatic impact drivers relevant to the land and coastal regions, while panel (b) shows the five climatic impact drivers relevant to the open-ocean regions. Marine heatwaves and ocean acidity are assessed for coastal ocean regions in panel (a) and for open-ocean regions in panel (b). Changes refer to a 20–30-year period centred around 2050 and/or consistent with 2 °C global warming compared with a similar period within 1960–2014, except for hydrological drought and agricultural and ecological drought, which is compared with 1850–1900. Definitions of the regions are provided in section 12.4, atlas.1 of the report and the interactive atlas available at https://interactive-atlas.ipcc.ch/.

49. The WG I report also shows that impacts and risks would be more widespread with global warming at 2.0 °C compared with 1.5 °C, and even more widespread or pronounced for higher warming levels. Figure 14 below presents the increase in the number of days per year when the maximum temperature exceeds 30 °C compared with the recent past for different levels of global

warming. It illustrates extreme heat thresholds that are relevant to agriculture and health. As shown in the figure, these thresholds are projected to be exceeded more frequently at higher global warming levels. Higher latitude ecosystems will also be affected by lower extreme heat thresholds. This indicates that strong reduction in GHG emissions would strongly limit the increase in the frequency of exceeding such dangerous heat thresholds, while limiting the number of regions where such this occurs. It also illustrates how the increase in intensity of climate impacts experienced in the future depends on the overall aggregated effect of steps already taken and decisions made.

Figure 14: **Changes in the number of days per year with maximum temperature above 30 oC relative to 1995–2014**



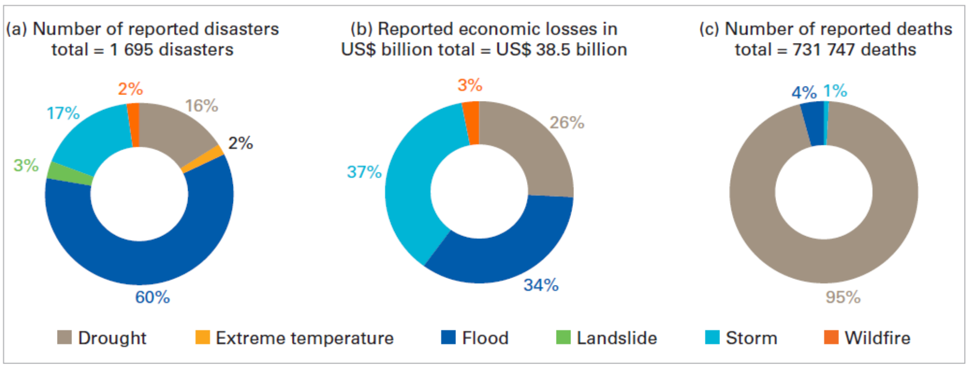
Source: Adapted from slide 4 of Part 2 presentation by WG I Co-Chairs.

50. With regard to regional impacts, including on extremes, of incremental global temperature warming, evidence in the literature indicates that there is a linear relationship between regional changes in extremes and global warming. This is illustrated in figure 11.3 of the WG I report. The IPCC interactive atlas enables exploration of regional changes in climatic impact drivers under different temperature warming scenarios (e.g., 1.5 °C, 2.0 °C).

51. Improved understanding of changes to extreme weather events under different levels of warming has been a key area of progress in the WG I contribution to AR6, compared with previous ARs. One example provided by a WG I expert during the open discussion related to dangerous heat thresholds: the number of days exceeding 35 °C, which affect, among others, rice productivity and human health, increase by15 days per year in multiple regions with every half a degree of global warming.

52. As presented by the WMO-RCC Africa representative, the African continent has experienced a large number of hydrological and meteorological disasters (most of which were floods) in the past 50 years, with considerable human and economic impacts (figure 15 below).

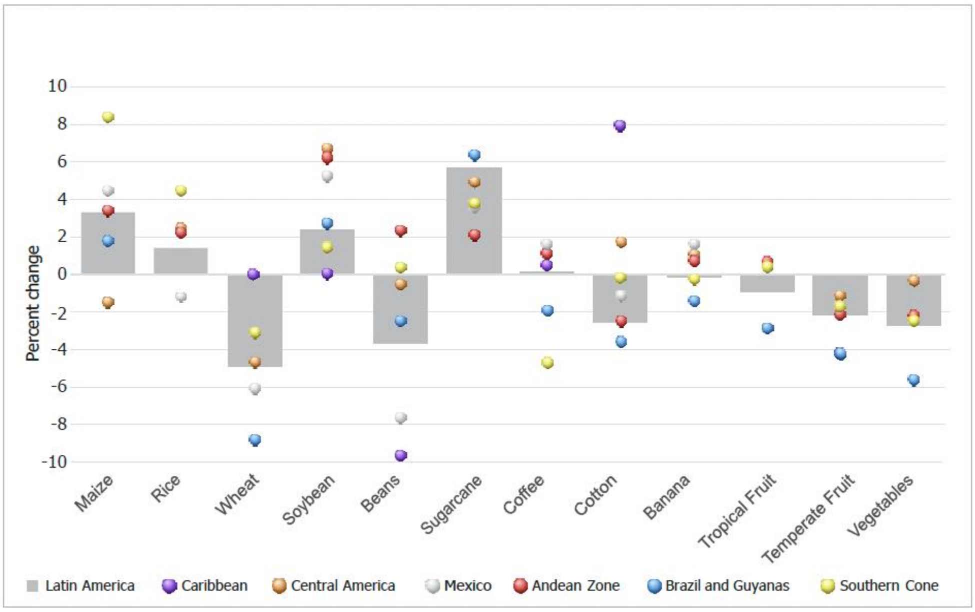
Figure 15: **Overview of disasters, economic losses and deaths reported in Africa (1970–2019)**



Source: Slide 8 of presentation by the WMO-RCC Africa representative.

53. José Marengo, WMO-RCC Latin America and the Caribbean, highlighted that, in 2020 alone, extreme weather events affected over 8 million people in Central America, exacerbating food insecurity in countries already crippled by economic shocks, COVID-19 restrictions and conflict. Hurricanes Eta and Iota hit Honduras in November 2020, affecting about 4 million people and damaging nearly 290,000 hectares of crops. They caused a total loss of over USD 2 billion in Honduras, representing 0.8 per cent of GDP, adding to the COVID-19 related loss of 7.8 per cent of GDP. Future projections, as shown in figure 16 below, show that climate change will lead to a reduction in crop yields for most crops and in most countries in the region.

Figure 16: **Projected changes in crop yields in 2030 relative to 2010 in Latin American and Caribbean subregions**



Source: Slide 3 of presentation by José Marengo, WMO-RCC Latin America and the Caribbean.

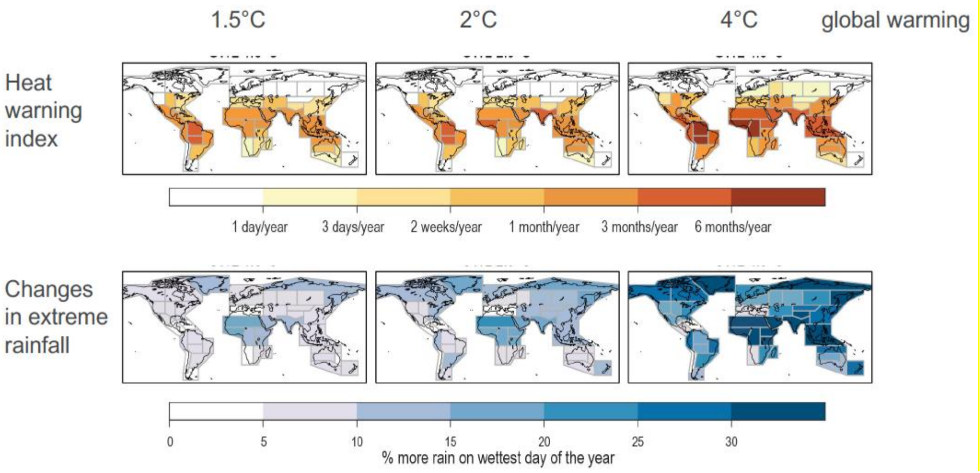
54. In response to the comment from an observer as to whether rising atmospheric CO_2 levels have led to notable global increase in crop (e.g. wheat and rice) yields, the WMO-RCC Africa representative noted that, while higher CO_2 levels may have helped increase the crop productivity in some regions, climate change has caused disruptions to the onset and total amount of seasonal rainfall, and the cessation of the rainfall season, to the detriment of agricultural productivity.

