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Summary of the 48th Session of the Intergovernmental Panel on Climate Change (IPCC-48): 1-6 October 2018

The 48th session of the Intergovernmental Panel on Climate Change (IPCC-48) convened from 1-6 October 2018 in Incheon, Republic of Korea, and brought together more than 500 participants from over 130 countries.

On Saturday, 6 October, the Panel adopted the Summary for Policymakers (SPM) of the Special Report on Global Warming of 1.5°C (SR15) and approved the Technical Summary and the underlying assessment report. Throughout the week and through the last night, the first Joint Session of Working Groups (WGs) I, II and III discussed the SPM line-by-line in order to reach agreement.

IPCC-48 convened on Monday morning, 1 October, with an opening ceremony, including a video message from the President of the Republic of Korea Moon Jae-in. IPCC-48 was then suspended so the Joint WG Session could begin its work, and met briefly on Friday to address additional agenda items. On Saturday afternoon, IPCC-48 reconvened to adopt the SR15 SPM.

The Joint WG Session represented the first time that the three IPCC WGs have worked together to produce a report in an interdisciplinary manner. While the SPM was reviewed in a plenary setting, discussion of some subsections, paragraphs, figures and definitions took place in informal huddles or in contact groups that were established as needed.

The SPM consists of four sections:

- Understanding Global Warming of 1.5°C;
- Projected Climate Change, Potential Impacts, and Associated Risks;
- Emission Pathways and System Transitions Consistent with 1.5°C Global Warming; and
- Strengthening the Global Response in the Context of Sustainable Development and Efforts to Eradicate Poverty.

The report was produced in response to an invitation from the parties to the UN Framework Convention on Climate Change (UNFCCC) that was extended in 2015, as part of the decision that adopted the Paris Agreement.

IPCC-48 also adopted decisions on:

- the IPCC Scholarship Programme, agreeing to appoint four new members to the Board of Trustees to make decisions on programme funding; and
- the *Ad Hoc* Task Group on Financial Stability (ATG-Finance), agreeing to consider hiring an external expert to address the financial stability of the IPCC.

The Panel also took note of reports on:

- progress made by the Task Group on the Organization of the Future Work of the IPCC in Light of the Global Stocktake (TG-FWLGST);
- progress regarding the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2019 Refinement);
- the International Conference on Climate Change and Cities;
- the Expert Meeting on Assessing Climate Information for Regions;
- the Expert Meeting on Short-Lived Climate Forcers; and
- the Task Force on National Greenhouse Gas Inventories (TFI).

IPCC-49 will convene in May 2019 in Kyoto, Japan, to, *inter alia*, approve the 2019 Refinement to the 2006 Guidelines.

In this Issue

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A Brief History of the IPCC

The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the UN Environment Programme (UNEP) to assess, in a comprehensive, objective, open, and transparent manner, the scientific, technical, and socio-economic information relevant to understanding human-induced climate change, its potential impacts, and adaptation and mitigation options. The IPCC is an intergovernmental and scientific body with 195 member countries. It does not undertake new research or monitor climate-related data; instead, it conducts assessments of the state of climate change knowledge on the basis of published and peer-reviewed scientific and technical literature. IPCC reports are intended to be policy relevant, but not policy prescriptive.

The IPCC has three WGs:

- Working Group I (WG I) addresses the physical science basis of climate change;
- Working Group II (WG II) addresses climate change impacts, adaptation, and vulnerability; and
- Working Group III (WG III) addresses options for reducing greenhouse gas (GHG) emissions and mitigating climate change.

Each WG has two Co-Chairs and seven Vice-Chairs, with the exception of WG II, which has eight Vice-Chairs. The Co-Chairs guide the WGs in fulfilling the mandates given to them by the Panel with the assistance of Technical Support Units (TSUs).

The IPCC also has a TFI to oversee the IPCC National GHG Inventories Programme, also supported by a TSU. The Programme aims to develop and refine an internationally-agreed methodology and software for calculating and reporting national GHG emissions and removals, and encourage its use by parties to the UNFCCC.

The Panel elects its Bureau for the duration of a full assessment cycle, which includes preparation of an IPCC assessment report. The Bureau plans, coordinates, and monitors the IPCC's work, and is composed of climate change experts representing all regions. Currently, the Bureau comprises 34 members, and includes the IPCC Chair and Vice-Chairs, WG Co-Chairs and Vice-Chairs, and TFI Co-Chairs.

In 2011, the IPCC established an Executive Committee to assist with intersessional work and coordination among the WGs. The IPCC Secretariat is located in Geneva, Switzerland, and is hosted by the WMO.

IPCC Products

Since its inception, the IPCC has prepared a series of comprehensive assessment reports, special reports (SRs), and technical papers that provide scientific information on climate change to the international community.

The IPCC has completed five assessment reports, which were completed in 1990, 1995, 2001, 2007, and 2014. The Sixth Assessment Report (AR6) is expected to be completed in 2022. The assessment reports are structured in three parts, one for each WG. Each WG's contribution comprises an SPM, a Technical Summary and an underlying assessment report. Each report undergoes an exhaustive and intensive review process by experts and governments, involving three stages: a first review by experts, a second review by experts and governments, and a third review by governments.

Each SPM is then approved line-by-line by the respective WG. A Synthesis Report (SYR) is produced for the assessment report as a whole and integrates the most relevant aspects of the three WG reports and SRs of that specific cycle. The Panel then approves an SPM of the SYR line by line.

The IPCC has produced a range of SRs and technical papers on climate change-related issues, including:

- Land Use, Land-Use Change and Forestry (2000);
- Carbon Dioxide (CO2) Capture and Storage (2005);
- Climate Change and Water (2008);
- Renewable Energy Sources and Climate Change Mitigation (2011); and
- Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (2011).

Special Reports for the sixth assessment cycle include:

- Global Warming of 1.5°C;
- Ocean and Cryosphere in a Changing Climate (SROCC); and
- Climate Change and Land (SRCCL).

In addition, the IPCC produces methodology reports, which provide guidelines to assist countries in reporting on GHGs. Good Practice Guidance reports were approved by the Panel in 2000 and 2003. The latest version of the IPCC Guidelines on National GHG Inventories was approved in 2006, and the sixth assessment cycle includes a Methodology Report to refine these guidelines (2019 Refinement). Additionally, in 2013, the IPCC adopted a Supplement to the 2006 IPCC Guidelines: Wetlands (Wetlands Supplement), and the Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP Supplement).

In 2007, the IPCC was awarded the Nobel Peace Prize, jointly with former US Vice President Al Gore for its work and efforts "to build up and disseminate greater knowledge about manmade climate change, and to lay the foundations needed to counteract such change."

Sixth Assessment Cycle

IPCC-41 to IPCC-43: IPCC-41 (24-27 February 2015, Nairobi, Kenya) addressed future IPCC work; took a decision on the size, structure, and composition of the IPCC and TFI Bureaux; and adopted decisions relevant to the sixth assessment cycle. IPCC-42 (5-8 October 2015, Dubrovnik, Croatia) elected Bureaux members for the sixth assessment cycle. IPCC-43 (11-13 April 2016, Nairobi, Kenya) agreed to undertake the three SRs and the 2019 Refinement in the sixth assessment cycle. SR15 was produced in response to an invitation from the 21st session of the Conference of the Parties to the UNFCCC (COP 21), which asked the IPCC to provide an SR in 2018 on the impacts of global warming of 1.5°C above pre-industrial levels. The IPCC accepted the invitation in 2016 at its 43rd session.

The Panel also agreed that an SR on cities would be prepared as part of the seventh assessment cycle.

IPCC-44: During this session (17-21 October 2016, Bangkok, Thailand), the Panel adopted outlines of SR15 and the 2019 Refinement. The IPCC also adopted decisions related to, *inter alia*: the Expert Meeting on Mitigation, Sustainability, and Climate Stabilization Scenarios; communications and the AR6 scoping process; and a meeting on climate change and cities.

IPCC-45: This meeting (28-31 March 2017, Guadalajara, Mexico) approved the SRCCL and SROCC outlines, and discussed, *inter alia*; the strategic planning schedule for the sixth assessment cycle; a proposal to consider short-lived climate forcers (SLCFs); and options for resourcing the IPCC, which led to the decision to establish the ATG-Finance.

IPCC-46: During this session (6-10 September 2017, Montreal, Canada), the Panel, *inter alia*, approved the chapter outlines for the three WG report contributions to the AR6. The

Panel also heard an update on progress of the ATG-Finance, discussed various funding options for the IPCC, and agreed to extend its mandate until IPCC-47.

IPCC Cities and Climate Change Science Conference (CitiesIPCC Conference): This meeting (5-7 March 2018, Edmonton, Canada) brought together approximately 750 participants from the science, policy, and practice communities to help determine current and future sources of emissions, and identify pathways for cities to pursue emission reductions and resilience strategies. The meeting produced a research agenda to better understand climate change, its impacts on cities, and the critical role local authorities can play in addressing the climate challenge.

IPCC-47: During this session (13-16 March 2018, Paris, France), the Panel agreed to, *inter alia*:

- extend the ATG-Finance's mandate;
- establish a task group on gender;
- the terms of reference for a task group on the organization of the future work of the IPCC in light of the global stocktake under the Paris Agreement;
- expand the IPCC Scholarship Programme to include funding for chapter scientists; and
- enhance developing country participation in IPCC activities.

The Panel also heard presentations by the WG Co-Chairs on the reports from the WG Bureaux regarding the selection of Coordinating Lead Authors, Lead Authors, and Review Editors for WG contributions to the AR6, as well as progress reports on the Special Reports and the 2019 Refinement. The meeting was preceded by a 30th anniversary celebration of the IPCC, hosted by the Government of France.

Reports of IPCC-48 and the Joint Session of WGs I, II and III

On Monday, 1 October, IPCC Secretary Abdalah Mokssit opened the session. IPCC Chair Hoesung Lee welcomed delegates to "one of the most important meetings in IPCC history," highlighting that the first-ever joint meeting of the Panel's three WGs would convene to consider, line-by-line, the SPM for SR15. Outlining the IPCC's work on SR15, he said the report's final draft contains over 6,000 references and considered approximately 42,000 comments on all the drafts of the report. He called on governments to ensure a strong, robust, and clear SPM that upholds the IPCC's scientific integrity. He noted the IPCC's improved financial situation, reporting that the IPCC had invested USD 2 million in the report, and various countries had covered additional costs.

President Moon Jae-in, Republic of Korea, via video, observed that abnormal extreme weather events threaten developing countries and vulnerable populations in particular. He recognized that the IPCC's scientific endeavors contribute to reinforcing global action to safeguard environmental justice and democracy. He also highlighted his country's efforts, including its national emissions trading programme and its support for vulnerable developing countries.

Elena Manaenkova, Deputy Secretary-General, WMO, commended the IPCC for improving its financial position and echoed the WMO's call to IPCC members to ensure financial support for SRs and contributions to national meteorological agencies contributions. Noting the increasing influence of the IPCC and the WMO, she highlighted UN Secretary-General António Guterres' recent call to the UN General Assembly to "listen to the earth's best scientists" on climate trends.

Jian Liu, Chief Scientist, UNEP, highlighted the important co-benefits that accompany climate action, pointing to urgent challenges, such as pollution—in particular indoor air pollution, where damages exceed the gross domestic product (GDP) of Japan—and species loss, with more than 10,000 species disappearing annually.

Youssef Nassef, Adaptation Programme Director, UNFCCC, noted the urgent need for science to inform climate policymaking, including implementing the Paris Agreement. He thanked the IPCC for responding so quickly to the UNFCCC's invitation for the SR15, which he said will feed directly into the Talanoa Dialogue and a special event at UNFCCC COP 24 in Katowice, Poland, in December 2018. He explained the report's relevance to other UNFCCC mechanisms, including the transparency framework and the global stocktake.

Kim Eun-kyung, Minister of Environment, Republic of Korea, noted that SR15 would provide a "stepping stone" towards achieving the Paris Agreement's long-term goal. Among steps her government is taking to address climate change, she highlighted: its 2030 GHG reduction target; pre-emptive adaptation measures to protect vulnerable populations; and support to developing countries, including through the Global Green Growth Institute and the Green Climate Fund.

Kim Jong-seok, Administrator, Korean Meteorological Agency (KMA), called attention to extreme weather events in the Republic of Korea in 2018, and the KMA's continuing contributions as a national focal point to the IPCC, and urged IPCC-48 to take steps that contribute to post-2020 climate governance.

Park Nam-chun, Mayor of Incheon Metropolitan City, noted the host city's position as a global hub for addressing climate change issues, both as host for international organizations and conferences, and as an eco-friendly city.

The IPCC adopted the provisional agenda (IPCC-XLVIII/Doc.1) and the draft report of IPCC-47 (IPCC-XLVIII/Doc.2) without amendment.

Approval of the SR15 SPM by the Joint WG Session

The first Joint Session of WGs I, II and III opened on Monday afternoon and met through Saturday afternoon, working line-by-line to approve the SPM for SR15. The joint session considered a Final Draft of the SPM that was made available the day before the conference, which was a revision of the Final Government Draft (FGD) dated 4 June to incorporate the more than 3,600 government comments received. A side-by-side comparison and a tracked-change version were also prepared to enable participants to compare the two drafts. Throughout the week, many issues were discussed in informal huddles or sent to contact groups.

For each subsection, the WG Co-Chairs first presented the headline statement, followed by discussions on the paragraphs in the subsection. After agreement was reached on the paragraphs to ensure consistency across the subsection as a whole, delegates returned to the headline statement.

Opening of the Joint Session of WGs I, II and III

On Monday afternoon, WG I Co-Chair Valérie Masson-Delmotte opened the joint session, noting that SR15 marks the first time the three WGs have collaborated in an integrated manner. She noted that the report involved the efforts of 91 authors and 133 contributing authors, and highlighted the receipt of over 3,600 comments on the FGD of the SPM.

Saudi Arabia, supported by Tanzania, Egypt, Pakistan, India, Mali, and Bolivia, expressed concern that the final draft had not been released well in advance of the meeting, noting that his delegation had invested time and effort reviewing the FGD.

Delegates agreed that the tracked-change version would be projected on screen, the authors would explain the modifications, and new comments would be incorporated into the clean version of the final draft.

Supported by the US, China, and Belgium, Saudi Arabia called for a general statement in the SPM summarizing the state of knowledge on 1.5°C and highlighting existing knowledge gaps. He also noted gaps and shortcomings in the draft SPM, referring to, *inter alia*:

- deviation from the report's agreed outline;
- lack of information on adaptation;
- lack of information on the costs of achieving 1.5°C global warming; and
- missing references to means of implementation.

Introduction

The joint WG session discussed the SPM's introduction on Monday afternoon. Saudi Arabia proposed including a paragraph describing gaps in knowledge and in the literature that represented challenges in preparing the report. Masson-Delmotte noted that any description of gaps was highly content-specific, and that the report's various sections already reference certainty levels and relevant knowledge gaps.