55. Parties asked questions about the potential risks of global warming exceeding 1.5 °C, particularly with relation to changes in the cryosphere and sea level. In response, a WG I expert explained that, if temperatures can stay below or close to the 1.5 °C increase, there is a much greater chance of maintaining sea ice throughout the summer in the Arctic. However, if warming exceeds 1.5 °C, both Greenland and the West Antarctic ice sheets will be much closer to being lost over longer timescales. In particular, if temperatures get close to the 2 °C increase, the chances of instability and widespread loss of ice from around Antarctica become much greater. However, as shown in figure 7 above, there is considerable uncertainty associated with sea level rise risks under high levels of warming.

5. Understanding of impacts and risks associated with extreme events

56. The WG I report highlighted that, by the end of the century, scenarios with low or very low GHG emissions would strongly limit the increase in the frequency of extreme sea level events, heavy precipitation and pluvial flooding, and exceedance of dangerous heat thresholds, while limiting the number of regions where such exceedances occur, relative to scenarios with intermediate or high emissions and higher warming levels (figure 17 below). In other words, the climate the world will experience in the future depends on current decisions.

Figure 17: **Extent and magnitude of extreme heat and rainfall conditions under different levels of global warming**



Source: Slide 22 of Part 1 presentation by WG I Co-Chairs, adapted from WGI contribution to AR6, bottom panel of figure TS. 6 which presents maps of CMIP6 median projections of two climatic impact drivers at three different global warming levels (GWLs) (columns for 1.5, 2 and 4 °C) for the AR6 land regions. The heat warning index is the number of days per year as an average across each region at which a heat warning for human health at the level of 'danger' would be issued by the National Oceanic and Atmospheric Administration of the United States of America. The maps of extreme rainfall changes show the percentage change in the amount of rain falling on the wettest day of a year relative to 1995–2014 as an average across each region when the respective GWL is reached.

57. A Party asked about the impacts on cryosphere of different emissions and temperature warming scenarios. The IPCC WG I Co-Chair explained that chapter 9 of the WG I report is dedicated to the ocean, cryosphere and sea level change. Some of the faster responding components of the cryosphere, such as the summer Arctic sea ice, snow and permafrost he depth of permafrost, are linear to temperature rise when warming is within 2–3 °C. In this context, every small fraction of warming matters.

58. Responding to a question from a Party on progress made in understanding the implications of incremental global warming levels since the publication of SR1.5, a WG I expert indicated that much progress has been made since SR1.5, in particular in terms of understanding the thresholds for the Greenland ice sheet. SR1.5 focuses on the impact of various warming temperatures, whereas scientists now consider that thresholds depend more significantly on the size of the ice sheet. As the size is reduced, the ice sheet melts much more rapidly.

59. In response to a request for details on new insights related to low probability and high impact outcome under different levels of global warming, an IPCC expert used sea level rise as an example. She noted that, under low emissions scenarios SSP1–1.9, SSP1–2.6 or SSP2–4.5, the high impact events associated with significant ice loss around Antarctica are much less likely. She highlighted that a further important aspect to consider was that it was not a question as to whether one metre of sea level rise will be reached but when it will be reached. Limiting global warming at a relatively low level will result in a later date for that sea level rise, which would allow more time for coastal communities and ecosystems to adapt. Even if global surface temperature change is stabilized at 1.5 °C above pre-industrial levels, ultimately this will result in a mean sea level rise of between two and three metres. If global warming stabilizes at higher levels, then sea level rise will be much higher. For example, even at 2 °C of warming, global mean sea level will rise by up to six metres.

60. In response to a request from a Party for further information on tipping points, the WG I Co-Chair explained that the WG I report explored the issue in several ways. Comparisons of projected changes between the current and previous assessments were undertaken to explore the potential of abrupt changes and the possibility of irreversible behaviour. The WG I report concluded that Arctic summer sea ice changes are irreversible and there is also potential irreversibility for the Greenland and Antarctic ice sheets. There is currently very low confidence for aspects related to irreversibility for Antarctic sea ice. The Atlantic circulation is very likely to decline this century with a medium level of confidence of no collapse. These changes to the Atlantic meridional overturning circulation are also irreversible. The WG I report also explored biogeochemical tipping points that can affect the ability of vegetation to store carbon, as well as possible feedback associated with tropical or boreal forests dieback (see box TS. 9 of WGI contribution to IPCC AR6).

6. Concurrent events, compound impacts and limits to adaptation

61. As highlighted in the WG I report and further elaborated by WG I experts during the open discussions, there has been an increase in the occurrence of concurrent conditions associated with extreme hot weather, dry conditions and windy conditions that can lead to wildfire, extreme sea level events with high tides, storm surge and extreme rainfall, leading to a near doubling in the frequency of coastal flooding events since the 1960s. Frequency of such concurrent events will increase in many regions with any further level of warming. For instance, what were previously once-in-a-century extreme sea level events will occur about 20–30 times more frequently by 2050. If warming stays below 2 °C, such once-in-a-century events will occur annually by 2100 at 60 per cent of coastal locations. If levels of warming are even higher, the occurrence rate could stand at 80 per cent of coastal locations and bring with it a strong increase in the probability of compounded flooding, owing to the combined effects of sea level rise and increased heavy precipitation. Sea level rise contributes not just to increased coastal flooding but also increased coastal erosion along most sandy coasts.

62. The representative from WMO-RCC Asia highlighted that the COVID-19 pandemic had hampered countries’ efforts to respond to the impacts of extreme weather events and at risk communities faced the dual challenge of tackling the pandemic and climate-related hazards. Cyclone Amphan, one of the strongest cyclones ever recorded, hit densely populated coastal areas in Bangladesh and India during the rapid spread of COVID-19 in May 2020. The response to the impact of Amphan was hampered by restrictions imposed during the pandemic and the disruption of supply chains. In Central America, as underlined by a representative from WMO-RCC Latin America and the Caribbean, a record number of hurricanes and tropical cyclones in 2020 caused significant socioeconomic losses. A significant number of countries in the region do not have a multi-hazard early warning system and local governments in even more countries do not currently have a plan in place to act on any early warnings.

63. Following presentations by representatives of WMO-RCCs, Parties enquired about the current coverage in WMO regional State of the Climate reports of compound risks caused by interactions between multiple hazards (such as drought, extreme heat and wildfire). Parties also discussed the linkage between climate change and extreme weather events, including concurrent events. The representative from WMO-RCC SWP, noted that, although there are other factors, such as deforestation, underpinning some weather extremes, in many parts of the world, especially in middle and higher latitudes, dangerous fire weather events have been associated with some of the recently observed extreme wildfire events. It was suggested that future WMO reports should try to report on these compound events.

64. In addition, the importance of multi-hazard early warning systems was highlighted in addressing the increasingly more severe and frequent extreme weather events, in particular in developing countries where significant investment is required to develop such systems. In this context, WMO has been pilot-testing an initiative to catalogue hazardous hydrometeorological events through WMO-RCCs in Europe and South-West Pacific. This would provide a source of information for analysing damages reported and the associated meteorological conditions, hence facilitating further research on long-term trends in extreme and compound extreme weather events. One Party underlined the significant value of all WMO-RCCs working to establish an inventory of extreme weather events to systematically collate information essential to, among others, facilitating attribution research and prioritizing adaptation action. However, in order to establish such an inventory, there are challenges regarding standardized definitions of hazardous events and availability of basic data, in particular related to impacts.

65. As underlined by a WG I expert, the WG I report reflects advances in understanding of the interplay between climate change and urbanization at city scale and increasing amounts of information are available for local-level decision-making. For example, cities can intensify human-induced warming and run-off locally. With more intense rainfall events or more severe extremes of heat, the outcome could be concurrent with extreme conditions. Response options include moderating the changes through climate-smart urban planning.