The European Union (EU), supported by Luxembourg, argued that including such a generic qualifier in the introduction to an IPCC report would be unusual, noting that if no literature exists on a subject, it cannot be assessed. Saint Lucia, supported by Saint Kitts and Nevis, objected to including such a paragraph, recalling that 6,000 studies had been surveyed for the SR.

As a compromise, WG III Co-Chair Jim Skea proposed adding a sentence reflecting that, in the SPM, knowledge gaps associated with the underlying chapters of the report are identified in each section. This was supported by many countries. With minor amendments, this addition was accepted.

Final SPM Text: The introduction introduces the background of the SR15, noting the IPCC's 2016 decision to accept the 2015 invitation from UNFCCC parties, to prepare a report, in 2018, on "on the impacts of global warming of 1.5°C above pre-industrial levels and related GHG emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development and efforts to eradicate poverty." The final text states that the SPM presents the key findings of the SR.

A. Understanding Global Warming of 1.5°C

On Monday, delegates began discussions on this section, with an author explaining that it combines elements from the SR15 first section, on framing and context, with elements from subsequent chapters. She said the section had been modified compared to the FGD, including through improved balance in terms of mitigation and adaptation, and a clearer description of feasibility framing and enabling conditions.

A1: This subsection, first addressed on Monday afternoon, focuses on **observed and projected levels of global warming**. Regarding the headline statement, Belgium, supported by Norway, proposed including a definition of global warming, and agreed to the insertion of a footnote clarifying that global warming in the headline statement refers to a 30-year average in a period centered on 2017, assuming the recent rate of warming continues. Saudi Arabia questioned the credibility of the science underlying the statement, with the authors reporting that over 1000 studies support this statement. The UK, supported by Estonia, called for specifying the relevant range of dates, from pre-industrial times to 2017, and text was inserted to reflect this. With those changes, the paragraph and footnote were agreed.

A.1.1: This paragraph addresses **observed global warming relative to pre-industrial levels and its current rate of increase.** Delegates proposed various alternatives for the headline statement to accommodate a request from Saudi Arabia, supported by Brazil, Egypt, and India, for language indicating that the observed increase in global mean surface temperature (GMST) is the result of a long-term trend since pre-industrial times. Switzerland and others suggested drawing on relevant wording used in AR5 and the SR15 underlying assessment. Following informal consultations, delegates agreed to preface the sentence with the text "reflecting the long-term warming trend since pre-industrial times."

Regarding a sentence on anthropogenic global warming's current rate of increase, delegates accepted a proposal from WG II Vice-Chair Sergey Semenov to clarify that the cited anthropogenic global warming levels are estimates. Following suggestions from France, Ireland, Norway, and the US, the authors proposed moving text on the rate of global warming into a new sentence and specifying that the rate is a result of past as well as ongoing emissions. This paragraph was then agreed.

A.1.2: This paragraph addresses **greater degrees of warming in many land regions and seasons**. On a reference to seasons in a sentence on variations in warming levels, Kenya and Nicaragua noted that many countries do not experience seasons. WG I Vice-Chair Panmao Zhai suggested language to reflect seasonal fluctuations from an annual average temperature.

Regarding text on greater degrees of warming in the Arctic, Ukraine suggested including reference to "many polar regions" to also cover Antarctic hotspots.

Switzerland, with Ecuador, noted that mountainous areas are experiencing more global warming than low-lying areas and requested the inclusion of numbers behind a statement that warming is generally higher over land than over the ocean.

Following informal consultations, the authors proposed adding reference to warming greater than the global "annual" average experienced in many land regions and seasons but said:

- figures for specific land regions could not be included due to a lack of homogeneity;
- there is broad empirical support for including reference to the Arctic but not the Antarctic; and
- assessment of mountain areas and communities will be considered in the SROCC.

Participants then approved the paragraph with the authors' suggestions.

A1.3: This paragraph, which was first addressed on Tuesday afternoon, focuses on **trends in intensity and frequency of some extreme weather events in response to 0.5°C warming**. WG I Co-Chair Masson-Delmotte explained that the paragraph had been moved up from Section B on projected changes, impacts, and risks, and was revised to include a confidence level and an explicit link to what observations about past warming suggest about the impacts of additional warming.

Saudi Arabia opposed the paragraph's reference to the effects of warming in recent decades, noting SR15's mandate is to focus on 1.5°C warming relative to pre-industrial times. Tanzania, Mali, Zambia, and Nicaragua called for a reference to drought to reflect the realities of global climate change, but an author explained that the report had not assessed changes in drought, given a dearth of literature specific to further warming of 0.5°C.

On Wednesday morning, new language from informal consultations was introduced that maintained a reference to possible implications of additional 0.5°C warming but omitted specific examples of the manifestations of extreme weather.

Germany supported this proposal, but Saudi Arabia preferred deleting the entire paragraph, citing its primary reliance was on one source.

On Wednesday afternoon, Saudi Arabia said he could support new compromise language if reference to the implications of further warming was deleted. Germany, Saint Lucia, Grenada, the Marshall Islands, France, Angola, and others objected to this deletion absent guarantees that the text would be included elsewhere in the SPM. After the language was included in Section B1.1 on robust differences in regional climate characteristics, delegates agreed to the paragraph.

A.2: On Wednesday morning, WG I Chair Masson-Delmotte opened discussion on this subsection on the **implications of past emissions for future warming**. Following initial comments, a contact group convened to discuss the subsection's three paragraphs.

On the statement that past emissions alone are unlikely to cause global warming, Sweden, supported by the Republic of Korea, cautioned that the text did not adequately reflect the headline statement's intention to convey that warming to 1.5°C and beyond is mainly dependent on current and future emissions.

Brazil, with India and Ecuador but opposed by Saudi Arabia, called for acknowledgement that past emissions are responsible for current warming but that past emissions alone are unlikely to raise GMST.

Following contact group consultations, a modified headline statement was approved on Thursday, which states that warming from anthropogenic emissions from the pre-industrial period to the present will continue to cause further long-term changes in the climate system, but that these emissions alone are unlikely to cause global warming of 1.5°C.

A2.1: This paragraph addresses **projected global warming effects of emissions up to the present**, although it originally focused on the projected effects of an immediate elimination of anthropogenic emissions. Saudi Arabia stressed that the immediate elimination scenario is not feasible, and requested the addition of a statement to that effect from the underlying report.

France, supported by Australia, Mali, China, Spain, Saint Kitts and Nevis, Finland, and Grenada, proposed characterizing this scenario as a "thought experiment."

An author noted that the paragraph aims to convey that reaching a 1.5°C temperature increase solely due to past emissions is not inevitable, and therefore limiting future warming to 1.5°C is still potentially feasible.

Following contact group discussions, an author proposed adding language noting that the statement is a hypothetical scenario, and that further global warming in this scenario "in addition to the 1°C caused by past emissions" would be less than 0.5°C with high certainty in the short term, and medium certainty over a century.

The paragraph was approved with minor edits, and without qualifiers on the hypothetical nature of the scenario.

A2.2: This paragraph discusses **reaching and sustaining net-zero CO2 emissions and declining net non-CO2 radiative forcing**. Responding to Australia, in reference to "non-CO2 radiative forcing," an author explained that this refers to the aggregate impact of everything other than CO2 on global energy forcing, and noted that net anthropogenic global emissions must equal zero to halt to global warming. The author suggested referring to "net" declining non-CO2 radiative forcing.

Germany, supported by Chile, Canada, and the UK, requested language that explains that keeping within the remaining carbon budget requires net negative CO2 emissions.

Saint Kitts and Nevis, supported by Angola, requested acknowledgement that net negative CO2 emissions may also be required to reverse ocean acidification and halt rising global sea levels.

Following contact group discussions, this paragraph was modified to refer to "net" non-CO2 radiative forcing and to reflect that the scale of emissions is global. On Wednesday evening, delegates agreed to the paragraph.

A3: This subsection was introduced in plenary and subsequently discussed in an informal huddle and addresses **climate-related risks for natural and human systems**. In plenary on Saturday, the headline statement was agreed as presented by the informal group. It conveys that climate-related risks for natural and human systems depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options.

A3.1: This paragraph addresses **already-observed impacts on natural and human systems from global warming**. Egypt, supported by Saint Lucia, the Maldives, and Trinidad and Tobago, called for a stronger emphasis on the impacts on natural systems. On Saturday, the paragraph without inclusion of this suggestion.

A3.2: This paragraph addresses **future climate-related risks**. Regarding a statement on long-term and irreversible risks, Saudi Arabia supported a reference to the "many other" risks that are short-term and reversible. The authors responded that reversible risks had not been assessed for the underlying report and thus could not be referred to in the SPM. Delegates agreed to a suggestion from the US to refer to the larger "aggregate" risks associated with global warming that exceeds 1.5°C. With a further editorial change, the paragraph was agreed.

A3.3: During initial discussion of this paragraph on **adaptation and mitigation in response to risks**, the US, supported by Saudi Arabia, called for the text to reflect both the benefits and risks of mitigation and adaptation in a balanced manner. On Saturday morning, text that emerged from informal consultations was agreed without any change.

Figure SPM 1: This figure, on cumulative emissions of CO2 and future non-CO2 radiative forcing determining the chance of limiting warming to 1.5°C, illustrates **observed global temperature change and responses to stylized emission pathways** and was first addressed on Tuesday.

Norway, supported by Australia and Chile, proposed including a definition in the SPM of "non-CO2 radiative forcing." The US asked that a range, rather than a specific date, be used to indicate when present trends will lead to a 1.5°C increase in GMST. Saudi Arabia and the US argued that the figure and caption were too complex and "full of jargon."

A contact group produced a number of changes, including simplified text and graphics. The figure was approved on Wednesday evening.

Final SPM Text: The final text for this section addresses: current global warming, and trends associated with 0.5°C warming; how anthropogenic emissions to the present relate to global warming; and climate-related risks under different temperature scenarios.

Subsection A1 addresses **current global warming and trends** associated with 0.5°C warming, and stresses that:

- human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C;
- global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate;

- estimated anthropogenic global warming is currently increasing at 0.2°C (likely between 0.1°C and 0.3°C) per decade due to past and ongoing emissions;
- warming greater than the global annual average is being experienced in many land regions and seasons; and
- trends in intensity and frequency of some climate and weather extremes have been detected over time spans during which about 0.5°C of global warming occurred.

Subsection A2 addresses **how anthropogenic emissions to the present relate to global warming**, and underscores that:

- warming from anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia, and will continue to cause further long-term changes in the climate system, such as sea level rise, with associated impacts, but these emissions alone are unlikely to cause global warming of 1.5°C;
- anthropogenic emissions up to the present are unlikely to cause further warming of more than 0.5°C over the next two to three decades or on a century time scale; and
- reaching and sustaining net-zero global anthropogenic CO2 emissions and declining net non-CO2 radiative forcing would halt anthropogenic global warming on multi-decadal timescales.

Subsection A3 addresses **climate-related risks at present**, at 1.5°C warming and at 2°C warming, and emphasizes that:

- climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C;
- these risks depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options;
- impacts on natural and human systems from global warming have already been observed; and
- future climate-related risks depend on the rate, peak, and duration of warming, and would be reduced by the upscaling and acceleration of far-reaching, multi-level, and cross-sectoral climate mitigation and by both incremental and transformational adaptation.

This section also includes Figure SPM.1, which conveys, through different stylized anthropogenic emission and non-CO2 radiative forcing pathways, that cumulative CO2 emissions and future non-CO2 radiative forcing determine the probability of limiting warming to 1.5°C.

B. Projected Climatic Changes, their Potential Impacts, and Associated Risks

This section addresses projected changes, impacts and risks and was first taken up on Wednesday. In response to reservations expressed by Saudi Arabia on gaps in knowledge, an author underlined the high confidence levels for many of the statements and said that any gaps were reflected in the relevant paragraphs.

B1: The subsection addresses **robust differences in regional climate characteristics**. The headline statement on differences in regional climate characteristics under different warming scenarios was approved on Thursday following a suggestion from Trinidad and Tobago to refer to both drought "and precipitation deficit" in a list of projected differences in regional climate characteristics, and an editorial change to the footnote.

B1.1: On **projected impacts of a further 0.5°C of global warming**, reference to "observed" changes was removed. Language that global warming results in climatic changes was replaced with wording that is "associated" with such changes, in response to a concern raised by Saudi Arabia. A confidence level was cited (medium) following inputs from the US and Switzerland.

On regional changes in climate at 1.5°C warming, Belgium, Angola, and Portugal asked for clarification on references to "changes in drought," following which the text was modified to refer to an increase in intensity or frequency of droughts in some regions. The revised paragraph was approved.

B.1.2: This paragraph on **projected increase of temperature extremes on land** was agreed with minor editorial changes.

B1.3: During Wednesday's discussions on this paragraph, which describes **the differences between a 1.5°C scenario and a 2°C scenario in terms of droughts and precipitation deficits, as well as heavy precipitation**, Tanzania, supported by Botswana, Trinidad and Tobago, South Africa, Algeria, Egypt, the Bahamas, and Zambia, said the "heavy precipitation" language in the paragraph was "unbalanced" when contrasted to the stronger "extreme" event language in subsection B1.1. They called for the inclusion of drought and desertification, with others requesting to add tropical cyclones to the list. Zimbabwe, supported by Egypt, argued against the emphasis on the difference between 1.5°C and 2°C, recalling that the mandate was simply to assess the 1.5°C scenario.

Some participants recalled that the approved outline for the SPM included a comparison of the two scenarios. Saudi Arabia called for all regions to be included. Informal consultations produced revised text addressing many of these issues.

Mali, supported by Nigeria, WG II Vice Chair Taha Zatari, Saudi Arabia, Iraq, and others, objected to the absence of West Asia and some parts of Africa in the paragraph, noting an abundance of available data on drought. The authors explained that very little data exists on risk of drought and other events under a 1.5°C scenario compared to a 2°C scenario. Regarding a sentence on the probability of drought being lower in some regions under a 1.5°C scenario, participants agreed on language to reflect that drought covers both the risk of more frequent and intense droughts, as well as the risks from the impact of droughts. The revised paragraph was approved.

B2: The headline statement for this subsection, which focuses on the **projections of sea level rise by 2100 and beyond**, was first discussed on Wednesday afternoon. Egypt, supported by Zimbabwe, said the statement's starting point should be the impacts of 1.5°C, not the difference between global warming of 1.5°C compared to 2°C.

Germany, the Netherlands, and Luxembourg supported elevating language from a subsequent paragraph on "the possibility of triggering multi-meter sea level rise" to the headline statement. India warned against deriving headline statements from medium confidence levels, while the EU explained that the reason for the medium confidence level relates to the incomplete approaches adopted by old studies.

Responding to concerns expressed by some countries regarding "panic-inducing headlines," Friends World Committee for Consultation said "what can bring panic is when decision makers do not respond sufficiently to scientific findings."

Following informal consultations, this headline statement was approved on Thursday.

B2.1: This paragraph, which was first discussed on Wednesday evening, addresses **projected sea level rise and potential impacts**. Delegates discussed, *inter alia*, why a baseline of 1986-2005 rather than pre-industrial levels had been used, with the authors recalling that a similar approach was used in the IPCC's Fifth Assessment Report (AR5) because the data for pre-industrial times was inadequate. Egypt, supported by India but opposed by

Singapore, reiterated that the focus should be on the impacts of 1.5°C, rather than differences between 1.5°C and 2°C scenarios.

On Thursday morning, an author explained that while it was not possible to make a robust estimate of the number of people at risk from sea level rise under the 1.5°C or 2°C scenarios, it was possible to estimate the difference in the number of people at risk between the two scenarios, which the author explained is 10 million. India noted this message would be difficult to convey to policymakers. Egypt said the statement does not reflect the possibility of multi-meter sea level rise occurring, which would put hundreds of millions of people at risk, and noted that the underlying report discusses this. WG II Co-Chair Hans-Otto Pörtner said that B2.2 addresses multi-meter sea level rise, and the paragraph was approved as presented.

B.2.2: This paragraph, on **sea level rise continuing beyond 2100 even if global warming is limited to 1.5°C**, was discussed in a contact group. On Thursday, participants agreed to include the contact group's proposed language that marine ice sheet instability in Antarctica and/or irreversible loss of the Greenland ice sheet "could be triggered around 1.5°C to 2°C of global warming." The paragraph was agreed.

B.2.3: This new paragraph, on **warming increasing the risks associated with sea level rise, and the risks being higher at 2°C warming than at 1.5°C**, was introduced on Thursday following contact group discussions on Wednesday. India requested reference to adaptation costs in a sentence that notes that the slower rate of sea level rise at 1.5°C warming reduces the associated risks, enabling greater opportunities for adaptation. WG II Co-Chair Pörtner noted a lack of information regarding these costs, with India requesting that this be noted in the section on gaps in the literature. The paragraph was then agreed with minor edits.

B3: This subsection addresses **climate-induced impacts on biodiversity and ecosystems**. Regarding the headline statement, Germany, supported by Belgium, Sweden, the EU, and Luxembourg, called for reinserting a sentence from the FGD that warned of potential irreversible impacts in an "overshoot" (i.e., exceeding the temperature target and then returning to it) emissions pathway. Haiti, supported by the Dominican Republic, Cuba, Saint Lucia, Saint Kitts and Nevis, and Trinidad and Tobago, opposed reference to the "benefits" of keeping to a 1.5°C scenario, preferring not to characterize 1.5°C pathways as "beneficial" lest that confuse policymakers. The authors proposed revised text referring to the "impacts" of a 1.5°C scenario and, with this amendment, the paragraph was approved.

B3.1: On Thursday, Saudi Arabia and India expressed concern with the "medium" confidence level associated with this paragraph, which highlights **specific percentages of species projected to lose their geographic range**. Saudi Arabia called for acknowledging the basis is only one study. After much discussion, a footnote was added explaining that illustrative numbers were adopted from one recent meta-study. With this and other minor amendments, this paragraph was agreed.

B3.2: This paragraph, on **transformation of terrestrial ecosystems** under global warming scenarios of 1.5°C and 2°C, was first discussed on Wednesday. Saudi Arabia, supported by Pakistan and India, asked that the text explain that the underlying analysis actually focuses on differences between 1°C and 2°C scenarios, and a footnote to that effect was proposed. The US expressed discomfort with the evidence base. Belgium, supported by the UK, Germany, Spain, Austria, Canada, and Ireland, opposed a footnote, arguing that the SPM should not contain this level of detail, and warning that the request for it bordered on interfering with the scientists' mandated role to assess evidence in accordance with IPCC policies.

On Thursday, following informal consultations, countries agreed to a revised paragraph describing the 1°C scenario and interpolated 1.5°C impacts, and qualifying the percentages of land affected in interquartile ranges.

B3.3: This paragraph, on **risks to high-latitude tundra and boreal forests**, was discussed in informal consultations that produced a draft paragraph specifying a range of projected land area impacts rather than a single number. France pointed out that the text, and the SPM overall, does not mention research on terrestrial sinks. Peru, supported by Ecuador and Botswana, highlighted similar gaps in the areas of tropical forests and savannahs. While agreeing that these are important gaps, the authors pointed out that the research in these areas related to pathways consistent with1.5°C is insufficient to merit their inclusion in the report or the SPM. The revised paragraph presented by the informal group was agreed.

B.4: The headline statement for this subsection on **increases in ocean temperature and ocean acidity and decreases in ocean oxygen levels**, and risks to marine biodiversity, fisheries and ecosystems, was agreed with minor edits.

B4.1: Introducing a paragraph on the **probability of a sea-ice-free Arctic Ocean during summer**, WG II Co-Chair Pörtner explained that the text had been amended by the authors in response to government comments on the FGD, to include timescale and the effect of temperature overshoot. Switzerland, the EU, Saint Lucia, Fiji, and others supported these additions, and the paragraph was agreed as presented.

B4.2: This paragraph on **marine species ranges, coastal resources, and productivity of fisheries and aquaculture** was agreed with minor amendments.

B4.3: On Thursday, on a paragraph **on ocean acidification**, delegates agreed to replace language on "expected" amplified adverse effects of warming with wording on "projected" effects. Belgium noted that ocean acidification is associated with CO2 emissions, rather than with global warming per se, and that this has implications for certain geo-engineering approaches that involve continued CO2 emissions. In response, participants agreed to include language on "CO2 concentrations associated with" global warming. Responding to a request from Mali, they also agreed to indicate that further adverse effects are projected at 2°C. The paragraph was agreed.

B4.4: This paragraph concerns **risks to fisheries and aquaculture associated with climate change impacts in the ocean**. On Thursday, the US questioned the medium confidence level cited in the context of projected decreases in global annual catch for marine fisheries, noting the paragraph's reliance on a single study. In response, delegates agreed to refer to "one global fishery model," rather than "models." This paragraph was then agreed with minor editorial changes.

B5: This entire subsection was discussed in a contact group on Thursday. On Friday afternoon, the headline statement on **climate-related risks to health, livelihoods, food and water supply, human security, and economic growth** was agreed.

B5.1: This paragraph addresses **populations and regions at a disproportionately higher risk of adverse consequences of global warming**, and was considered on Friday afternoon. Additions introduced in the contact group included a reference to "some" indigenous peoples and to least developed countries (LDCs). Following clarification on a question from Botswana

that "dryland" refers to all types of drylands, and the replacement of a reference to "populations" with "local communities," the paragraph was accepted.

B5.2: This paragraph, which addresses **the consequences of global warming for human health**, was accepted on Friday afternoon, following minor amendments forwarded by the contact group.

B5.3: This paragraph, on the **effects of different temperature scenarios on food availability**, was considered on Friday afternoon. India noted that positive rainfall anomalies for Southeast Asia had been projected, and questioned why this region had been included in a list of regions for which reduced rice and maize yields have been projected. Following clarification that the sentence concerns the thermal tolerance of crops, rather than rainfall, and that the diversity of climate change effects is captured through a reference to "net" yield reductions, the paragraph was accepted.

B5.4: This paragraph, which addresses the **consequences of global warming on water scarcity**, was agreed to on Friday afternoon, with minor changes.

B5.5: This paragraph, which addresses the **consequences of global warming on global aggregated economic growth**, was discussed on Friday afternoon. Delegates accepted a new qualification that risks to economic growth exclude the costs of mitigation, adaptation investments, and the benefits of adaptation. A footnote explaining that impacts on economic growth in this context refer to changes in GDP, and that many impacts, such as loss of human lives, cultural heritage, and ecosystem services, are difficult to monetize, was also accepted.

B5.6: This paragraph, which addresses **exposure to multiple and compound climate-related risks** under different temperature scenarios, was accepted on Friday afternoon with minor changes.

B5.7: This paragraph on an **increase in the assessed levels of risk since AR5 for four of the five Reasons for Concern (RFCs)** was agreed with amendments to several of the confidence levels expressed.

B6: This section addresses **adaptation needs, options, and limits to adaptation and adaptive capacity**. Regarding the headline statement, the US asked to refer to limits to "adaptive capacity" rather than "adaptation." Saint Kitts and Nevis said that reference to "associated losses" was needed, given that "limits to adaptation and associated losses" had been deleted from a subsequent paragraph. Trinidad and Tobago pointed to discussion of limits to adaptation and associated losses in the underlying report. India said an absence of literature on "associated losses" should be signaled as a knowledge gap in the SPM. WG II Co-Chair Pörtner clarified that if the underlying chapter shows no degree of confidence for a statement, the statement is not suitable for the SPM. Following informal consultations, a sentence noting limits to adaptation and adaptive capacity for some human and natural systems at 1.5°C of global warming, with associated losses, was added to the headline statement.

B6.1: On a paragraph on **the range of adaptation options available to reduce the risks to natural and managed ecosystems**, language proposed by Nicaragua on avoided "forest degradation" was added to a list of adaptation options. The paragraph was then accepted.

B6.2: A paragraph on **adaptation challenges for ecosystems, food, and health systems** was accepted as presented.

B6.3: Regarding a paragraph on **limits to adaptive capacity at 1.5°C of global warming**, an author explained that the underlying report shows that there is significant literature on adaptive capacity but not on limits to adaptation. Thus, an author's suggestion to refer to "limits to adaptive capacity" instead of limits to adaptation and associated losses was accepted, and the paragraph was agreed.

Figure SPM 2: Reasons for Concern: This figure addresses how the level of global warming affects risks associated with the RFCs and selected natural, managed, and human systems. On Friday, participants approved the figure and the caption, as modified by the contact group, to spell out specific impacts and risks associated with each RFC.

Final SPM Text: The final text for this section addresses projected climate change, potential impacts, and associated risks with global warming, particularly at 1.5°C as compared to 2°C.

Subsection B1 focuses on climate models projecting differences in regional climate characteristics, and contains paragraphs on, *inter alia*,

- evidence that warming is associated with changes in weather extremes;
- regional differences in temperature extremes;
- projected increases in intensity or frequency of weather extremes, droughts, and heavy precipitation; and
- increases in such risks at 2°C global warming, compared to 1.5°C, in some regions.

Subsection B2 focuses on sea level rise beyond 2100, with magnitude and rate depending on future emission pathways, and contains paragraphs on:

- model-based projections of global mean sea level rise at 1.5°C global warming showing up to 10 million fewer people exposed to related risk as compared to 2°C;
- potential marine ice instability and/or irreversible loss of the Greenland ice sheet with continuing sea level rise beyond 2100; and
- exposure of small islands, low-lying coastal areas, and deltas to risks associated with sea level rise.

Subsection B3 focuses on the impacts on terrestrial, freshwater, and coastal ecosystems, and contains paragraph on:

- impacts associated with biodiversity-related risks;
- the transformation of ecosystems at up to 2°C global warming; and
- high-latitude tundra and boreal forests at risk.

Subsection B4 focuses on impacts on marine resources, and contains paragraphs on:

- the probabilities of a sea-ice-free Arctic Ocean during summer at 1.5°C and 2°C global warming;
- the risk of irreversible loss of many marine and coastal ecosystems, including coral reefs, with increased global warming;
- the level of ocean acidification due to increasing CO2 concentrations; and
- increasing risks to fisheries and aquaculture.

Subsection B5 focuses on climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth, and contains paragraphs on, *inter alia*:

- risks to human health from global warming of 1.5°C and beyond;
- reductions in cereal crops, food availability, feed quality, and water resource availability;
- the proportion of the global population potentially exposed to increasing water stress;
- risks to global aggregated economic growth and to economic growth in the tropics and southern hemisphere sub-tropics;
- proportions of people susceptible to climate-related risks, particularly those susceptible to poverty in Africa and Asia and across overlapping energy, food, and water sectors; and

- substantial evidence that since AR5 the assessed risk levels increased for four of the five RFCs.

Subsection B5 also contains a figure showing how the level of global warming affects impacts and/or risks associated with the RFCs.

Subsection B6 focuses on adaptation needs, the range of adaptation options, and the limits to adaptation and adaptive capacity, with associated losses, and it contains paragraphs on:

- the range of adaptation options available to reduce risks to, *inter alia*, natural and managed ecosystems;
- adaptation challenges for ecosystems, food, and health systems, especially for vulnerable regions, including small islands and LDCs; and
- limits to adaptive capacity at 1.5°C of global warming and beyond.

C. Emission Pathways and System Transitions Consistent with 1.5°C Global Warming

WG III Co-Chair Jim Skea introduced this section on Thursday afternoon. An author presented changes made to the FGD as a result of government comments, including more detail on the carbon budget and the comparison with AR5, and information on non-CO2 emissions.

C1: On Thursday afternoon, delegates provided general comments on this subsection, which discusses **pathways, non-CO2 emissions, and the carbon budget**. A contact group was established to address some of the paragraphs. Regarding the headline statement, authors introduced interquartile ranges and, with a few more editorial changes, the paragraph was agreed.

C1.1: On this paragraph, addressing **different emission pathways and scenarios**, Saudi Arabia called for reference to all pathways, including those with overshoot, and this view prevailed. Saint Kitts and Nevis preferred the existing focus on pathways with no or limited overshoot. On Friday evening, this paragraph was discussed and accepted.

C1.2: Regarding a paragraph addressing a **reduction in non-CO2 emissions**, Australia questioned the high-energy demand assumed in some pathways. Brazil noted that some pathways assume high bioenergy demand, and emphasized the importance of discussing appropriate management approaches if these demands are to be sustainable.

Saint Kitts and Nevis asked for precise quantification of methane and non-CO2 gases. Mexico called for including a definition of non-CO2 emissions in the SPM, and a footnote to this effect was added.

On Friday afternoon, WG I Vice-Chair Noureddine Yassaa reported that a huddle on this paragraph had resulted in inclusion of management approaches related to bioenergy and to all model pathways. With these changes and two more for clarification, the paragraph was agreed.

C1.3: The contents of this paragraph on **the remaining carbon budget** had initially been included in three separate paragraphs in the final draft, but the final SPM compresses them into one. General comments were made in plenary on Thursday and the paragraphs were then discussed in a contact group.

On the remaining carbon budget, Japan and Saudi Arabia noted a lack of clarity on the text's two budget numbers, based on different probabilities of limiting global warming to 1.5°C, and asked how they were derived. China and the US queried the scenarios used for the carbon budget and related uncertainties. The US suggested presenting the whole range of values discussed in the literature.

France called for highlighting the number of years that the carbon budget refers to. India proposed starting with the total carbon budget and then referring to the remaining carbon budget.

The Marshall Islands and Saint Kitts and Nevis, opposed by the Netherlands and the Republic of Korea, suggested deleting a sentence referring to the significance for the carbon budget of defining global warming in terms of either global mean air temperature or GMST, given the potential for confusion.

On the implications of historical emissions for the remaining carbon budget, Switzerland proposed improving the logical flow of the carbon budget paragraphs. India and Germany suggested adding language noting that the 1.5°C carbon budget would be exhausted within 10-15 years at current emissions rates.