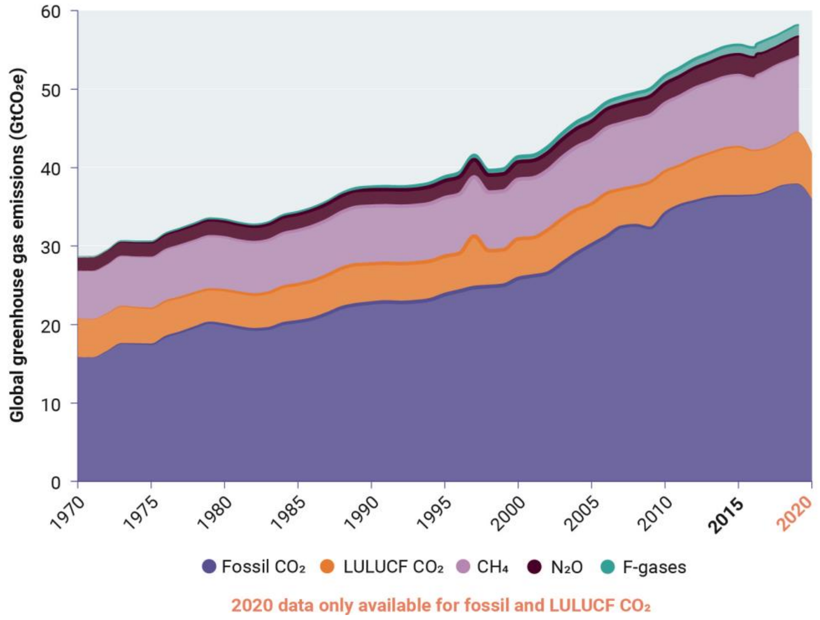
B. Assessing the overall aggregated effect of the steps taken by Parties

1. Mitigation action

(a) Steps taken and plans included in nationally determined contributions

66. A representative from UNEP, presented the twelfth edition of the UNEP Emissions Gap Report, an annual science-based assessment of the GHG emissions gap.[12] As shown in figure 18 below, the COVID-19 pandemic and the ensuing containment measures led to a drop in global GHG emissions in 2020, with an unprecedented reduction of 5.4 per cent in CO_2 emissions. However, if data on other GHG emissions are considered, the drop in total GHG emissions was lower than the drop in CO_2 emissions. Furthermore, a strong rebound in GHG emissions is expected in 2021, which would mean that the expected emissions in 2021 are likely to be only slightly lower than the record high emissions of 2019.

Figure 18: **Trends in global greenhouse gas emissions**



Source: Slide 4 of presentation by the UNEP representative.

67. In terms of the new and updated NDCs, by the end of September 2021, UNEP identified that 121 Parties (representing 52 per cent of global emissions) had communicated new or updated NDCs. About half of these new and updated NDCs included lower than previous 2030 emissions targets, just under 20 per cent imply equal or higher than previous 2030 emissions;[13] the effect of the remaining NDCs is unclear, as they are not comparable with their predecessors. These new and updated NDCs are generally more transparent and more likely to include GHG targets than previous NDCs. New or updated unconditional NDCs lead to a total annual additional reduction of about 2.9 Gt CO_2 eq in 2030 compared with the previous NDCs. If the announced pledges (as of 30 September 2021) of China, Japan and the Republic of Korea are also included, the aggregate reduction increases to just over 4 Gt CO_2 eq. Therefore, while there is some progress in terms of more ambitious emission reduction targets, the aggregate impact of the mitigation pledges on projected global GHG emissions is relatively limited.

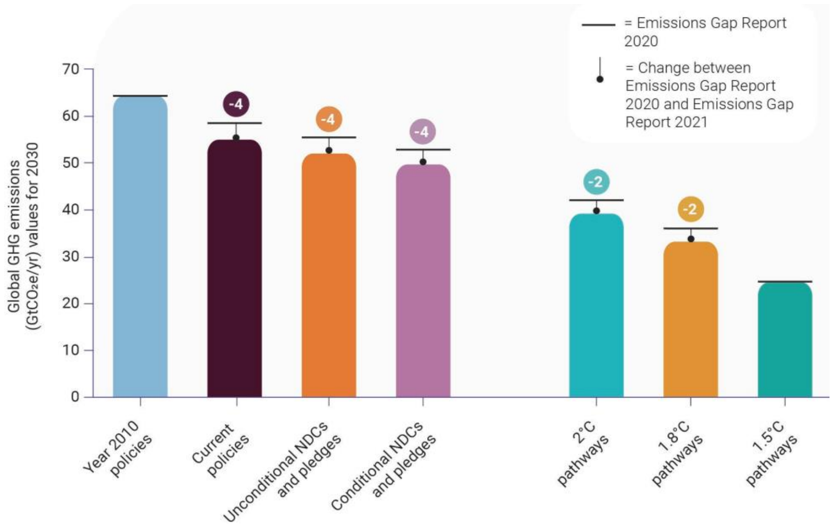
68. Figure 19 below illustrates the impacts on global emissions for 2030 associated with new mitigation policies, as included in the new and updated NDCs, and official announcements and pledges, as expressed in changes from the UNEP Emissions Gap Report in 2020. Owing to more recent policies, as well as the impact of COVID-19, emissions in 2020 decreased by 4 Gt CO_2 eq. The impact of the announced and submitted 2030 pledges is also about 4 Gt CO_2 eq. Furthermore, updates on underlying emissions scenarios compatible with 2 ºC, 1.8 ºC and 1.5 ºC pathways have

[12] The report is available at https://www.unep.org/resources/emissions-gap-report-2021.

[13] This does not necessarily mean targets in these NDCs are less ambitious than those contained in previous NDCs, as the difference could be a result of differences in emissions accounting.

led to 2 Gt CO_2 eq lower emission levels for 2 °C and 1.8 °C. However, the emissions gap in 2030 remains large.

Figure 19: **Impacts of recent climate policies, nationally determined contribution targets and announced pledges, and updates on underlying scenarios compatible with 2 ºC, 1.8 ºC and 1.5 ºC pathways on global greenhouse gas emissions at 2030**

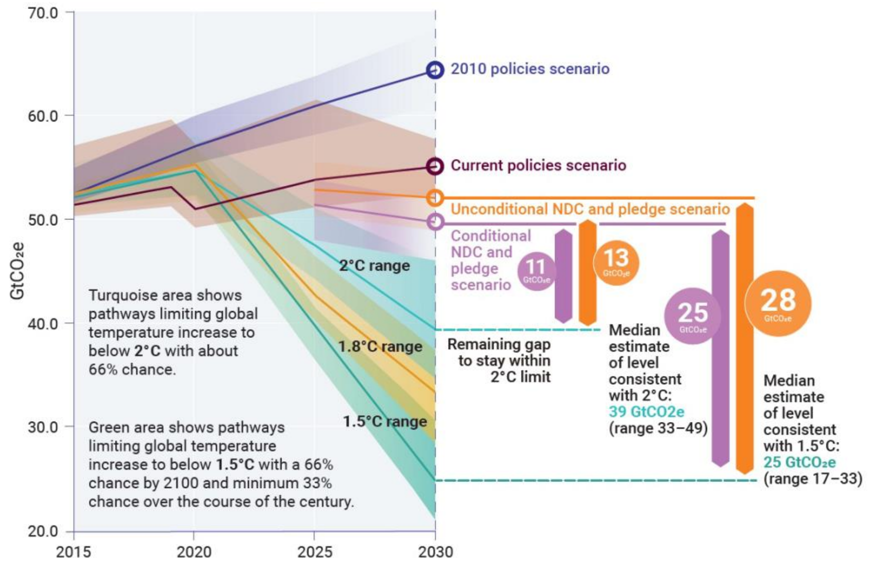


Source: Slide 7 of presentation by the UNEP representative.

69. As shown in figure 20 below, even if the conditional and unconditional NDCs are fully implemented, there will still be a gap of 11–13 Gt CO_2 eq in 2030, with respect to a 2 ºC increase, and of 25–28 Gt CO_2 eq with respect to a 1.5 ºC increase. Compared with the prior NDCs, the new unconditional NDCs and announced pledges reduce global emissions in 2030 by 7.5 per cent. However, an ambition level four times higher would be needed to be on track for an increase of no more than 2ºC, and seven times higher for no more than 1.5 ºC.

70. These gaps do not, however, take into account the net zero emission pledges made in 2021 by 50 Parties covering 57 per cent of global domestic GHG emissions, including 12 of the G20 members covering 54 per cent of global domestic GHG emissions. However, there are important ambiguities in these pledges, in terms of the sectors and gases covered, whether or not they include offsets, international aviation and shipping emissions, lack of transparency regarding plans for implementation and reviewing progress towards the delivery of pledges.

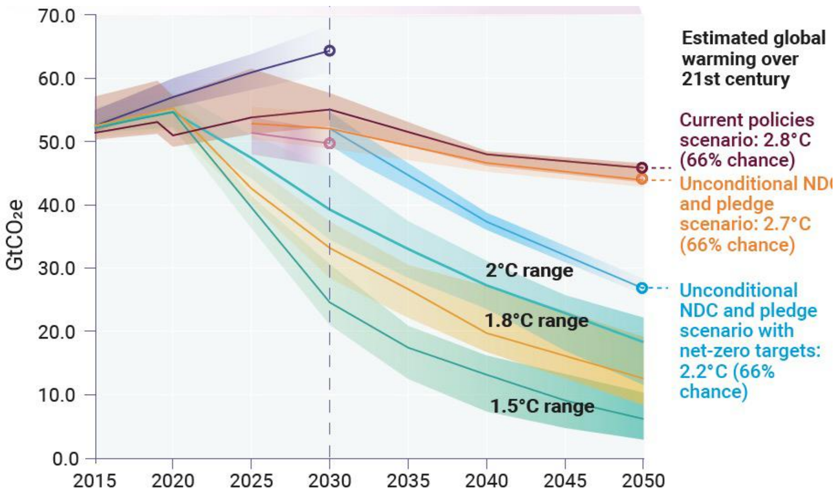
Figure 20: **Emissions gaps in 2030 for staying within global warming limits under different mitigation policy scenarios**



Source: Slide 8 of presentation by the UNEP representative.

71. Nonetheless, full implementation of the net zero targets in addition to 2030 pledges would bring global warming levels closer to the Paris Agreement temperature goal. As shown in figure 21 below, if the level of ambition implied by current policies continues over the course of the century, there would be global warming of about 2.8 ºC with a 66 per cent chance at the end of the century. Unconditional NDCs lower that by 0.1 ºC to 2.7 ˚C. However, if both the unconditional NDCs and the net zero targets are fully implemented, global warming can be limited to about 2.2 ºC by the end of the century. Considerable efforts are needed to get there: 10 G20 members are on track to achieve their previous NDCs, while 7 are still off track; assessed against current policy scenarios; the G20 as a whole are projected to fall short of achieving their original unconditional NDCs by 1.1 Gt CO_2 eq annually.

Figure 21: **Global warming implications at the end of the century under 2030 pledges and net zero targets**



Source: Slide 10 of presentation by the UNEP representative.

72. In response to a question from a Party on the political message related to a drop of 5.4 per cent in global CO_2 emissions in 2020 owing to COVID-19 containment measures, the UNEP representative noted that structural changes are needed in order to achieve the mitigation goal required to limit warming to 1.5 ºC. Locking down societies and shutting down economies for periods of time is neither sufficient nor appropriate.

73. One Party enquired about distribution of remaining carbon budget from 2020 for achieving the long-term global goal. the UNEP representative explained that the UNEP Emissions Gap Report assesses remaining carbon budget at a global level but does not analyse or allocate carbon budget to individual Parties.

74. Commenting on the presentation by UNEP, one Party underlined that there needs to be a separation between discussions under SED2 and those under the global stocktake. In response, the expert explained that the Emissions Gap Report series is not intended to be a preview of the global stocktake but aims to provide annual updates on the current situation, possible future scenarios and pathways towards these scenarios. A question was also raised regarding the rationale for the least-cost approach to comparing alternative mitigation pathways while equitable, common but differentiated responsibilities are also core principles under the Convention. One of the authors of the UNEP Emissions Gap Report 2021, noted that, while the author team is fully aware of the other core principles, the Convention clearly states, as one of its core principles, that climate policies and actions should be cost-effective so as to ensure global climate benefits at the lowest possible cost, which is an explicit definition of least-cost pathways.

(b) Linking longer-term pledges to near-term policies

75. Parties have different starting positions, face different circumstances and have different opportunities to make their best contributions towards global net zero, as highlighted by the OECD–IEA Climate Change Expert Group report examining net zero targets of 51 Parties and the European Union.[14] The wide diversity in the nature of net zero commitments makes it difficult to compare

[14] The report is available at https://read.oecd.org/10.1787/8d25a20c-en?format=pdf.

countries' targets by merely looking at headline figures and descriptions. In addition, near-term policy actions are often inconsistent with the systemic transformation implied by reaching net zero. For example, in 2020 alone, G20 and emerging economies spent over USD 345 billion subsidizing fossil fuel use.

76. As presented the UNEP representative, G20 countries, accounting for about 76 per cent of global emissions, are, as a group, not on track to achieve either their original 2030 pledges or their new ones. There is an urgent need to enhance ambition and accelerate action to bridge the emissions gap and set global emissions on a credible path towards net zero to keep the temperature goal of the Paris Agreement within reach. In addition, there need to be credible near-term policies and plans for achieving the net zero emissions target, together with a review process and intermediate milestones.

(c) Progress and initiatives to address data and methodological gaps

77. Recognizing the critical need for better, more comparable data and information on the policies that will drive the transition to net zero, including their impacts on people and communities, OECD launched IPAC.[15] An OECD representative noted that IPAC intends to provide for clear, comparable indicators on national and collective efforts towards net zero.

78. Complementary to the work of the UNFCCC, IPAC will help participating countries measure their progress and improve their climate action through targeted policy advice. IPAC contains four components: the IPAC dashboard, the climate action monitor, a web portal to exchange good practices and country-specific notes. The dashboard aims to help track and assess progress to climate commitments through internationally harmonized indicators centred on three elements: emissions, impacts and risks, and actions and opportunities. The climate action monitor provides a digest of country progress towards climate objectives and alignment with the Paris Agreement goals and a snapshot of key trends and developments, highlighting areas requiring further analysis or policy.

79. In response to a comment from a Party on the coverage of Parties by IPAC, the OECD representative noted that all Parties are invited to participate in IPAC and share data and good practices through the different components of the programme.

2. Assessment of climate finance flows

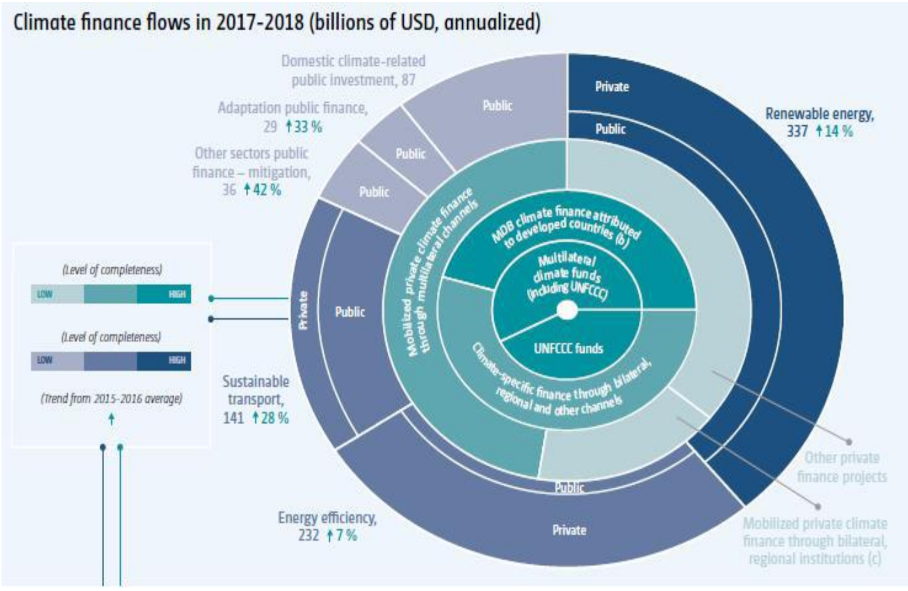
80. A member of the SCF, highlighted the key findings from the Fourth SCF Biennial Assessment and Overview of Climate Finance Flows. Highlighting the key features of the report, which focuses on climate financial flows for 2017–2018, she noted that extensive consultations with Party and non-Party stakeholders were held and an additional chapter mapping information relevant to Article 2.1c of the Paris Agreement was included.