Several countries, including Grenada, Togo, and China, pointed to inconsistencies between this section and the corresponding chapter in the underlying report. The US called for adding text on the carbon budget for a 2°C goal to compare to the 1.5°C goal.

In response to a query from Saudi Arabia, the author said "an immediate and steady decline" means embarking on a ten-year trajectory, starting now, to reach net zero carbon emissions.

On uncertainties and choices regarding non-CO2 mitigation vis-à-vis carbon budgets, Belgium, supported by Grenada, noted that pursuing any limit in temperature with a probability higher than 66% implies a smaller carbon budget.

An author agreed with France and Grenada that following different decarbonization pathways alters possibilities for non-CO2 mitigation.

The US queried the utility of taking a carbon budget approach versus identifying different pathways. Switzerland, supported by Trinidad and Tobago, requested that the authors reconsider trying to agree on one number for a carbon budget. India objected, while the Netherlands highlighted the uncertainties in the carbon budget exercise.

A contact group, co-chaired by France and the Marshall Islands, addressed the carbon budget on Thursday evening and Friday morning.

On Friday afternoon, contact group rapporteur WG I Vice-Chair Jan Fuglestvedt reported that the paragraph had been revised to improve consistency and to convey uncertainties, and the lower budget figures in the SPM compared to those in AR5. A lengthy discussion ensued as Egypt requested further reference to those numbers in the AR5 carbon budget to allow for consistency, and to avoid the impression that the latest estimations invalidate the carbon budget presented in AR5. The authors explained the methodology used in SR15 and how the budget differs from previous estimations, including that it considers direct observations, and non-CO2 emissions, and is specific to 1.5°C. To explain this difference, various formulations for footnotes were proposed, with participants eventually agreeing to refer to the carbon budget in the SPM and to leave out references to estimations for earlier periods.

C1.4: On Friday evening, this paragraph, on **solar radiation management (SRM) measures**, was introduced for consideration, with WG III Co-Chair Skea saying that references had been included in the final draft to note risks of such measures and the fact that they do not mitigate ocean acidification. The paragraph was accepted without change.

C2: This subsection addresses **pathways that limit warming to 1.5°C**. A headline statement explaining that pathways limiting global warming to 1.5°C with no or limited overshoot would require rapid and far-reaching transitions in various sectors was addressed during informal consultations. Following this, revised language was presented which included mention of a significant

upscaling of investment. With the addition of reference to the transport sector, as proposed by Luxembourg and France, the paragraph was agreed with minor editorial changes.

C2.1: On Thursday evening, this paragraph, which **compares pathways that limit warming to 1.5°C with those for 2°C**, was considered. It specified that system changes, in such sectors as energy, land, urban and infrastructure, and industrial systems, involved in the former scenario are more rapid and pronounced over the next two decades. Saint Kitts and Nevis said language on the historically unprecedented scale of change associated with 1.5°C pathways needed to be "explained, contextualized, and clarified." An author clarified that the present-day size of global economies and the global population is unprecedented.

Following informal consultations, authors proposed, and the group agreed, to remove reference to similar pathways to limit temperature rise to 1.5°C and 2°C, given the statement's potential for confusion. With a few more editorial changes, the paragraph was agreed.

C2.2: Regarding this paragraph on **energy systems under pathways limiting global warming to 1.5°C with no or limited overshoot**, Germany, France, Canada, Grenada, Switzerland, the EU, and Belgium called for reinserting text from the FGD on the significantly decreased share of primary energy from coal under pathways consistent with 1.5°C, given its high confidence level and relevance. Saudi Arabia, Egypt, Pakistan, Estonia, and the US opposed singling out a specific fossil fuel.

Poland called for reference to the need for further technological breakthroughs. India noted the difference between energy demand and energy need.

Grenada, supported by the EU, suggested referring to the ways in which renewable energy technology has "improved dramatically," as was done in the underlying report. The EU also drew attention to "radical improvements" on energy efficiency, and Belgium suggested text to indicate that a system transition in electricity generation may be underway.

This paragraph was revisited in plenary on Friday, following contact group discussions. Germany asked for the full list of low-carbon energy sources, including renewables, nuclear, and fossil fuels with carbon capture and storage (CCS), to be removed, which Saudi Arabia, the US, and Japan opposed. France, supported by Belgium, asked for reinserting a description of coal use in 1.5°C pathways, which had been deleted from Section C in a previous draft of the SPM. The US then asked for similar descriptions of other energy sources. The final text covers coal, renewables, nuclear, fossil fuel with CCS, and natural gas. Following contact group discussions on how to describe the impacts of technical progress in renewables on global energy system transition, the text was amended in plenary to describe such progress as "signaling" that transition. The paragraph was approved as revised.

C2.3: Regarding a paragraph on **emissions from industry**, Japan suggested replacing "technically proven" with "technically possible" when referring to new and existing technologies and practices, including electrification, hydrogen, sustainable bio-based feedstocks, product substitution, and carbon capture, utilization and storage. Egypt proposed reflecting the institutional and economic constraints to deploying these new technologies and practices.

On Saturday, following contact group discussions, India and Norway proposed specifying that new and existing technologies and practices are technically proven "at various scales." The UK suggested that their large-scale deployment "may be," rather than "is," limited by various constraints. With those changes, and a change in confidence statement from high to medium, the paragraph was approved.

C2.4: On a paragraph on **the urban and infrastructure system transition with 1.5°C global warming with no or limited overshoot**, Kenya called for language on estimating the extent to which changes in land and urban planning are needed.

Germanwatch, supported by the EU, emphasized the challenges in shipping and aviation transport, and called for including a sentence on this from the underlying report. Saudi Arabia objected, saying that the emissions from this sector are "minuscule" and that they are already under the purview of other international bodies.

The EU, with Germany and Switzerland, suggested also referring to resource use efficiency or "material substitution," for example in the construction sector, and called for inserting language on the percentage of electricity demand in the building sector.

Egypt, with Brazil, Saudi Arabia, and Ecuador, objected to referring to social, institutional, and economic barriers as those that "may" inhibit avenues towards an urban and infrastructure system transition, saying it was not reflective of the great challenges facing developing countries. Brazil pointed to financial and technology transfer barriers.

On Saturday morning, following contact group discussions, a medium confidence statement was added to a sentence on the need for changes in land and urban planning practices, and deeper emission reductions in transport and buildings. Following a request by Belgium and Norway, a sentence was added reflecting that "technical measures and practices enabling deep emissions reductions include various energy efficiency options," to replace a deleted sentence that had included reference to electrification. With these changes, the paragraph was approved.

C2.5: On **transitions in global and regional land use in pathways to 1.5°C with no or limited overshoot**, the EU said the numbers presented for the amount of land needed for energy projects and forests come from model projections and, supported by Brazil, noted that the numbers assume a steep increase in agricultural productivity, the feasibility of which might not have been considered.

Brazil observed that the land sector was the only one considered at the regional level and noted that "environmental concerns" are not applied to other sectors, such as energy and waste in the SPM.

The US preferred maintaining language on finance and technology transfers in a separate section.

Saudi Arabia called for better reflecting trade-offs between food and energy production, and for reinstating a list that appeared in the FGD on the competing demands on land.

Grenada called for the reinsertion of data on the impacts on land of a 2°C target and for lower limits for estimates of land impacted to be given for all numerical references.

Poland called for wording on sustainable forest management. Germany called for language on conservation measures.

The Netherlands said he did not understand the background and justification for many of the paragraph's statements, noting that 500 million hectares of agricultural land equals a third of all agricultural lands. India noted a 3% decline in forest cover between 1990 and 2015, according to the latest Forest Resource Assessment of the Food and Agriculture Organization of the UN (FAO).

C2.6: A new paragraph on **energy-related mitigation investment in 1.5°C pathways** was drafted and discussed in a contact group on Thursday and Friday, in response to plenary requests by Saudi Arabia and others for additional information

on the costs of different emissions pathways. Saudi Arabia, supported by Egypt, had commented that data on costs is crucial for policymakers, and pointed to many useful details in the underlying report, such as that 2016-2050 energy costs to support a 1.5°C pathway would be USD 500 billion higher than investment under a 2°C-consistent pathway. They called for new paragraphs to describe both energy supply investment costs and marginal abatement costs.

In the contact group, one country requested that total supply-side investments be reflected, while others preferred the existing draft text, which reflected both demand- and supply-side investments and only counted those necessary to achieve a 1.5°C pathway relative to the baseline ("mitigation" investment). Ultimately, supply- and demand-side mitigation investments were described separately. One country objected to references to 1.5°C pathways "redistributing" global energy investment, and the final wording describes the extent to which renewable energy investments are scaled up. In plenary on Friday, India asked that the figures be given context by comparison to, for example, global GDP or energy investment. The paragraph was approved without the revision.

C2.7: This new paragraph on **total and marginal abatement costs of a 1.5°C pathway** was drafted under the same circumstances as paragraph C2.6, discussed in the same contact group and plenary sessions.

In the contact group, countries requested that the text reflect the fact that only a limited number of studies on a 1.5°C pathway were available to assess. A number of countries also requested clear explanatory text distinguishing marginal costs from total costs, arguing that the former alone might be misleading to policymakers, since they can be quite high without that necessarily implying that total costs are also high. The text that emerged from the contact group did not contain such an explanation, noting only that the literature distinguishes marginal and total costs. In plenary on Friday the contact group text was adopted without revision.

C3: This section, addressing **carbon dioxide removal (CDR)**, was first discussed on Friday. Regarding the headline statement, Saudi Arabia asked for reference to the high-overshoot pathways to 1.5°C. Saint Kitts and Nevis objected, praising the authors for their focus on no- and low-overshoot pathways. She also noted that other sections in the SPM questioned both the possibility of deploying bioenergy with carbon capture and storage (BECCS) at the needed scale, and the effectiveness of CDR in lowering emissions back from overshoot.

Friends World Committee for Consultation noted that no- and low-overshoot pathways to 1.5°C involve behavior change, individual consumption, and low-intensive diets, and questioned whether this was adequately reflected in the SPM. Switzerland asked for clarity on the role of CDR in addressing "residual" emissions and, in response, the text was rewritten to clarify CDR's two roles: compensating for positive emissions on the pathway to 1.5°C; and correcting after overshoot. India asked for language indicating that models were hypotheticals, and the text was revised to that effect and agreed.

C3.1: Regarding this paragraph describing **CDR measures**, WG III Co-Chair Skea described revisions made as compared to the FGD, including: listing the various CDR technologies in order of maturity; including reference to land restoration, weathering, and alkalization; and mention of the trade-offs involved in the use of CDR. On Friday, the paragraph was agreed without further discussion.

C3.2: On a paragraph on **BECCS and agriculture, forestry, and other land use (AFOLU) levels in 1.5°C pathways**, Switzerland, supported by India, asked for language clarifying that outcomes were "projected" to convey the involvement of scenarios, and this change was made. The EU asked whether limitations in BECCS' deployment potential might be expressed in terms of land area, but the authors explained that this was impossible because the varying qualities of land complicates efforts to reduce it to common measures such as acres.

Norway argued that the word "impractical," referring to the low possibility of BECCS deployment at high ranges, did not convey the intended meaning. The authors proposed deleting the phrase, noting that the remainder of the sentence already expressed that meaning. China questioned the high confidence level associated with the assertion that some 1.5ºC pathways avoid BECCS altogether, noting that it was based on only a few studies, and the authors agreed to lower the level to medium. With these changes, the paragraph was agreed.

C3.3: On Friday evening, WG III Co-Chair Skea noted that this paragraph, on **CDR and its constraints**, had been revised compared to the FGD to, *inter alia*, reflect that more overshoot requires more CDR. In response to a question from Tanzania, an author explained that the paragraph's final sentence seeks to convey that extracting a ton of carbon from the atmosphere might not be as effective as not emitting it in the first place, and suggested a reference to "net negative emissions," instead of CDR to enhance clarity. With this change, the paragraph was accepted.

C3.4: This paragraph, on **impacts of CDR measures,** was discussed on Friday evening. In response to a request from Switzerland, an author said referring to "mostly negative" impacts of CDR measures would not be appropriate, given that CDR measures also include afforestation and ecosystem restoration. Regarding a question on whether impacts on the climate should be mentioned, an author said that in addition to removing CO2 from the atmosphere, CDR measures also have an albedo effect on the climate, but preferred not to complicate the sentence with this information. Switzerland proposed, and delegates agreed to, inclusion of a reference to impacts on ecosystem "functions and" services. In response to interventions from Brazil and Norway, participants agreed on language stating that afforestation and bioenergy "may," rather than "can," compete with other land uses. The paragraph was accepted.

C3.5: On **AFOLU-related CDR measures**, eSwatini, supported by Zimbabwe, South Africa, and Tanzania, questioned language calling for "effective governance," and proposed replacing it with reference to "sustainable land management." Germany, supported by the Dominican Republic, Switzerland, Norway, Ireland, Poland, and Luxembourg, argued that effective governance was broader than sustainable land management, in that it involves, *inter alia*, administering participatory approaches, conserving carbon stocks, and undertaking measurement and verification. The authors proposed a formulation referring to both terms and the paragraph was approved.

Figure SPM 3: This figure consists of Figures **SPM.3a**, showing **global emissions pathway characteristics**, and **SPM.3b,** on **characteristics of four illustrative pathways in relation to global warming of 1.5°C**, and was discussed in a contact group on Wednesday evening and Thursday morning. On Thursday afternoon, WG III Vice-Chair Andy Reisinger highlighted agreement reached in a contact group, which involved mainly introducing simplified language and further clarification in the caption. This included a relabeling of illustrative model

pathways in a more generic way in the figure while providing traceability to the underlying chapter, and explaining the selection of the non-CO2 forcers included.

Regarding SPM 3b, Reisinger noted a "tension" in group discussions between identifying indicators to link to emissions associated with different pathways, and avoiding policy prescriptiveness. He introduced a table that sought to bridge these positions, which included a footnote mentioning, *inter alia*, that the illustrative model pathways are not intended to be prescriptive. He then read out the metrics that delegates in the contact group had agreed to. On Friday, Figures SPM.3a and SPM.3b were agreed as modified by the contact group.

Final SPM Text: This section addresses global warming pathways, transitions required to limit global warming to 1.5°C, and CDR.

Subsection C1 on **global warming pathways** notes that:

- in model pathways with no or limited overshoot of 1.5°C, global net anthropogenic CO2 emissions decline by about 45% from 2010 levels by 2030, reaching net zero around 2050;
- for limiting global warming to below 2°C, CO2 emissions are projected to decline by about 20% by 2030 in most pathways (10–30% interquartile range) and reach net zero around 2075 (2065–2080 interquartile range)
- non-CO2 emissions in pathways that limit global warming to 1.5°C show deep reductions that are similar to those in pathways limiting warming to 2°C;
- different portfolios of mitigation measures face different implementation challenges, and potential synergies and trade-offs with sustainable development;
- limiting global warming requires limiting total cumulative global anthropogenic CO2 emissions since the pre-industrial period, i.e. staying within a total carbon budget;
- by the end of 2017, anthropogenic CO2 emissions since the pre-industrial period are estimated to have reduced the total carbon budget for 1.5°C by approximately 2200 ± 320 gigatons of CO2 (GtCO2), and the associated remaining budget is being depleted by current emissions of 42 ± 3 GtCO2 per year;
- the choice of the measure of global temperature affects the estimated remaining carbon budget; and
- SRM measures are not included in any of the available assessed pathways, and although some SRM measures may be theoretically effective in reducing an overshoot, they face large uncertainties and knowledge gaps as well as substantial risks.