81. Figure 22 below provides an overview of climate finance flows for 2017–2018. The blue outer circles present a breakdown of finance flows by major economic sector, while flows from developed to developing countries are summarized in the green inner circles, with UNFCCC funds at the core.

82. As shown in the figure, the annual average climate finance flow for 2017–2018 was about USD 775 billion, a 16 per cent increase since the previous biennial reporting period of 2015–2016. Renewable energy and sustainable transport investments account for most of the climate finance flows. In addition, the continued decline in renewable energy technology cost means that any new investment goes further: commissioned renewable energy capacity in 2018 increased by 100 per cent from that in 2012, but with only a 22 per cent increase in investment.

[15] See details at www.oecd.org/climate-action/ipac/.

Figure 22: **Key findings from the Fourth Biennial Assessment and Overview of Climate Finance Flows**



Source: Slide 6 of presentation delivered by the SCF member.

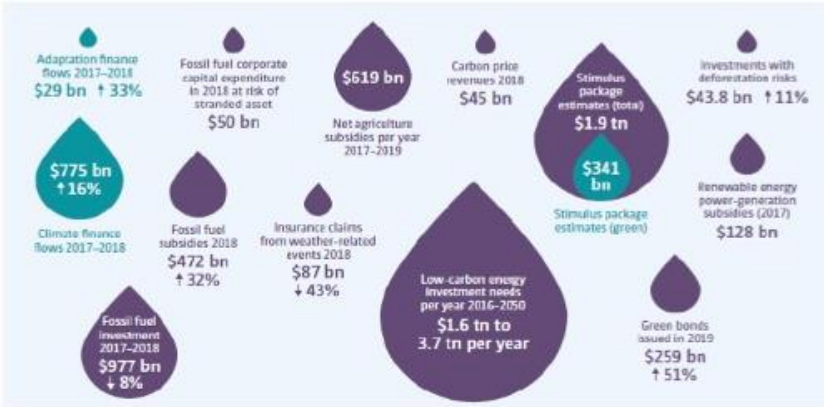
83. As shown in the figure, in 2017–2018, compared with 2015–2016, climate finance flows, through various channels, from developed to developing countries increased. On a comparable basis, climate-specific finance flows from the 23 Parties included in Annex II to the Convention increased by 13 per cent to an annual average of USD 36.3 billion but, compared with the USD 100 billion pledge, there still remained a significant gap. UNFCCC funds and multilateral climate funds saw an increase of 30 per cent in project approvals. However, there was a drop in replenishments of the Green Climate Fund and the Global Environment Facility; multilateral development banks increased their own climate funds to developing and emerging economies by 50 per cent compared with 2015–2016, with about USD 25 billion per year attributed to flow from developed countries.

84. The SCF member highlighted that support for mitigation remains greater than adaptation across all channels and this was also reflected, for example, in the poster by ESCWA. Although adaptation is a priority for Arab States, public finance channelled to support mitigation was 3.5 times higher than that for adaptation between 2013 and 2019. Further, limited adaptation finance is not reaching the most vulnerable, as the six Arab LDCs received only 18 per cent of the adaptation finance in the region.

85. Grants continue to be a key instrument for adaptation finance, which accounts for 94 per cent of multilateral finance for adaptation. However, access to climate finance remains a significant challenge, in particular access to multilateral climate funds.

86. The SCF member also commented on the current climate finance flows within the broader finance flow context. As shown in figure 23 below, although the total climate finance flows are increasing, they remain relatively small in volume, indicating opportunities for increasing investment in climate actions. Further, finance flows in GHG intensive activities remain worryingly high. Given the scale and speed needed for transformation to low GHG emission and climate-resilient development pathways, a sole focus on climate finance flows will be insufficient to meet the overarching objectives of the Paris Agreement. Opportunities exist to align broader finance flows with low-carbon and climate-resilient development pathways.

Figure 23: **Climate finance flows in the broader context of finance flows for 2017–2018**

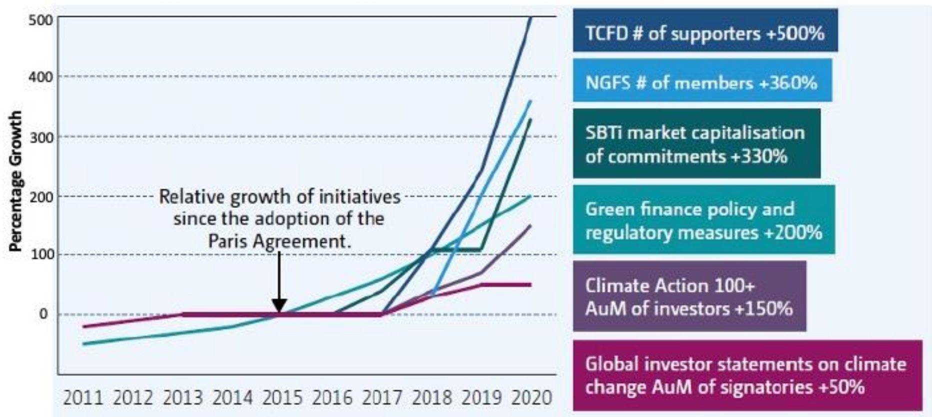


Source: adapted from slide 11 of presentation by the SCF member.

87. In terms of mapping information relevant to Article 2.1(c) of the Paris Agreement, a new addition to the biennial report of the SCF, the SCF member highlighted a significant growth in climate finance initiatives by investors, corporations and other businesses since the adoption of the Paris Agreement (figure 24 below). Many of these efforts explicitly refer to achieving the goals of Paris Agreement and its Article 2.1(c), and are mostly executed as collective initiatives and organizations. This highlights the importance of networks, knowledge-sharing and common goal-setting.

88. Regarding the real economic impact and risk of greenwashing associated with financial flows relevant to Article 2.1(c), the SCF member noted that this remains a challenge. Therefore, measuring the effective role of financial access in the context of Article 2.1© is a notable topic of debate, including which metrics are most important as indicators of success. Furthermore, consideration of climate-resilient development pathways is also needed to complement existing approaches. It is also important to ensure that just-transition financing is incorporated into approaches to align action with the goals of the Paris Agreement, or, in the classification of consistency, consistency with those goals, including supporting vulnerable developing countries whose access to development finance is undermined by climate change impacts.

Figure 24: **Significant growth in initiatives since the adoption of the Paris Agreement**



Source: adapted from slide 13 of presentation by the SCF member.

89. In response to questions from Parties on climate finance flows aimed at addressing loss and damage, and supporting technological solutions other than renewables and energy efficiency such as carbon capture and storage and through innovative instruments such as debt for climate swaps, a member of the Secretariat team supporting the SCF noted that, while the issues are discussed in the technical report of the Fourth Biennial Assessment and Overview of Climate Finance Flows, research is at an early stage and there is currently insufficient information to be able to provide a global assessment. However, as studies continue and the evidence base grows, it was expected that such issues will be addressed in subsequent assessment reports.

90. Parties also inquired about the breakdown between public and private sector finance within the total climate finance flows from developed countries to developing countries. The staff member of the Secretariat noted that the public financial flows from developed to developing countries take place through various channels (i.e. bilateral flows, multilateral climate funds and multilateral development banks) and are reported in different data sources following different approaches. The Fourth Biennial Assessment and Overview of Climate Finance Flows has not attempted to aggregate across various finance flow channels. On the question of private sector finance flows from developed to developing countries, the Secretariat staff member noted that private finance mobilized by public sources was around USD 14 billion per year on average for 2017–2018. In addition, there are other private finance projects or investments that have been made in developing countries but information on the associated finance flows is not as solid, and can range from USD 5 to 10 billion, depending on how many projects are processed in the year.

91. A Party highlighted that, by invoking Article 2.1 ©, finance allocated for existing projects in developing countries has been curtailed, stopped, truncated or dissuaded over the last five years. Therefore, he cautioned that the provision of Article 2.1(c) does not override equity, common but differentiated responsibilities, climate justice, and equitable access to sustainable development.

92. A Party inquired about the cost of achieving the long-term global goal. The UNEP Emissions Gap Report author noted that, this is an area where more studies are needed to cost the limiting of warming for different levels and associated adaptation costs. Padraig Oliver from the secretariat added that the biennial assessment and overview of climate finance flows is an ex-post analysis of what has been provided as opposed to how much is required. However, there is some analysis on the alignment between where the climate finance is flowing to and the needs of developing countries. The SCF has been mandated, for the first time, to prepare, every four years, a report on the determination of the finance needs of developing countries.[16]

93. Meenakshi Rama, Third World Network, highlighted that there is a significant gap between climate finance needed by developing countries and the current level of climate financial flows. Citing a recent Oxfam report,[17] she noted that, of the USD 59.5 billion in public finance reported by developed countries, climate-specific net assistance may have been just USD 19–22.5 billion in 2017–18. The report also states that around 20 per cent of the reported public finance was estimated to be in the form of grants, compared with 80 per cent reported as loans and other non-grant instruments, and that of all reported climate finance, about 40 per cent was non-concessional finance. Therefore, how climate finance is counted remains as an issue. On the other hand, financial needs expressed in NDCs of developing countries amount to USD 5.8–5.9 trillion by 2030, which is 100 times the annual public finance flow from developed countries to developing countries in 2017–2018; and the United Nations Conference on Trade and Development estimates that about 2 per cent of world GDP annually is needed (at least USD 1.7 trillion) for developing countries to achieve objectives of the Paris Agreement and 2030 Agenda for Sustainable Development in the coming decades, owing to the COVID-19 pandemic.

C. Challenges and opportunities

1. Challenges

(a) Data and information

94. As Parties discussed with IPCC experts, a lack of long-term records at sufficient resolution to be able to perform robust statistical trend analysis and, for some regions, the lack of attribution studies are limiting the depth of scientific assessments on some of the key issues discussed at SED2 and, more importantly, hindering low-carbon and climate-resilient decision-making. A lack of sufficient observations in some areas undermines scientists' ability to make meaningful statements about the state of the regional climate, let alone what will happen in the future. This is a particularly acute challenge in SIDS, as highlighted by some Parties.

95. As noted by the representative from WMO-RCC Asia, Asia as a whole is currently well placed to respond to extreme weather events and is among the regions with the greatest early warning

[16] Decision 4/CP.24, paras. 13–14.

[17] Oxfam International (2020), *Climate Finance Shadow Report 2020*, available at https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621066/bp-climate-finance-shadow-report-2020-201020-en.pdf.

system capacity. Of the countries for which data are available, 35 per cent reported having a multi-hazard early warning system in place. However, those data were obtained from only 56 per cent of the region (19 out of 34 countries), covering about 38 per cent and 50 per cent of LDCs and SIDS in the region, respectively. There is therefore a substantial need for improved data from all countries in the region in order to obtain a clearer picture of the gaps and needs for Asia as a whole.

96. In relation to developing a systematic inventory for extreme weather events through the WMO-RCC system, the WMO-RCC Africa representative, highlighted the importance of structural reform to forge a close working relationship between national meteorological services and disaster risk management agencies. Data on impacts of extreme weather events do exist, at least in some countries, but are held by other national agencies (e.g. statistics institutes and civil protection agencies) and are not yet operationally connected with the meteorological services. There is therefore much to be gained through inter-agency collaboration in making the extreme weather event data and the impact data interoperable and ultimately improving the capacity for tailoring sector- or user-specific weather and climate services.

97. Filling gaps in data, information and knowledge on past and current changes is essential and must be addressed as a priority. However, the WG I Co-Chair highlighted that many decisions taken today are only informed by knowledge of past climate, instead of what is happening now or what is likely to happen in the future. In order to make effective and climate-resilient development plans, it is critical to use current knowledge on what has already changed, as well as the full range of possible future changes.

(b) Knowledge and capacity

98. Robust climate hazard monitoring linked to early warning systems can inform anticipatory action and contingency planning, thereby reducing disaster risks and impacts on lives and livelihoods. However, multi-hazard early warning systems are underdeveloped in many developing countries. For example, in South America, only 3 out of a total 12 countries have such a system.

99. A Party highlighted the significant challenge related to accessing observational data, in particular with regard to precipitation, which is highly variable both spatially and temporally. Parties were informed that the Global Precipitation Climatology Centre collects in situ observations from up to 100,000 precipitation gauges and maintains a large database of monthly and daily precipitation records.[18]

100. A Party from Africa highlighted that low research capacity has been a major constraint for the region, in particular in the ability to attribute extreme events to climate change. Parties also discussed the potential role of WMO-RCCs to support regional research capacity-building through regional collaboration among centres or by building capacity to improve the science outputs. The Co-Chair of WG I noted that all IPCC special reports underscore the importance of climate literacy, education and training as key enabling conditions to achieve the long-term global goal. The WMO-RCC South-West Pacific representative noted that many island States in the Pacific face significant capacity challenges, with entire national meteorological services only having a few members of staff in some cases. There is, however, some effective regional collaboration on climate services. For example, a partnership between Australia and many of the island States in the region provides seasonal climate predictions and other climate-resilient decision support tools.

2. Opportunities

(a) Bridging the mitigation gap and getting on track to net zero

101. The UNEP representative outlined opportunities to bridge the emissions reduction gap and bring global emissions onto a credible path to net zero around the middle of the twenty-first century. She highlighted opportunities within the context of COVID-19 recovery, method emission reduction and market mechanisms.

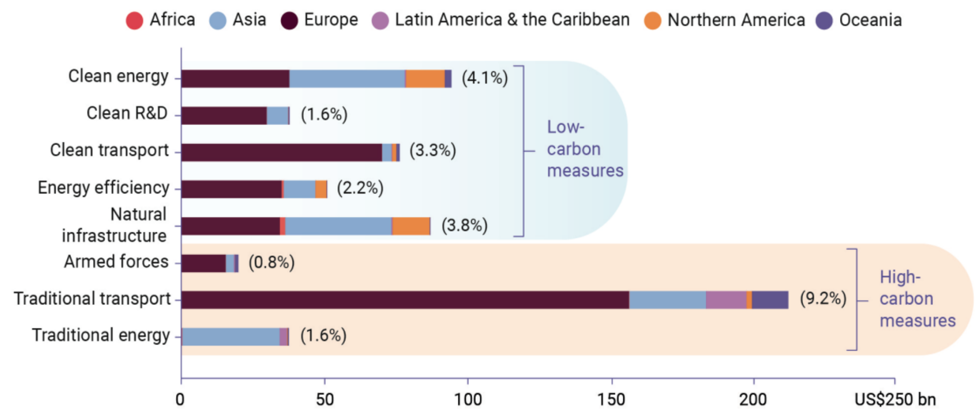
102. In the context of COVID-19 recovery, as shown in figure 25 below, approximately USD 16.7 trillion had been spent on COVID-19-related rescue and recovery packages by May 2021. Of this, USD 2.25 trillion is considered recovery spending. Only around 17–19 per cent (USD 390–440 billion) of the recovery spending is likely to reduce GHG emissions. Furthermore, as noted by the OECD representative, the OECD–IEA joint analysis showed that, in 2020 alone, G20 and emerging

[18] Details are available at www.dwd.de/EN/ourservices/gpcc/gpcc.html.

economies spent over USD 345 billion subsidizing fossil fuel use.[19] Therefore, there is an important opportunity to use any upcoming pandemic fiscal recovery measures and spending to accelerate a green transition.

103. In response to a question on examples of recovery spending which target both pandemic response and low-carbon agendas, the UNEP representative noted that these mutually beneficial mainly focus on clean energy, energy efficiency and green transportation.

Figure 25: **Global recovery spending as at May 2021 across sectors by region (US billion) low-carbon initiatives (top) and high-carbon initiatives (bottom)**



Source: Slide 13 of presentation by the representative of UNEP.

104. Regarding methane, a reduction in its emissions can contribute to slowing down the rate of global warming in the short term and to reducing peak warming throughout the twenty-first century. As noted by the UNEP representative, opportunities exist for reducing methane emissions from fossil fuels, agriculture and waste. A growing number of countries are looking into methane emission reductions in their NDCs but there is still scope to increase this considerably. The current NDCs only cover a fraction of the methane reduction that is required to be consistent with a 2 °C temperature goal, and only about 23 per cent of what is needed for the 1.5 °C goal. In particular, out of the 46 Parties accounting for 90 per cent of GHG emissions from agriculture, only 12 Parties include measures targeting emissions from livestock in their NDCs. There are therefore opportunities for further action, with more advanced research and technology development.