Subsection C2 on **transitions required to limit global warming to 1.5°C** emphasizes that:

- pathways limiting global warming to 1.5°C with no or limited overshoot would require rapid and far reaching transitions in energy, land, urban, and infrastructure (including transport and buildings), and industrial systems;
- these systems transitions are unprecedented in terms of scale, but not necessarily in terms of speed, and imply deep emissions reductions in all sectors, a wide portfolio of mitigation options and a significant upscaling of investments in those options;
- pathways that limit global warming to 1.5°C with no or limited overshoot show system changes that are more rapid and pronounced over the next two decades than in 2°C pathways;
- in energy systems, modelled global pathways (considered in the literature) limiting global warming to 1.5°C with no or limited overshoot generally meet energy service demand with lower energy use, including through enhanced energy efficiency, and show faster electrification of energy end use compared to 2°C;
- CO2 emissions from industry in pathways limiting global warming to 1.5°C with no or limited overshoot are projected to be about 75-90% (interquartile range) lower in 2050 relative to 2010, as compared to 50-80% for global warming of 2°C;
- such reductions can be achieved through combinations of new and existing technologies and practices, including electrification, hydrogen, sustainable bio-based feedstocks, product substitution, and carbon capture, utilization and storage;
- these options are technically proven at various scales, but their large-scale deployment may be limited by economic, financial, human capacity, and institutional constraints in specific contexts;
- in pathways limiting global warming to 1.5°C with no or limited overshoot, the electricity share of energy demand in buildings would be about 55-75% in 2050 compared to 50-70% in 2050 for 2°C global warming;
- in the transport sector, the share of low-emission final energy would rise from less than 5% in 2020 to about 35-65% in 2050 compared to 25-45% for 2°C global warming;
- transitions in global and regional land use are found in all pathways limiting global warming to 1.5°C with no or limited overshoot, but their scale depends on the pursued mitigation portfolio;
- total annual average energy-related mitigation investment for the period 2015 to 2050 in pathways limiting warming to 1.5°C is estimated to be around USD 900 billion USD2015, corresponding to total annual average energy supply investments of USD 1600-3800 billion USD2015 and total annual average energy demand investments of USD 700-1000 billion USD2015 for the period 2015 to 2050, and an increase in total energy-related investments of about 12% in 1.5°C pathways relative to 2°C pathways; and
- modelled pathways limiting global warming to 1.5°C with no or limited overshoot project a wide range of global average discounted marginal abatement costs over the 21st century; they are roughly 3-4 times higher than in pathways limiting global warming to below 2°C.

Subsection C3 on **CDR** underscores that:

- all pathways that limit global warming to 1.5°C with limited or no overshoot project the use of CDR on the order of 100-1000 GtCO2 over the 21st century;
- CDR would be used to compensate for residual emissions and, in most cases, achieve net negative emissions to return global warming to 1.5°C following a peak;
- CDR deployment of several hundreds of GtCO2 is subject to multiple feasibility and sustainability constraints;
- significant near-term emissions reductions and measures to lower energy and land demand can limit CDR deployment to a few hundred GtCO2 without reliance on BECCS;
- existing and potential CDR measures include afforestation and reforestation, land restoration and soil carbon sequestration, BECCS, direct air carbon capture and storage, enhanced weathering, and ocean alkalinisation;
- these measures differ widely in terms of maturity, potentials, costs, risks, co-benefits, and trade-offs;
- some pathways avoid BECCS deployment completely through demand-side measures and greater reliance on AFOLU-related CDR measures;
- pathways that overshoot 1.5°C of global warming rely on CDR exceeding residual CO2 emissions later in the century to return to below 1.5°C by 2100, with larger overshoots requiring greater amounts of CDR;

- limitations on the speed, scale, and societal acceptability of CDR deployment hence determine the ability to return global warming to below 1.5°C following an overshoot;
- carbon cycle and climate system understanding is still limited about the effectiveness of net negative emissions to reduce temperatures after they peak;
- most current and potential CDR measures could have significant impacts on land, energy, water, or nutrients if deployed at large scale; and
- some AFOLU-related CDR measures such as restoration of natural ecosystems and soil carbon sequestration could provide co-benefits such as improved biodiversity, soil quality, and local food security: if deployed at large scale, they would require governance systems enabling sustainable land management to conserve and protect land carbon stocks and other ecosystem functions and services.

The section includes two figures. SPM.3a, on global emissions pathway characteristics, shows global net anthropogenic CO2 emissions in pathways limiting global warming to 1.5°C with no or limited overshoot and pathways with higher overshoot.

SPM.3b, on characteristics of four illustrative model pathways in relation to global warming of 1.5°C, shows a range of potential mitigation approaches and vary widely in their projected energy and land use, as well as their assumptions about future socio-economic developments, including economic and population growth, equity and sustainability.

D. Strengthening the Global Response in the Context of Sustainable Development and Efforts to Eradicate Poverty

This section was first discussed on Friday morning.

D1: This subsection addresses estimates of the **global emissions outcome of current nationally stated mitigation ambitions as submitted under the Paris Agreement**. The headline statement of the final draft that governments discussed on Friday initially referred to the gap between current nationally determined contributions (NDCs) and a 1.5°C target, but Saudi Arabia, supported by Egypt, opposed the reference to NDCs, arguing that NDCs were outside the mandate and agreed outline for SR15. They argued that NDCs were only potential commitments and, in some cases, conditional on support. This paragraph was further discussed in a contact group, during which the authors proposed alternate text to describe NDCs. This was rejected by two countries, who noted that the proposed text still referred to "ambitions submitted under the Paris Agreement," and that this wording made it clear that the subject was NDCs, even without using that term. Many countries argued that the mandate and the underlying science argued for reference to both NDCs and the Paris Agreement.

Revised text was presented to plenary on Saturday, which removed mention of NDCs but did reference the Paris Agreement. Several countries agreed to consider this revised text. This was opposed by Saudi Arabia, Egypt, and Ecuador, who opposed reference to the Paris Agreement, and by Saint Kitts and Nevis, the Marshall Islands, Belgium, Grenada, and France, who preferred the previous formulation with explicit reference to NDCs. No consensus was reached following attempts by various countries to find a way forward.

Absent consensus, WG III Vice-Chair Skea noted that IPCC procedures mandate that differing views must be explained and, upon request, recorded. He noted the greatest weight of opinion rested with the contact group text, which referenced the Paris Agreement but not NDCs, and proposed its acceptance, with Saudi Arabia and Egypt requesting to record their opposition in the report of IPCC-48. On that basis, the paragraph was approved.

D1.1: This paragraph, on **pathways that limit global warming to 1.5°C**, was discussed in Friday's plenary. Saudi Arabia opposed reference to NDCs, arguing that it exceeded the SR15 mandate from the UNFCCC, and that it was inappropriately policy prescriptive. The EU, supported by many countries, argued that the SR15 outline, agreed during IPCC-44, mandated assessing the pace of development of mitigation and adaptation options relative to the target of 1.5°C, and that policymakers expected and needed an assessment of the scale of NDC ambition relative to the 1.5°C aspirational goal.

The Netherlands, supported by many countries, argued that the draft text was policy relevant but not policy prescriptive. Trinidad and Tobago, supported by other small island developing states, stressed that the NDC assessment was critically important. In response to these arguments, in a contact group that sought unsuccessfully to find alternate acceptable wording for both D1.1 and headline statement for subsection D1, two countries argued that the scope of NDCs includes both mitigation and adaptation, making the draft text's focus on mitigation inappropriate. When brought back to plenary on Saturday, WG III Co-Chair Skea presented the contact group wording for both paragraphs, without reference to NDCs but with reference to the Paris Agreement, with Saudi Arabia and Egypt requesting to record their objections in the meeting report. On that basis, the paragraph was agreed.

D1.2: This paragraph addresses **overshoot trajectories resulting in higher impacts and associated challenges** and was agreed as presented on Saturday.

D1.3: This paragraph acknowledges **lower challenges in limiting global warming to 1.5°C with no or limited overshoot** and was agreed as presented on Saturday.

D2: This subsection addresses **avoided climate change impacts on sustainable development, eradication of poverty, and reducing inequalities**, which had originally been included as a subsection in Section A. On Saturday morning, a revised version of the headline statement was presented to plenary, highlighting that such avoided climate change impacts would be greater if global warming were limited to 1.5°C rather than 2°C, if mitigation and adaptation synergies were maximized while trade-offs were minimized.

China objected to language saying that limiting global warming to 1.5°C would make it "easier to achieve" sustainable development, noting the trade-offs associated with mitigation could be large. An author responded that the wording had a strong basis in the literature, citing ecosystems and poverty as examples of where important differences in impacts were projected under 2°C compared to 1.5°C scenarios. Following further consultations and revisions, the headline statement was agreed.

D2.1: This paragraph on **links between climate change impacts and responses and sustainable development**, which had originally been included in a subsection in Section A, was taken up in a huddle. On Saturday morning, delegates approved the paragraph, and its new placement, without discussion.

D2.2: This paragraph on **consideration of ethics and equity to help address the uneven distribution of adverse impacts** had originally been included in a subsection in Section A. On Saturday morning, delegates approved the paragraph and its new placement without further discussion**.**

D2.3: This paragraph, on **enabling conditions for mitigation and adaptation**, had originally formed a separate subsection in Section A. On Saturday morning, a condensed version of the original text was accepted without further discussion.

D3: The headline statement for this subsection on **adaptation options** was accepted as presented on Saturday. It explains that adaptation options specific to national contexts, if carefully

selected together with enabling conditions, will have benefits for sustainable development and poverty reduction.

D3.1: On this paragraph on **adaptation options that reduce the vulnerability of human and natural systems**, Nicaragua proposed highlighting the links between agriculture and forestry in a sentence listing synergies between adaptation and sustainable development. This suggestion was not agreed to. Saudi Arabia noted the absence of several sectors in the list of synergies and suggested deleting reference to sustainable development, which was nevertheless retained. An informal huddle resulted in agreement to specify that adaptation options have many synergies with aspects of sustainable development, "if well managed." The paragraph was then accepted.

D3.2: On a paragraph on **adaptation options resulting in trade-offs or maladaptations with adverse impacts for sustainable development**, which had originally referred only to poorly designed and implemented adaptation options, Spain advocated using the term "maladaptation" for adaptation with adverse impacts for sustainable development.

Tanzania, Ecuador, and Brazil questioned the example of intensive agriculture in a sentence highlighting poor adaptation efforts and their effects, while El Salvador queried text describing the negative impacts of urban infrastructure. Brazil and Chile suggested deleting both examples, as well as the list of impacts. India noted inclusion of intensive agriculture as poor adaptation contradicts a statement elsewhere in the SPM stating its necessity for achieving the 1.5°C target.

On Friday evening, delegates agreed to this paragraph, which includes changes introduced by the informal group, namely, *inter alia*, removal of references to the possible adverse effects of projects that intensify agriculture and expand urban infrastructure.

D3.3: This paragraph, on **enhancing effectiveness of adaptation and mitigation options**, was presented and agreed with a minor editorial change.

D3.4: On **adaptation and mitigation synergies and trade-offs**, participants discussed reference to ecosystem functions, and agreed to refer to ecosystem "functions and services" in line with language used by the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES). They also agreed to add reference to afforestation alongside reforestation. With these changes, the paragraph was agreed.

D4: This subsection addresses **mitigation options associated with synergies and trade-offs across the Sustainable Development Goals (SDGs)**. The headline statement was agreed on Saturday.

D4.1: This paragraph, which addresses **1.5°C pathways' synergies and trade-offs with the SDGs**, was first discussed on Saturday morning. Saudi Arabia suggested adding a new paragraph in this subsection reflecting that mitigation pathways below 1.5°C and 2°C often rely on land-related measures, which can compete with food production and have negative impacts for global food security. Participants agreed to add these food security concerns to D4.3.

D4.2: This paragraph, which addresses **1.5°C pathways with the most pronounced synergies with sustainable development**, was discussed on Saturday morning. Egypt said barriers to pathways should also be reflected, and, supported by Saudi Arabia, suggested a new sentence on "acknowledging the conditions for achieving sustainable development, eradicating poverty, and reducing inequalities in a 1.5°C warmer world." In response to India, the author clarified that the first high confidence level referred to in the paragraph reflects that studies show that limited energy demand is associated with a higher level of synergies.

The paragraph was agreed with the addition of text on the potential for sustainable development, eradicating poverty, and reducing inequality to limit warming, without reference to conditions.

D4.3: This paragraph addresses the impacts of land-based CDR and other **land-intensive mitigation options on the SDGs**. On Saturday morning, following a proposal from Saudi Arabia to include food security concerns in this paragraph, a huddle convened to discuss this paragraph, together with Figure SPM.4 on synergies and trade-offs.

The paragraph was agreed with revisions that note potential conflicts between food security and the deployment of large-scale land-related measures.

D4.4: This paragraph, on **risks for sustainable development in regions with high dependency on fossil fuels** was introduced in plenary on Saturday, with Saudi Arabia calling for broader references to various policy packages and opposing the singling out of specific ones, such as carbon pricing and fossil fuel subsidies. Their concern was addressed through more general and simplified language. Reference was also included on the challenges related to implementation, including those of energy costs, international competition, and depreciation of assets, as suggested by Egypt, and to the potential for maximizing co-benefits, as proposed by Germany. With these changes the paragraph was agreed.

D4.5: On Saturday morning, this paragraph on **redistributive policies that can resolve trade-offs for a range of SDGs** was accepted after an author clarified that a reference to "redistributive" policies is supported by the literature, in response to a suggestion from the US that a general reference to policies may be more acceptable.

D5: This subsection, which addresses **the role of investments, policy instruments, and behavioral change in limiting risks of global warming**, and the importance of sustainable development in achieving the 1.5°C objective, was briefly discussed in plenary on Friday, where it was explained that that FGD was revised to include parity of reference to mitigation and adaptation when referring to investments. The text was agreed without amendment.

Paragraphs D5.1, D5.2, D5.3 and D5.4 were taken up in a huddle on Saturday morning, and were presented to and considered in plenary on Saturday afternoon, where they were accepted as presented by the huddle with minor amendments.

D5.1: This subsection addresses the **directing finance toward investment in infrastructure for mitigation and adaptation**, which could involve the mobilization of private funds by institutional investors, asset managers, and development or investment banks, as well as the provision of public funds. The original formulation had, *inter alia*, referenced the redirection of world savings towards investment in infrastructure. This paragraph was agreed on Saturday.

D5.2: This paragraph on **adaptation finance** addresses knowledge gaps, cost estimates, sources of support for adaptation needs and barriers. The original formulation had included a numerical value for estimated costs as more than USD 22.5 billion, which was dropped during informal consultations. This paragraph was agreed on Saturday.

D5.3: This paragraph addresses **annual average investment needs in the energy system** of around USD 2.4 trillion between 2016 and 2035. The original formulation had discussed, *inter alia*, a doubling of average annual investment in low carbon energy technologies and energy efficiency and a decrease of investments in fossil fuel extraction and conversion by about 25% over the next two decades.

This paragraph was revised to delete reference to increases in low-carbon energy and energy efficiency investment, decreases in fossil fuel sector investment, and redistribution of global investments in infrastructure, and was agreed on Saturday.

D5.4: A paragraph on **policy packages that can help mobilize incremental resources and investments**, was also taken up in the huddle but further revised in plenary, with Saudi Arabia calling for broader references to various policy packages and opposing the singling out of specific ones. This concern was addressed through more general and simplified language. Reference was also included to various implementation-related challenges including energy costs, international competition, and depreciation of assets, as suggested by Egypt, and to the potential for maximizing co-benefits, as proposed by Germany. With these changes the paragraph was agreed.

D5.5: This paragraph, on **new disruptive technologies and practices, and climate-driven innovation**, was discussed at length on Saturday morning. In response to a concern from India, a reference to "public" support for such technologies was introduced. India also said that developing countries' position in the UNFCCC process is that public support is needed in addition to markets and said the literature on contested issues must reflect both sides of the debate. Brazil called for replacing "market uptake" with "private sector engagement and adoption." Noting such a reference would not have a strong basis in the underlying report, the author suggested "innovation diffusion" as alternative wording.

Following informal consultations, the paragraph was accepted, with final language referring to policy mixes that provide incentives for technology diffusion.

D5.6: On Saturday, a paragraph on **education, information, and community approaches** was approved as presented.

D6: The headline statement for this subsection, which addresses **societal and systems transitions and transformations that help limit global warming to 1.5°C**, was agreed as presented on Saturday.

D6.1: This paragraph, on **social justice and equity**, was considered and accepted on Friday evening with no discussion.

D6.2: This paragraph, on **climate-resilient development pathways**, was discussed on Friday evening. In response to a query from India, an author responded that the term "non-state actors" refers to civil society or societies, and the private sector, and noted that examples of civil society are listed in the underlying chapter. In response to interventions from Zimbabwe, Switzerland, and Singapore, a reference to differing potential for climate-resilient development pathways being due to different "starting points" was changed to refer to different "systemic vulnerabilities."

Bolivia suggested mentioning indigenous peoples in a list of those from whom strengthened contributions would be required, but the author argued that this statement was not supported by the literature. In the same sentence, the term "contributions" was replaced by "enhanced efforts." Additional changes were made to address concerns that elements of the paragraph were policy prescriptive or an incitement to action, and the paragraph was accepted.

D6.3: On **the relationship between 1.5°C pathways and cooperation and sustainable development**, India asked what was meant by cooperation. The authors explained that in modeling exercises, cooperation refers to the degree to which countries participate in global mitigation efforts, and suggested using the term "international cooperation" for greater clarity. With that revision and other edits for clarity, the paragraph was accepted.

D7: This section addresses **international cooperation and strengthening capacity for climate action**. On Friday evening, revised text for the headline statement on non-state actors and international coordination was forwarded to plenary by the informal group, stating that international cooperation is a critical enabler for developing countries and vulnerable regions. This was accepted.

D7.1: This paragraph, on **the role of partnerships**, was accepted without discussion.

D7.2: On this paragraph, which addresses **cooperation on strengthened accountable multilevel governance**, WG II Co-Chair Debra Roberts said the revised paragraph, compared to its formulation in the FGD, contained a stronger reference to technology and finance, as well as language on gender-responsive policies. The US supported a reference to "accountable" governance, which had not been included in the final draft.

An author noted that the section emphasizes the international aspects of collective action, but also aims to forge a link between the international, national, and sub-national levels. She agreed with Egypt that gender-"responsive" policies could also be referred to as gender-"sensitive." Egypt, supported by Saudi Arabia, stressed the need to refer not just to innovative finance, but to finance in general.

On Friday evening, revised text from a huddle on this paragraph that qualifies multilateral governance as needing to be strengthened and accountable was introduced and accepted.

D7.3: Regarding a paragraph addressing **international cooperation** to support the implementation of 1.5°C-consistent climate responses in developing countries, WG II Co-Chair Roberts noted that the revised paragraph, compared to its formulation in the FGD, highlighted, *inter alia*, the importance of domestic resources. China suggested language reflecting that international cooperation "is critical" for enabling conditions for implementation and, supported by India, stressed its importance for domestic implementation. Tanzania requested clarity on the term "international cooperation." Zambia said the UNFCCC process refers to "providing," not "enabling" finance and technology.

On Friday evening, revised text from a huddle was considered. An author clarified that the term international cooperation is contained in the SR15 mandate. In response to a query from India, the author said the paragraph's reference to international cooperation's role in enabling "access to" rather than "provision of" finance is a more accurate reflection of the literature. This paragraph was accepted.

D7.4: This paragraph, on **strengthening the global response to climate change through collective efforts**, was first discussed on Friday morning. China called for clarity on what is meant by "collective efforts." On Friday evening, the text, as agreed informally, was presented. It highlights collective efforts at all levels, in ways that reflect different circumstances and capabilities, taking into account equity as well as effectiveness. The paragraph was then accepted with a minor editorial change.

Figure SPM.4: This figure, which reflects **possible synergies and trade-offs between climate change mitigation with sustainable development**, was first addressed in a contact group on Thursday, during which delegates proposed amendments, including clarification of sectors, synergies, and trade-offs between mitigation actions and the SDGs, and identification of gaps in the literature, including on the benefits of avoided impacts of climate change resulting from mitigation.

In plenary on Saturday, Saudi Arabia called the figure a "misrepresentation of the literature," saying the figure was unclear on relationships between the SDGs and mitigation options

and on trade-offs and opportunity costs. He stressed the "hefty" price to be paid for maintaining global temperatures at 1.5°C.

The authors responded that the figure's depiction of synergies and trade-offs reflects the literature assessed and synthesized, as presented in Table 5.2 of the underlying report and its references, and noted the transparency of the process, including changes made on the basis of comments received from policymakers.

Saint Kitts and Nevis and the UK favored maintaining the figure as presented. WG II Co-Chair Roberts observed that the figure is one of SR15's more innovative elements, noting that the whole of this chapter is "over and above" the mandate contained in the UNFCCC's invitation to prepare SR15, but was anchored firmly in the IPCC's agreed SR15 outline. The figure was agreed.

Final SPM Text: This section discusses strengthening the global response in the context of sustainable development and efforts to eradicate poverty.

Subsection D1 acknowledges that pathways reflecting current nationally-stated mitigation ambitions as submitted under the Paris Agreement would not limit global warming to 1.5°C, even if supplemented by very challenging increases in the scale and ambition of emissions reductions after 2030.

It contains paragraphs on:

- pathways that limit global warming to 1.5°C with no or limited overshoot requiring clear emission reductions by 2030;
- pathways that overshoot this target, resulting in higher impacts and associated challenges, including the need to upscale and deploy CDR at rates and volumes that might not be achievable given considerable implementation challenges; and
- challenges from delayed action to reduce greenhouse gas emissions, including risk of cost escalation, reduced flexibility in the longer term, and uneven distributional impacts.

Subsection D2 acknowledges the greater avoided climate change impacts on sustainable development, eradication of poverty, and reducing inequalities from limiting global warming to 1.5°C, and contains paragraphs on:

- the SDGs as an established framework for assessing links between global warming of 1.5°C or 2°C and development goals;
- ethics and equity to help address the uneven distribution of adverse impacts of global warming, mitigation, and adaptation, particularly for poor and disadvantaged populations; and
- mitigation and adaptation conditions, including strengthened multi-level governance, institutional capacity, policy instruments, technological innovation and transfer, mobilization of finance, and changes in human behavior and lifestyles.

Subsection D3 acknowledges that adaptation options are specific to national contexts and can have benefits for sustainable development and poverty reduction with global warming of 1.5°C, although trade-offs are possible, and contains paragraphs on:

- synergies between adaptation options and sustainable development;
- possible maladaptations with adverse impacts for sustainable development, including increasing GHG emissions, water use, gender and social inequality, and encroaching on natural ecosystems;
- implementation of adaptation and mitigation options in a participatory, integrated manner, supported by national governments;
- synergies and cost savings from adaptation options that also mitigate emissions, but also the threat of trade-offs between mitigation and adaptation.

Subsection D4 focuses on mitigation options consistent with 1.5°C pathways and their multiple synergies and trade-offs across the SDGs, and contains paragraphs on:

- 1.5°C pathways with synergies with the SDGs and those with potential trade-offs between mitigation and SDGs;
- 1.5°C pathways that include low energy demand, low material consumption, and low GHG-intensive food consumption as having the most pronounced synergies and lowest number of trade-offs with respect to sustainable development and the SDGs, while supporting limiting warming to 1.5◦C;
- 1.5°C and 2°C pathways relying on the deployment of large-scale land-related measures like afforestation and bioenergy supply as competing with food production and food security if poorly managed;
- risks for sustainable development in regions highly dependent on fossil fuels for revenue and employment from mitigation consistent with 1.5°C pathways, and policies that promote economic and energy sector diversification to address associated challenges; and
- investment needs for redistributive policies across sectors and populations that shield the poor and vulnerable as a small fraction of overall mitigation investments in 1.5°C pathways.

The subsection also contains a figure on indicative linkages between mitigation options and sustainable development using SDGs, not including costs and benefits.

Subsection D5 discusses transitions limiting the risks from global warming of 1.5°C in the context of sustainable development and poverty eradication that can be enabled by an increase in adaptation and mitigation investments, policy instruments, acceleration of technological innovation and behavior changes.

It contains paragraphs on:

- directing finance towards investment in infrastructure for mitigation and adaptation, with mobilization of private funds as well as provision of public funds;
- knowledge gaps, such as insufficient data to calculate climate resilience-enhancing investments, and barriers, such as limited capacity and access to adaptation finance;
- the need for annual average investment in the energy system of about 2.5% of world GDP;
- policy tools to help mobilize resources, including through shifting global investments and savings and through market and non-market based instruments, with measures to secure equity;
- the possible need for widespread adoption of new and possibly disruptive technologies and practices in industry and finance; and
- the benefits of education, information, and community approaches in accelerating wide-scale behavior changes, and public acceptability of policy consequences and perceived fairness of distribution and procedures.

Subsection D6 states that sustainable development supports needed societal and systems transitions and transformations, and contains paragraphs on:

- social justice and equity as core aspects of pathways to 1.5°C global warming;
- the differing potential for climate-resilient development pathways given different contexts and vulnerabilities; and
- the consistency of sustainable development with fewer mitigation and adaptation challenges and costs, and the inconsistency of 1.5°C pathways with poverty, inequality, and lack of international cooperation.

Subsection D7 discusses strengthening capacities to provide an enabling environment, and contains paragraphs on:

- partnerships involving non-state public and private actors, institutional investors, the banking system, civil society, and scientific institutions;
- cooperation on strengthened accountable multilevel governance that includes, *inter alia*, non-state actors, coordinated sectoral and cross-sectoral policies at various governance levels, gender-sensitive policies, innovative financing, and cooperation on technology development and transfer;
- international cooperation as a critical enabler for developing countries and vulnerable regions; and
- collective efforts at all levels, reflecting different circumstances and capabilities, taking into account equity and effectiveness.

Box SPM 1: Core Concepts Central to SR15

On Monday afternoon, delegates began considering **Box SPM.1 on Core Concepts Central to SR15**. The concepts were addressed throughout the week as they first came up in the text and some were discussed in huddles.

Global mean surface temperature: On the definition of GMST, participants discussed, among other issues, whether "departures" from a specified reference period could instead be referred to as "anomalies" from such a period, but agreed to retain the former formulation.

Continuing the discussion on Tuesday, delegates considered whether, and if so how, to reflect that, in addition to the main approach cited, changes in GMST can also be approximated using changes in global mean near-surface air temperature. Some countries deemed this specification too technical for policymakers, while others stressed the value of highlighting the existence of different estimation methods. Following an informal huddle, delegates agreed to retain the additional specification with minor amendments, and the definition was approved.

Pre-industrial: This definition addresses the multi-century period prior to the onset of large-scale industrial activity around 1750, with the reference period 1850-1900 used to approximate pre-industrial GMST. On Tuesday, the definition was agreed without comment.

Global warming: In response to a US request for clarification, the text was amended to specify that the current warming trend is multi-decadal. The revised definition was approved on Tuesday.

Net-zero CO2 emissions: On Tuesday, delegates debated whether the word "approximately" was needed to qualify the balance between CO2 emissions and removals in this definition. Some deemed this wording more accurate, while others argued that it introduced ambiguity. Delegates agreed to delete this qualifier. They also discussed how to introduce a temporal dimension into such balance, eventually agreeing to the wording "over a specified period." The definition, which was then agreed, notes that net-zero CO2 emissions are achieved when anthropogenic CO2 emissions are balanced globally by anthropogenic CO2 removals over a specified period.

CDR: On Tuesday, delegates discussed, *inter alia*, Saudi Arabia's suggestion to include a reference to CO2 "utilization" in this definition, with Switzerland highlighting interesting developments in this field, and the EU and the Netherlands cautioning that there is no guarantee that such utilization will lead to long-term removal. Saudi Arabia's suggestion was not accepted.

Regarding a sentence describing sinks covered by CDR, Pakistan, supported by Ukraine, proposed deleting text stating that "natural CO2 sinks" are excluded from CDR, arguing that it may be confusing to specifically exclude such sinks when anthropogenic enhancement of them is covered. Brazil, supported by Belgium, Germany, and the Marshall Islands, proposed retaining the text, noting that it specifies the scope of coverage. India suggested that the definition refer to "proposed and ongoing" anthropogenic enhancement of sinks, but several countries objected. Informal consultations produced text that referred to "existing and potential" anthropogenic enhancement of sinks, and the revised definition was approved.

Total carbon budget: Following revisions by a contact group, this was defined as estimated cumulative net global anthropogenic CO2 emissions from the pre-industrial period to the time that anthropogenic CO2 emissions reach net zero that would result, at some probability, in limiting global warming to a given level, accounting for the impact of other anthropogenic emissions. It was agreed as presented.

Remaining carbon budget: This definition, as presented following contact group discussions, states that estimated cumulative net global anthropogenic CO2 emissions from a given start date to the time that anthropogenic CO2 emissions reach net zero would result, at some probability, in limiting global warming to a given level, accounting for the impact of other anthropogenic emissions. It was agreed without further comment.

Temperature overshoot: On Thursday, following contact group discussions, several countries said the definition should not contain a description of how overshoot might be mitigated, so references to CDR and reductions/emissions of other GHGs were removed. The definition was then agreed.