105. Carbon markets have the potential to deliver real emission abatement and drive ambition, but only when rules are clearly defined, designed to ensure that transactions reflect actual reductions in emissions, and supported by arrangements to track progress and provide transparency. By helping drive down the costs of emission reduction, carbon markets can create room for countries, companies and other actors to enhance their mitigation ambition in both the short- and long-term. The number of countries that have indicated in their new or updated NDCs the planned or possible use of voluntary cooperative approaches has almost doubled compared with previous NDCs, indicating significantly increased interest.

(b) Improving data availability, quality and reporting

106. To address the acute gap in systematic observations in LDCs and SIDS, the SOFF, a United Nations multi-donor trust fund, was launched at COP 26.[20] The SOFF would support efforts to finance surface observations that could fill the data gaps that limit understanding of the climate system and constrain ability to predict and adapt to extreme weather events.

107. To address data and information gaps which hinder the provision of and access to decision-critical analytics and knowledge, a range of initiatives have been launched. Some of these were presented during this second meeting of SED2. The Copernicus Marine Environment Monitoring Service, the marine component of the Copernicus Programme of the European Union, through a poster, highlighted its services of providing free, regular, systematic and authoritative information

[19] Details are available at www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/ENV/EPOC/IEA/SLT(2021)3&docLanguage=En.

[20] Details regarding the SOFF are available at https://alliancehydromet.org/systematic-observations-financing-facility/.

on the state of the blue (physical), white (sea ice) and green (biogeochemical) ocean at the global and regional scale. It provides data on a set of essential variables including the mean sea level and sea surface temperature of blue ocean, ocean acidity and marine eutrophication of green ocean and Arctic and Antarctic sea ice extent of white ocean. In addition to in situ observations, it carries out data assimilation and numerical modelling, providing data and analysis on a range of timescales, from multiple years (for observed statistics) to multiple days (for forecasts) and daily and hourly (real-time observations).

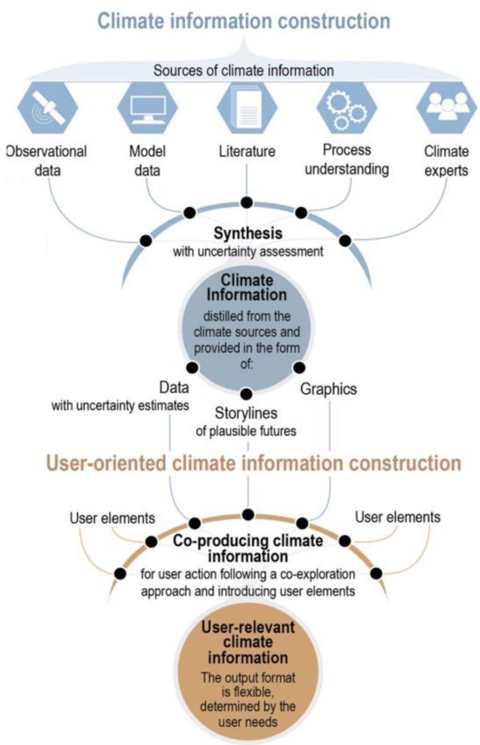
108. The joint Working Group on Climate of the Committee on Earth Observation Satellites and the Coordination Group for Meteorological Satellites, through its poster, introduced its work on analysing satellite-derived climate data records of Global Climate Observing System essential climate variables. Building on and coordinating the work of its large network of member agencies, it supports user applications and stakeholder decision-making on mitigation and adaptation.

109. There have also been initiatives to make climate data and science more accessible to decision makers. ESCWA, through a poster, provided an example of a regional initiative focusing on assessing climate change impacts on water resources and socioeconomic vulnerability in Arab States. The regional knowledge hub under the initiative provides climate analysis that informs regional cooperation and climate-resilient policy decisions in Arab States.

110. During this second meeting of SED2, Parties discussed practical ways of making use of improving information and knowledge on climate change and its impacts so that low-carbon and climate-resilient decisions can be supported by the best available science. In this regard, an IPCC expert noted a significant programme supported by the Government of the United Kingdom of Great Britain and Northern Ireland which enables scientists from that country to work with partners in other parts of the world, such as Brazil, China, South-East Asia and Southern Africa, to turn available climate information into action-oriented climate services.

111. The WG I contribution to AR6 also synthesizes the current state of knowledge related to best practices to distil context-specific and actionable climate information (figure 26 below). This includes the metadata analyses required to construct and synthesize climate information (the top part of figure 26) and the co-production of user-oriented climate information through an interactive process involving multiple stakeholders (the bottom part of figure 26).

Figure 25: **Multiple lines of evidence for the co-production of user-relevant regional climate information framed by context and values**



Source: adapted from slide 5 of the Part 2 presentation of the WG I Co-Chairs.

112. With relation to tracking and reporting on climate finance flows, as noted by the OECD representative, OECD, data from countries are improving, with increasing granularity. It is expected that, with better coordination and support under the Convention and its Paris Agreement, future reports on climate finance flows will be more granular and consistent, and of better overall quality. In addition, he highlighted the opportunity for technical contributions from experts towards the development of specific indicators, indices or tools which could be added to the IPAC platform. Analytical tools and methods for the use of big data or economic surveys, for example, could contribute to the improvement of reporting on climate action and support.

(c) Enhancing enabling conditions and financial support

113. As illustrated by ESCWA through a poster, innovative finance instruments could be explored to scale up financial support for developing countries. ESCWA launched its regional debt swap initiative in 2020 to support climate-resilient investment projects in middle-income countries with high debt burdens.[21]

III. Reflections

114. The second meeting of SED2 has contributed to bridging science and policy through extensive exchange of information, views and insights among Parties and a wide range of experts. It has helped to deepen understanding of the current state of the Earth's climate system and human influence on it, what it will take to achieve the long-term global goal and of overall progress towards achieving that goal. Throughout the deliberations, a set of substantive and procedural issues were noted that will be taken into account in the preparation of the third meeting of SED2.

115. Regarding procedural issues, Parties expressed appreciation for the in-depth knowledge and expertise of the WG I team, who provided comprehensive updates on the latest physical science basis for climate change and responded to numerous comments, queries and questions from Parties and observers. Parties requested that sufficient time be allocated at the third meeting for discussions on the upcoming contributions of IPCC Working Groups II and III to AR6. While Parties welcomed the opportunity to discuss the relevant issues with detailed regional information, it was noted that discussions under the two themes of the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it need to be made more distinct, with time allocated for the two themes to be balanced. In addition, although Parties appreciated the additional opportunities for dialogue through interactions with poster presenters during the first meeting of SED2 when the plenary proceedings were entirely virtual, Parties noted that, when SED2 meetings take place in person, poster sessions also need to be held in person, in order to be of maximum value. Finally, Parties called for expert presentations to focus exclusively on the themes of the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it, as per decision 5/CP.25, paragraph 4.

116. In preparing for the third meeting of SED2, the good practices from the first and second meeting will be built upon and duplication with the global stocktake and other processes under the Convention and the Paris Agreement will be avoided. The organization of the third meeting will take into consideration views submitted by Parties and observers on this matter, including the key technical inputs to the meeting and key questions to be addressed. An information note about the third meeting will be published prior to the fifty-sixth session of the subsidiary bodies (June 2022).

117. The second meeting of SED2 contributed substantively to enhancing Parties' understanding of the long-term global goal and scenarios towards achieving it in the light of the ultimate objective of the Convention by highlighting the following:[22]

(a) Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere and across the climate system as a whole have been observed in all parts of the world. Human

[21] The poster contributed by ESCWA is available at https://unfccc.int/sites/default/files/resource/Poster_P2_UNESCWA%20Climate%20Finance%20in%20the%20Arab%20Region%20-%20UNESCWA.pdf for details.