Emissions pathway: On Thursday, following contact group revisions to the definition of "pathway," participants agreed that the term has too many meanings, and proposed describing classification of emission pathways to cover "no overshoot," "limited overshoot," and "higher overshoot." India requested that the definition clarify that emission pathways are: model dependent; not trajectories of emissions growth or decline in specific countries; and globally aggregated and hypothetical. A revised definition addressing these concerns was agreed.

Impacts: Regarding a list of specific impacts from climate change, Saudi Arabia and South Africa said the definition should either refer to all impacts or not list any.

An author noted that glossary definitions in the underlying scientific report use words based on the scientific literature, but that SPM definitions must build on AR5 definitions and be consistent across the three WGs.

Following informal consultations, delegates approved the definition incorporating an author's proposal to delete examples of specific impacts.

Risk: This definition, which was agreed without amendment, includes the potential for adverse consequences from a climate-related hazard for human and natural systems, resulting from the interactions between the hazard and the vulnerability and exposure of the affected system.

Climate-resilient development pathways: This definition was discussed on Friday. The US expressed concern with the formulation's reference to "equitable societal transformations across all scales and economies," saying it was overly broad. An author explained that the climate-resilient development pathway trajectories are not global but include all levels, including communities and nations, and refer to all countries and economies. She also noted that the reference comes from AR5 and that the equity-related elements mentioned in the definition are justified in the context of societal transformations as proposed in the literature. Discussions moved to informal consultations. On Friday evening, a revised definition was agreed, which refers to "trajectories that strengthen sustainable development at multiple scales and efforts to eradicate poverty through equitable societal and systems transitions and transformations."

Closure of Joint Session of WGs I, II and III

On Saturday afternoon, the WGs approved the SPM by the WGs and accepted the underlying report and forwarded to the IPCC Plenary. The Joint Session closed at 2:50 pm.

IPCC-48 Agenda Items and Decisions

IPCC-48 convened on Monday morning, Friday afternoon and Saturday afternoon, during which the plenary heard progress reports and adopted a number of decisions.

Ad Hoc Task Group on Financial Stability

On Monday morning, delegates considered the report of the ATG-Finance (IPCC-XLVIII/Doc.3). ATG-Finance Co-Chair Thelma Krug recalled IPCC-47's agreement that, while the IPCC's financial situation has improved, there is still a need to focus on long-term financial stability, and that the ATG-Finance should explore the relevant experiences of other UN organizations. She noted only 12 countries had responded to a second questionnaire on barriers governments face in contributing.

ATG-Finance Co-Chair Youba Sokona noted: a Trust Fund balance at the beginning of 2018 of CHF 5.3 million; total received contributions of CHF 4.4 million as of 25 September 2018; and total pledges of CHF 5.5 million as of 30 September. On the expenditure side, he noted an approved 2018 budget of CHF 7.9 million, 2018 expenditures of CHF 4.6 million as of 19 September, and projected total expenditures of CHF 5.7 million by the end of 2018, well under budget.

Sokona said an electronic forum to stimulate more responses from members would be established, and recommended the Panel consider employing external experts as other UN organizations have successfully done.

Germany, supported by Japan, Sweden, and Belgium, requested details regarding the terms of reference for such external experts, and the budget implications. Krug responded that such details will be presented to IPCC-49.

Switzerland suggested considering contributions based on the UN indicative scale of assessments, and expressed doubts regarding the usefulness of an external consultant on finance. He noted that the IPBES had benefited from a seconded finance expert from the Government of France and encouraged countries to consider such an approach for the IPCC.

Japan noted a 50% increase in its contribution to the Trust Fund in fiscal year 2018, and promised continued in-kind contributions.

The Republic of Korea, supported by Belgium, welcomed the idea of an electronic forum. He noted his country's annual contributions of roughly CHF 120,000 since 2009, and the commitment to continue contributing through 2020. He highlighted his country's pledge to annually contribute CHF 441,000 to the SYR TSU for the sixth assessment cycle.

Tanzania expressed hope that its first-time contribution to the IPCC would inspire more contributions from others. Bangladesh noted its intention to begin contributing in the future, while Mali, recalling its past contributions, emphasized the importance of in-kind contributions for awareness building. Sri Lanka announced that his country would begin to contribute in 2019.

Ghana asked about potential contributions from the Green Climate Fund and the Global Environment Facility. Sokona noted ongoing efforts to explore such prospects.

On Saturday, the Panel adopted a decision on the ATG-Finance.

Final Decision: In its decision (IPCC-XLVIII/Doc.3), the Panel, *inter alia*:

- expresses its gratitude to all member governments who have contributed to the IPCC's Trust Fund, and notes with appreciation many first time contributors as well as increases in contributions;
- requests the IPCC Secretariat to present terms of reference for an external consultant on financial stability of the IPCC and the budgetary implications of such a function at IPCC-49; and
- requests the IPCC Secretariat to explore possibilities with IPCC member governments for secondments of staff with financial expertise to work on matters pertaining to the financial stability of the IPCC.

Progress Reports

International Conference on Climate Change and Cities: WG II Co-Chair Roberts introduced this report (IPCC-XLVIII/INF.1, Rev.1), noting that the conference, held from 5-7 March 2018 in Edmonton, Canada, had recommended, *inter alia*, that the Panel consider:

- holding an expert meeting after the completion of the AR6, with a focus on city-level local modeling, to provide recommendations for the seventh assessment cycle;
- increasing the frequency of dialogue between intergovernmental bodies on cities and climate change science;
- including an urban focus at IPCC outreach events; and
- cities as a cross-cutting topic for future assessment cycles.

Germany noted that, while co-sponsored by the Panel, the conference was not an IPCC conference *per se*, and requested that greater efforts be made in the future to clearly communicate the Panel's role in similar events.

The Panel took note of the report.

Expert Meeting on Assessing Climate Information for Regions: WG I Co-Chair Masson-Delmotte introduced this report (IPCC-XLVIII/INF.5), noting the expert meeting convened from 16-18 May 2018 in Trieste, Italy, to, among other things, foster cross-WG collaboration on such information. She highlighted plenary discussions on, *inter alia*, scoping for the AR6 Regional Atlas, which had identified key Atlas features, and the need to ensure traceability of underlying information. She pointed to a summary of the meeting's recommendations in the report. The Panel took note of the report.

Expert Meeting on Short-Lived Climate Forcers: Kiyoto Tanabe, TFI Co-Chair, introduced this report (IPCC-XLVIII/INF.4) on the May 2018 expert meeting held in Geneva, Switzerland. He reported on future TFI work proposed by the TFI Bureau and Scientific Steering Committee to, *inter alia*:

- convene an expert meeting to identify gaps in current SLCF inventory methodologies to help countries that wish to begin reporting national SLCF inventories; and
- develop a further work plan, including possible production of a new methodology report for SLCF inventories during the seventh assessment cycle.

Tanabe thanked Switzerland and Norway for their financial contributions.

Norway, supported by Switzerland, Mexico, and Chile, called for earlier development of a methodological report, specifically during the AR6 cycle. With Sweden, he proposed that IPCC-48 take note of the expert meeting's recommendations in its report and request additional proposals on future work on SLCFs from the TFI for discussion at IPCC-49.

Japan encouraged assessment at IPCC-49 of how work on SLCFs during the sixth assessment cycle would align with ongoing work. Finland cautioned against overburdening the TFI before completion of its current work in May 2019.

The Panel took note of the report.

Task Force on National GHG Inventories: TFI Co-Chair Eduardo Calvo Buendia introduced this report (IPCC-XLVIII/INF.3), and reviewed progress thus far on the 2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories. He noted the final government review would take place between 28 January and 4 March 2019, followed by the approval session in May 2019 in Japan. On other activities, he noted, *inter alia*, progress made on AFOLU worksheets, and more than 1000 new data from different sources added to the Emission Factor Database. The Panel took note of the report.

Acceptance of the Actions Taken at the First Joint Session of WGs I, II and III

On Saturday afternoon, IPCC Chair Lee invited delegates to accept the actions taken by the Joint Session of WGs I, II, and III and the SPM it had forwarded.

Saudi Arabia expressed "substantial disagreement" with references to NDCs in the report's technical assessment, and to the Paris Agreement in the SPM, and listed sections of the Technical Summary and the underlying report he considered to be outside the Panel's mandate.

The US underscored that the Panel's acceptance of SR15 does not imply its endorsement of the report's findings, nor does approval of the SPM imply endorsement of all of its key messages. He reiterated that the US intends to withdraw from the Paris Agreement at the earliest opportunity absent the identification of more favorable terms for the "American people."

Egypt stressed that pathways linked to NDCs are subject to the conditionalities reflected in these NDCs, in particular those of developing countries.

Chair Lee indicated that the statements would be included in the draft IPCC-48 report. The actions of the Joint Session were accepted, including approval of the SPM (IPCC-XLVIII/Doc. 5), and acceptance of the underlying report and Technical Summary.

Organization of the Future Work of the IPCC in Light of the Global Stocktake

This agenda item, which included a progress report by the Task Group on the Organization of the Future Work of the IPCC in Light of the Global Stocktake (IPCC-XLVIII/INF.2, Corr.2) was taken up by the Panel on Friday morning. Task Group Co-Chair Eric Brun reviewed the action plan proposed by the group and noted that the group is still seeking a rapporteur, preferably from a developing country. He asked the Panel to take note of the Group's action plan and of the acronym for the Task Group, namely TG-FWLGST. The IPCC took note of the progress report.

Implementation of the IPCC Conflict of Interest Policy

IPCC Vice-Chair Krug introduced the report, noting no conflict of interest had been found, and that all appointed experts would be admitted to their roles. The IPCC took note of the report.

IPCC Scholarship Programme

Reporting on the IPCC Scholarship Programme (IPCC-XLVIII/Doc.4, Rev.1) on Friday morning, IPCC Vice-Chair and Chair of the Science Board Ko Barrett presented nominees for the Board of Trustees to make decisions on funding for the Scholarship Programme. She presented four trustees for the Panel as follows:

- Hironori Hamanaka, former Vice Minister of Environment, former Chair of the Institute for Global Environmental Strategies, Japan;
- Fatima Denton, Director, UN University, Institute for Natural Resources in Africa, Ghana;
- Jose Goldemberg, São Paulo Research Foundation, Brazil; and
- Mary Robinson, former President of Ireland and former UN High Commissioner for Human Rights.

On Saturday, the Panel adopted its decision approving the nominees to the Board of Trustees for the Scholarship Programme.

Place and Date of IPCC-49

On Saturday afternoon, IPCC Secretary Mokssit announced that IPCC-49 would be held in Kyoto, Japan, in May 2019.

Closing Plenary

During the closing plenary, the Republic of Korea welcomed the acceptance of the "historic" SR15 and recalled the words of Nelson Mandela: "Everything seems impossible until it's done."

IPCC Chair Lee thanked all those who had contributed to the "keenly awaited" SR15 and its SPM, including the authors, TSUs, and WG Co-Chairs. Highlighting "an SPM we can be proud of," he said governments could start to use the SPM immediately, including at the Talanoa Dialogue during UNFCCC COP 24.

Chair Lee gaveled the meeting to a close on Saturday at 3:41 pm.

A Brief Analysis of IPCC-48

The SR15: IPCC Lights the Way

As delegates gathered for the IPCC's 48th session in Incheon, Republic of Korea, an unprecedented buzz of global attention focused on what IPCC Chair Hoesung Lee called "one of the most important meetings in the history of the IPCC." The Special Report on the Impacts of Global Warming of 1.5°C (SR15), approved at this meeting, is not the first or last IPCC special report, but its timing, history, and context make it unique. Assessing its import, one seasoned delegate characterized the report as a "lighthouse," cutting through the fog of uncertainty to provide clear warning of the rocks ahead and illuminating routes that might provide safe passage. This brief analysis examines the review of SR15 and its key messages, and considers its significance to the IPCC, the UNFCCC, and beyond.

Origins of the Journey

SR15 was produced by the IPCC at the behest of the UNFCCC in the decision that adopted the Paris Agreement in 2015. As part of that Agreement, parties agreed to limit global warming to 2°C above pre-industrial levels, and to pursue efforts toward an even more ambitious 1.5°C limit. But the roots of a 1.5°C target stretch back further than that, to research commissioned by the Alliance of Small Island States in 2008, and subsequent pressure from those states and environmentalists, that helped realize the first mention of the 1.5°C target in the UNFCCC's 2010 Cancun Agreements. The architects of the Paris Agreement saw the SR15 as a critically important basis for greater ambition.

The work that produced SR15 was groundbreaking in a number of ways. Significantly, SR15 represents the first time the IPCC's three Working Groups have collaborated on a single report, forcing natural scientists, economists, geographers, and others to transcend disciplinary boundaries for a common cause. SR15 was also completed on a compressed timescale, finalized

just 18 months after Lead Authors first convened to discuss its outline. The report involved over 90 Coordinating Lead Authors, Lead Authors, and review editors, from 40 countries, assisted by 133 contributing authors. These authors assessed more than 6,000 references in their review of the scientific literature for SR15.

Key Messages from the Report

Perhaps the strongest message of the report, surprising even to those steeped in climate policy, was the stark difference between the beacon signals cast from two alternative not-so-distant shores: global warming targets of 1.5°C and 2°C. Three years ago, when governments committed to the 1.5°C aspirational goal, little was known about what risks would be avoided relative to 2°C of warming, or what the pathways toward that goal might look like.

As the report makes clear, 1.5°C of warming will have major impacts, including reaching critical ocean ecosystem thresholds and losing 70-90 percent of the warmer water coral reefs, for example. At the current rate of emissions, this is expected to happen within two or three decades.

But impacts are significantly higher in a 2°C warming scenario. The report finds that a 2°C, compared to a 1.5°C, target, would likely mean: twice as many land species losing their climatically-determined range; as much as two million square kilometers more of permafrost lost (over centuries), an average of twice as many people exposed to climate-related water stress (although spiking much higher in some regions); and several hundred million more people exposed to climate-related risks and more susceptible to poverty.

The IPCC offers a glimmer of hope amid the dire news. Another key message from SR15 is that limiting global warming to 1.5ºC is still possible; however, it will not be easy. By 2030—just over a decade away—anthropogenic CO2 emissions would need to drop by an unprecedented 45 percent and fall to net zero by 2050. That means reducing CO2 emissions from industry by 75-90 percent in 2050 relative to 2010. Most of the 1.5°C pathways that avoid overshoot (i.e., exceeding the target and then returning to it) involve the use of carbon dioxide removal (CDR) technologies on scales that may create problems of their own, and simply may not be achievable. They include uncertain and not yet mature technologies such as direct air carbon capture and storage and enhanced weathering and ocean alkalinisation, as well as afforestation and bioenergy, which require land use changes on an unprecedented scale and compete with other land uses and may significantly impact on agricultural and food systems, biodiversity and other ecosystem services. Pathways without CDR rely on scenarios that involve significant emission reductions through widespread behavioral changes in areas such as transport and energy use.

A more positive takeaway message from SR15 is the synergy between achieving sustainable development and limiting global warming to 1.5°C. Many of the pathways that achieve the 1.5°C target also help achieve the SDGs in critical areas like human health or energy access, where new technologies such as decentralized renewable energy systems and microgrids are transformative. The report also shows that combatting global warming reduces health risks from heatwaves, ozone pollution, and vector-borne diseases like malaria. There are risks and trade-offs, however, such as increased energy used for desalination in water-scarce regions and adverse impacts for economies that are tied to fossil fuel production. The report cautions that the uneven distribution of impacts underscores the need for international cooperation for a managed transition, conscious of equity concerns, lest the adverse impacts of climate change mitigation measures, like the adverse impacts of climate change itself, fall disproportionately on the poor and vulnerable.

Choppy Waters

Many IPCC members remarked on the unusually difficult review of the Summary for Policymakers (SPM) at IPCC-48. Much of the underlying tension was fed by spillover from unresolved issues in the UNFCCC process. One issue that fueled battles through the night on Friday and late into Saturday morning concerned whether the SPM should mention the Paris Agreement. Eventually, the Co-Chairs, in a move that had exhausted delegates reaching for never-opened rulebooks in the dying hours of the meeting, invoked the rules of procedure to address lack of consensus, and Saudi Arabia and Egypt registered reservations in the final meeting report.

The political sensitivities were further amplified by SR15's inevitable conclusion that limiting global temperature rise to 1.5°C would have radically different implications for different countries. For one delegate from a small island state vulnerable to sea level rise and tropical storms, charting a clear path to 1.5°C was a matter of "survival." For economies dependent on fossil fuels, the benefits of ambitious climate change mitigation have to be weighed against heavy losses in export revenues.

These tensions, coupled with the understanding that SR15 would constitute a powerful push towards more ambitious efforts within the UNFCCC process, played out in widely different visions of how the underlying science should be presented in the SPM. For example, the US and others wanted to see pathways to 1.5°C describing not just the share of renewables in the energy mix, but also shares of nuclear, gas, and fossil fuels with carbon capture and storage. Various European countries, including Germany, wanted a description of the precipitous decline of coal in that mix. Saudi Arabia and others wanted the difference in abatement costs between a 1.5°C and a 2°C target expressed as marginal costs, making the ambitious alternative look quite expensive. Through it all, the scientists and Co-Chairs were tasked with the challenge of ensuring that the final result accurately reflected the underlying assessment. While some of the elements in the SPM may have lost poignancy in the process, the urgent message of the science still shines through.

Charting the Course

SR15 is critically important to the UNFCCC's Paris Agreement. As planned, it arrives in time to feed into this December's Talanoa Dialogue, which will take stock of collective efforts to date. The report will also loom large as parties craft their new or updated pledges of climate action under the Paris Agreement—their nationally determined contributions (NDCs)—in the run up to the 2020 deadline. A special event during the Dialogue has been scheduled to consider the report and a keynote address will take place in the COP plenary.

SR15 will be used by many countries for different ends in the climate change negotiations. Small island states, for whom the report holds special significance, will wield it as powerful ammunition in the call for greater ambition in NDCs, and will urge greater efforts toward completing the Paris Agreement work programme at COP 24. Others will use the report's findings to underline that the costs of transition, especially in fossil-fuel dependent economies, are daunting, and international support for a just transition is necessary. The US will likely argue that the high costs of action identified in the report mean that other socially desirable investments are preferable to those combatting climate change.

The report also feeds into the process of producing IPCC's much-anticipated Sixth Assessment Report (AR6), and has fostered an abundance of research that will bolster AR6 treatment of a 1.5°C scenario. The strength of the research response to SR15 surprised even the authors, who initially worried that they would have limited literature to draw on—a reminder of the power of the IPCC process to drive research. While the timeline for SR15 has resulted in important gaps in areas such as terrestrial and ocean sinks, many will be addressed next year by two more special reports—on Climate Change and Land and on the Ocean and Cryosphere in a Changing Climate—that will benefit from more studies to assess.

SR15 will also play a key role in the pursuit of sustainable development and the SDGs, where its messages of synergies and trade-offs will resonate with the development community well beyond the corridors of climate change negotiations. The Panel was careful, in agreeing to the UNFCCC's request for the report, to place it in the context of "strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty." It will be an important bulwark for those arguing that climate action is compatible with, and necessary for, action on social imperatives such as poverty alleviation. But it also serves as a stark warning that trade-offs between them—which some delegations repeatedly warned will be difficult to avoid—must be properly managed to avoid far-reaching adverse impacts on such critical development priorities as food production, health, and poverty eradication.

The world's leading scientific authority on climate change has delivered a clear message on the vital importance of greater ambition; only immediate and pervasive course change on an unprecedented scale will allow us to stay below 1.5°C of global warming. But SR15's impact will depend on the world's response to that message; a lighthouse only has value if travelers actually heed its warning and turn the wheel to avoid shipwreck. Will the UNFCCC process be responsive? Will national governments redouble their efforts to raise ambition? It bodes well that the report has received unprecedented media coverage, with the NGO coalition Climate Action Network tracking over 2,400 news articles worldwide even before the launch of the report. All eyes now turn to Katowice, Poland, where UNFCCC parties will gather in December to take stock of efforts to date, and work to finalize the work programme that will allow the Paris Agreement to take effect in 2020. SR15's reception there will provide the first indication of the report's ultimate impact, although its significance as a clarion warning signal is already clear.

Upcoming Meetings

Private Investment for Climate Conference: The 2018 Green Climate Fund (GCF) Private Investment for Climate Conference is the only global conference on private investment for climate, and is expected to bring key players from the private sector together to explore innovative ways of investing in climate activities. **dates:** 10-11 October 2018 **location:** Incheon, Republic of Korea **contact:** GCF Secretariat **phone:** +82-32-458-6059 **fax:** +82-32-458-6094 **email:** info@gcfund.org **www:** https://gcfconference.com/

Seventh Conference on Climate Change and Development in Africa (CCDA-VII): This conference will convene under the theme, "Supporting the Implementation of the Paris Agreement in Africa: From Policies to Action," to examine Africa's Nationally Determined Contributions (NDCs) and define actionable climate interventions. The Conference, organized by the African Climate Policy Centre (ACPC), convenes each year under the auspices of the Climate for Development in Africa (ClimDev-Africa) Programme. ClimDev-Africa is a consortium of various African development institutions. **dates:** 10-12 October 2018 **location:** Nairobi, Kenya **contact:** African Climate Policy Center **email:** https://www.uneca.org/contact/African_Climate_Policy_Center **www:** https://www.uneca.org/ccda7

Third Global Conference on Health and Climate: This event aims to advance global action on climate change and health. It will focus on: empowerment of health leadership in island countries to integrate health into national climate change planning; evidence production through country profiles of climate change and health; implementation by building climate-resilient health systems; and provision of resources through facilitating access to climate and health financing mechanisms to support climate resilient health systems of island countries. This is the third in a series of WHO-organized conferences that have used an innovative, geographically dispersed approach. **dates:** 16-17 October 2018 **location:** St. George's, Grenada **www:** https://www.paho.org/

21st Meeting of the Green Climate Fund Board: The 21st meeting of the Board of the Green Climate Fund (GCF) follows the 20th meeting of the Board, which convened from 1-4 July and failed to agree on a number of decisions. **dates:** 17-20 October 2018 **location:** Manama, Bahrain **contact:** GCF Office of Governance Affairs **phone:** +82-32-458-6038 **fax:** +82-32-458-6094 **email:** info@gcfund.org **www:** https://www.greenclimate.fund/

2018 Arctic Circle Assembly: The annual Arctic Circle Assembly is the largest annual international gathering on the Arctic and is attended by heads of state and government, ministers, members of parliaments, officials, experts, scientists, entrepreneurs, business leaders, indigenous representatives, environmentalists, students, activists and others interested in the future of the Arctic. **dates:** 19-21 October 2018 **location:** Reykjavik, Iceland **contact:** secretariat@arcticcircle.org **www:** http://www.arcticcircle.org/assemblies/future

TFI—Fourth Lead Authors Meeting for the Elaboration of the 2019 Refinement: This will be the final Lead Authors meeting before the approval of the 2019 Refinement. The meeting will be preceded by a meeting of the Coordinating Lead Authors, Review Editors, and Steering Group on 21 October and followed by the 31st meeting of the TFI Bureau on 27 October. **dates:** 22-26 October 2018 **location:** Rome, Italy **contact:** IPCC Secretariat **phone:** +41-22-730-8208/54/84 **fax:** +41-22-730-8025/13 **email:** IPCC-Sec@wmo.int **www:** http://www.ipcc.ch

Pre-COP to the Katowice Climate Change Conference: The pre-COP will convene governments for political discussions in advance of the UN Climate Change Conference in December. Involvement of the private sector is also foreseen. **dates:** 24-27 October 2018 **location:** Krakow, Poland **contact:** Incoming COP 24 Presidency **email:** cop24@mos.gov.pl **www:** http://cop24.gov.pl/

Global Conference on Air Pollution and Health: The first Global Conference on Air Pollution and Health will consider the sub-theme, "Improving air quality, combatting climate change - saving lives." This event is being organized by the World Health Organization (WHO), in collaboration with UNEP, the WMO and the UNFCCC. **dates:** 30 October - 1 November 2018 **location:** Geneva, Switzerland **contact:** WHO **email:** aphconference@who.int **www:** http://www.who.int/airpollution/events/conference/en/

2018 CVF Virtual Climate Summit: The Climate Vulnerable Forum (CVF) will convene a global political leaders' summit to build increased support to safeguard those who are most

vulnerable to the impacts of climate change. Meeting ahead of UNFCCC COP 24, the Summit will highlight new national efforts; share perspectives on climate risks and opportunities to be gained by following a1.5°C pathway in terms of health, jobs and other benefits, while building wider international support. It will also help ensure that the necessary resources and finance are delivered to make this possible. **date:** 22 November 2018 **location:** virtual **contact:** Marshall Islands CVF Presidency **phone:** +692-625-2233/3445 **fax:** +1 212 9833202 **email:** info@thecvf.org **www:** https://thecvf.org/events/2018-cvf-virtual-summit/

Katowice Climate Change Conference: The Katowice Climate Change Conference includes COP 24, along with meetings of the COP serving as the Meeting of the Parties to the Kyoto Protocol, the Subsidiary Body for Scientific and Technological Advice, the Subsidiary Body for Implementation and the COP serving as the Meeting of the Parties to the Paris Agreement. **dates:** 2-14 December 2018 **location:** Katowice, Poland **contact:** UNFCCC Secretariat **phone:** +49-228-815-1000 **fax:** +49-228-815-1999 **email:** secretariat@unfccc.int **www:** https://unfccc.int/cop24/ and http://cop24.katowice.eu/ and http://cop24.gov.pl/

WG I - AR6 2nd Lead Author Meeting: This meeting will convene in Canada. **dates:** 7-13 January 2018 **location:** Vancouver, Canada **contact:** IPCC Secretariat **phone:** +41-22-730-8208/54/84 **fax:** +41-22-730-8025/13 **email:** IPCC-Sec@wmo.int **www:** http://www.ipcc.ch

WG II - AR6 1st Lead Author Meeting: This meeting will convene in South Africa. **dates:** 21-25 January 2018 **location:** Durban, South Africa **contact:** IPCC Secretariat **phone:** +41-22-730-8208/54/84 **fax:** +41-22-730-8025/13 **email:** IPCC-Sec@wmo.int **www:** http://www.ipcc.ch

WG I/II/III – Fourth Lead Authors Meeting on the Special Report on Climate Change and Land: This meeting is being organized by WG III. **dates:** 11-15 February 2018 (TBC) **location:** TBA **contact:** IPCC Secretariat **phone:** +41-22-730-8208/54/84 **fax:** +41-22-730-8025/13 **email:** IPCC-Sec@wmo.int **www:** http://www.ipcc.ch

2nd Latin American Symposium on Climate Change Adaptation: This event aims to foster climate resilience in Latin America by showcasing replicable experiences from research, field projects, and best practice. The symposium aims to: provide scholars, practitioners, and members of governmental agencies undertaking research and/or executing climate change projects in Latin America with an opportunity to present their work; foster information exchange; discuss methodological approaches and experiences deriving from case studies and projects; and provide a platform for networking and exploring possibilities for cooperation. The International Climate Change Information Programme (ICCIP), with international and local partners, is organizing the symposium. **dates:** 20-21 February 2019 **location:** Lima, Peru **contact:** Svenja Scheday, ICCIP **email:** svenja.scheday@haw-hamburg.de **www:** https://www.haw-hamburg.de/en/ftz-nk/events/latinamerica2019.html

WG III – AR6 First Lead Author Meeting: This meeting will take place in a location to be determined. **dates:** 1-5 April 2018 (TBC) **location:** TBA **contact:** IPCC Secretariat **phone:** +41-22-730-8208/54/84 **fax:** +41-22-730-8025/13 **email:** IPCC-Sec@wmo.int **www:** http://www.ipcc.ch

Second Synthesis Report Scoping Meeting: This meeting will take place in a location to be determined. **dates:** 8-14 April 2018 (TBC) **location:** TBA **contact:** IPCC Secretariat **phone:** +41-22-730-8208/54/84 **fax:** +41-22-730-8025/13 **email:** IPCC-Sec@wmo.int **www:** http://www.ipcc.ch

IPCC-49: This meeting will approve the 2019 Refinement to the 2006 National GHG Inventories. **dates:** 8-12 May 2018 **location:** Kyoto, Japan **contact:** IPCC Secretariat **phone:** +41-22-730-8208/54/84 **fax:** +41-22-730-8025/13 **email:** IPCC-Sec@wmo.int **www:** http://www.ipcc.ch

For additional meetings, see: http://sdg.iisd.org/

Glossary

2019 Refinement	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
AFOLU	Agriculture, forestry and other land use
AR5	Fifth Assessment Report
AR6	Sixth Assessment Report
ATG-Finance	*Ad Hoc* Task Group on the Financial Stability of the IPCC
BECCS	Bio-energy with carbon capture and storage
CCS	Carbon capture and storage
CDR	Carbon dioxide removal
CO2	Carbon dioxide
COP	Conference of the Parties
FGD	Final Government Draft
GDP	Gross domestic product
GHG	Greenhouse gases
GMST	Global mean surface temperature
IPCC	Intergovernmental Panel on Climate Change
LDCs	Least developed countries
NDC	Nationally Determined Contribution
RFCs	Reasons for Concern
SDGs	Sustainable Development Goals
SLCFs	Short-lived climate forcers
SPM	Summary for Policymakers
SR	Special Report
SR15	Special Report on Global Warming of 1.5 ºC
SRCCL	Special Report on Climate Change and Land
SRM	Solar radiation management
SROCC	Special Report on the Ocean and Cryosphere in a Changing Climate
SYR	Synthesis Report
TFI	Task Force on National Greenhouse Gas Inventories
TG-FWLGST	Task Group on the Organization of the Future Work of the IPCC in Light of the Global Stocktake
TSU	Technical Support Unit
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WG	Working Group
WMO	World Meteorological Organization