[22] Key contributions of the first meeting of SED2 under the two themes of the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it are summarized in paras. 280–281 of the summary report (available at https://unfccc.int/sites/default/files/resource/Summary%20report_SED1.pdf).

activities have contributed to many observed changes in weather and climate extremes, which have led to considerable socioeconomic and environmental impacts in all regions;

(b) Global surface temperature will continue to increase until at least the middle of the twenty-first century under all emissions scenarios considered in the WG I contribution to AR6. With every increment of global warming, changes get larger in regional mean temperature, precipitation and soil moisture. Global warming of 1.5 °C and 2 °C will be exceeded during the twenty-first century deep reductions in CO_2 and other greenhouse gas emissions occur in the coming decades;

(c) To limit global warming to 1.5 °C requires rapid, deep and sustained reductions in global GHG emissions, including reducing global CO_2 emissions by 45 per cent relative to the 2010 level by 2030 and to net zero around the middle of the twenty-first century, as well as deep reductions in other GHGs including methane. Experts also highlighted the critical role of nature in providing carbon removals and sinks. In scenarios where temperatures rise significantly higher than by 1.5 °C, net zero CO_2 emissions are still reached around the middle of the twenty-first century, but such scenarios rely heavily on CO_2 removal in the second half of the century to attempt to reverse warming back below 1.5 °C in 2100;

(d) Climate change information is increasingly available and robust at regional scale for impact and risk assessments. Human-induced climate change is already affecting every region on Earth, with human influence contributing to many observed changes in weather and climate extremes. Any further global warming would lead to increasing concurrence of extreme weather events in many regions.

118. Presentations and discussions during the second meeting of SED2 also shed light on the overall aggregated effects of the steps taken by Parties in order to achieve the long-term global goal:

(a) Pledges to reduce emissions and their implementation are both crucial. The pre-2020 pledges of Parties and their subsequent implementation, in terms of mitigation action and support for developing countries, have been insufficient to put the world on track to limiting temperature rise to well below 2ºC, let alone to 1.5ºC. Although all Parties to the Paris Agreement have submitted an NDC or an updated NDC, analysis shows there are only 10 G20 members, for example, on track to achieve their previous NDCs, while seven are still off track;

(b) Although there has been some progress in terms of more ambitious emission reduction targets, the aggregate impact of the mitigation pledges on projected global GHG emissions is relatively limited. Pledges for 2030 as included in current NDCs would still leave a 11 Gt CO_2 eq emissions gaps in 2030 if global warming was to be kept below 2 ºC. Comparing emissions under current policies with the 2 ºC and 1.5 ºC pathways, there is a gap of 12–18 Gt CO_2 eq for limiting warming to below 2 ºC, and a gap of 28–33 Gt CO_2 eq for limiting warming to 1.5 ºC. Bridging the emissions gap requires that countries increase their mitigation actions fourfold to limit warming to 2 °C and more than sevenfold for the 1.5 °C goal. If action is postponed further, it will make it impossible to achieve the long-term global goal;

(c) In 2017–2018, compared with 2015–2016, climate finance support from developed to developing countries increased by 13 per cent to an annual average of USD 36.3 billion, but compared with the USD 100 billion pledge, there remains a huge gap. Public climate finance from developed countries to developing countries in 2017–2018 merely amounted to 1 per cent of the financial needs required by 2030 to achieve the NDCs of developing countries;

(d) A large number of extreme weather events, many associated with climate change, have caused devastation in many parts of the world, particularly in developing countries. Actions have been taken to reduce vulnerabilities to the adverse impacts of climate change, such as the development of multi-hazard early warning systems and the adoption of climate-smart urban planning but the gaps in provision of and access to information, technology and finance remain considerable and hinder effective adaptation at scale in developing countries.

119. Experts and Parties also discussed progress made in relation to addressing information and knowledge gaps, including with regard to scenarios to achieve the long-term global goal and a range of associated impacts:

(a) The WG I contribution to AR6 presents a number of advances in the physical science basis of climate change, for example:

(i) a near-linear relationship between cumulative anthropogenic CO_2 emissions and the global warming they cause. This relationship implies that reaching net zero anthropogenic CO_2 emissions is a requirement to stabilize human-induced global temperature increase at any level, but that limiting global temperature increase to a specific level would imply limiting cumulative CO_2 emissions to within a carbon budget;

(ii) progress in our understanding of natural climate variability, which has led to the establishment of a linear relationship between the frequency and intensity of many extreme events and the level of global warming. This implies that every fraction of a degree of global warming could lead to a notable increase in the occurrence and concurrence of damaging extreme events at regional scale. It is expected that sea level rise of one metre is bound to happen while the precise timing of it occurring depends on the scale and speed of mitigation. To avoid the overwhelming adverse impacts of extreme sea level rise, rapid and early mitigation efforts are essential;

(b) There is new evidence of steps taken by Parties to achieve the long-term global goal, including mapping of information relevant to Article 2.1(c) of the Paris Agreement, which indicates significant growth in initiatives with the potential to increase levels of finance for climate action. This has, however, also revealed challenges related to, among others, the risk of greenwashing, a lack of inclusiveness and geographical balance, and insufficient support for climate-resilient development pathways.

120. Parties highlighted the importance of the availability of information on potential physical and socioeconomic impacts of different levels of projected climate change, and the associated mitigation costs. The contributions of IPCC Working Groups II and III to AR6 are expected to provide extensive information on the impacts and vulnerability of regions and sectors, as well as various mitigation pathways and associated costs in order to achieve the long-term global goal. They will be considered at the third meeting of SED2.

121. The dialogue between Parties and experts at the second meeting of SED2 highlighted a range of challenges and opportunities related to both themes of the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it:

(a) Achieving the long-term global goal is an imperative in order to avoid the most catastrophic impacts. However, to do so, decisive action in the coming decade is critical. This entails taking action on mitigation, adaptation and means of implementation. Developing countries require support from developed countries to scale up action on mitigation, as well as strengthening climate resilience to cope with adverse climate change impacts;

(b) Although Parties have different starting positions, face different circumstances and have different opportunities to make their best contributions towards global net zero, current mitigation pledges and implementation actions for 2030 are not consistent with a pathway for achieving the long-term global goal. Parties need to enhance their mitigation ambitions and pursue an accelerated path towards that goal. In particular, strong, rapid and sustained reductions in methane emissions could limit the warming effect resulting from declining aerosol pollution and improve air quality. Market mechanisms, with clearly defined rules and provisions for transparency and progress tracking, could also be explored to drive down the cost of mitigation, creating space for racketing up both near- and long-term ambitions. Full implementation of net zero targets pledged by Parties, in addition to 2030 pledges, would bring global warming levels closer to the long-term global goal. However, these net zero pledges urgently need to be backed up with near-term policies and action plans to give confidence that net zero emissions and ultimately the long-term global goal can be achieved;

(c) Although the sea level is expected to rise by at least one metre in all scenarios, a later date for this sea level rise would allow more time for coastal communities and ecosystems to adapt. The importance of multi-hazard early warning systems was highlighted in addressing the increasingly more severe and frequent extreme weather events, in particular in many developing countries where significant investment is required to develop such systems;

(d) In spite of an increase in global climate finance flows, significant gaps remain between what developing country Parties need in order to pursue a low-carbon and climate-resilient development pathway consistent with the long-term global goal and what is currently available. The deficit is particularly acute for adaptation, as the current climate finance flows to developing countries remain predominately concentrated on mitigation and of a less concessional nature;

(e) While there have been notable advances in information and knowledge as highlighted in the WG I report and by experts at the second meeting of SED2, knowledge gaps remain. They include, among others:

(i) Attribution of observed extreme weather events to human activities, in particular at the regional scale;

(ii) Regional physical impacts of projected climate change, including concurrent extreme events under differing levels of global warming;

(iii) Costs of mitigation and adaptation;

(f) Many challenges are associated with the availability, quality, standardization and transparency of basic data and information on climate system variables, socioeconomic impact indices, climate finance flows and mitigation actions. A range of new initiatives have been launched to increase the observing network in LDCs and SIDS, regularly document regional changes in the climate system and their impacts at regional level, improve the availability of public climate finance data through climate budget tagging, and help Parties strengthen and coordinate their actions through regular monitoring, policy evaluation and feedback on results and good practices.

122. Challenges also remain in accessing limited public climate finance, in particular for national and regional entities. Furthermore, a vast amount of COVID-19 financial recovery packages have been put in place by governments but only a small proportion of these is contributing to climate action. There is scope to deploy precious financial resources strategically to ensure that the COVID-19 recovery is green, resilient and inclusive. In addition, as being piloted by some Parties, innovative financial instruments could be explored to ramp up the financial support for developing countries to pursue a development pathway compatible with the long-term global goal.