INTERGOVERNMENTAL PANEL ON climate change

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**SIXTH ASSESSMENT REPORT (AR6) PRODUCTS**

# Outline of the Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty

Information note on the organization of the scoping meeting

(Submitted by the Secretary of the IPCC)

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greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty".

## 8. ANNOTATED OUTLINE OF CHAPTERS FROM SCOPING MEETING

The following text provides additional information on the annotated Special Report outline and reflecting BOG3 and the final plenary discussions, as synthesized by the chairs of each BOG3 group.

### CHAPTER 1: Framing and context

*Summarized by Valérie Masson-Delmotte and Thelma Krug*

- Understanding 1.5°C; reference levels, probability, transience, overshoot, stabilization
- 1.5°C in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty, with consideration for ethics and equity
- Key concepts central to understanding the report
- Building on AR5: new information, integrative approaches, response options: opportunities and challenges
- Assessment and methodologies across spatial and time scales and treatment of uncertainty
- Storyline of the report

Chapter 1 will frame the Special Report and the challenges associated with global warming of 1.5°C and associated global emission pathways.

The first bullet is related to the concept of global warming of 1.5°C and its interpretation, in relationship to reference temperature levels (pre-industrial climate, observations and current state of the climate system and level of warming), considering climate variability/natural fluctuations, anthropogenic warming and uncertainties in relationship between pathways and climate responses. A discussion relative to higher stabilization levels enables the evaluation of "avoided impacts". The concept of “overshoot” and its implications will also be discussed (duration, amplitude etc.).

The second bullet introduces the multi-dimensional approach to this special report, in relationship to the responses to climate change, including the Sustainable Development Goals and considerations of ethics and equity.

Since the impacts of global warming of 1.5°C and GHG emission pathways need to be addressed in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty, a broader range of literature than used before in IPCC assessments from the social sciences will be required, including in relation to the objectives of Sustainable Development.

The third bullet will introduce the key concepts required for the reader of the Special Report. These need careful cross-checked with the authors of other chapters, given the highly interdisciplinary nature of the report and to ensure that all key concepts are introduced upfront.

The fourth bullet expresses the expectation to provide a brief summary on key related Fifth IPCC Assessment Report (AR5) findings and gaps, an update of "where we are now": an update on the current status of human influence on the climate system and status of the climate system. A general overview of the new information that has emerged from the literature since the AR5 is introduced. The framework of this special report is introduced that will be built across Working

Groups and scientific disciplines, providing integrative approaches and a balanced assessment of opportunities and challenges associated with the impacts and response options. The chapter will also include a discussion of outstanding challenges and the development of additional research to be assessed more comprehensively in the Sixth IPCC Assessment cycle.

The fifth bullet reflects the requirement to describe the adopted perspectives on spatial and temporal scales in the special report chapters, as well as the methodologies for assessing probabilities and uncertainties.

Finally, the sixth bullet introduces the narrative for the Special Report and will explain the logic of the proposed flow of chapters in this Special Report.

**CHAPTER 2: Mitigation pathways compatible with 1.5°C in the context of sustainable development**

*Summarized by Jan Fuglestvedt and Fu Sha*

- Methods of assessment and assumptions in the literature
- Constraints on and uncertainties in global greenhouse gas emissions and other climate drivers for limiting warming to 1.5°C
- Characteristics of mitigation and development pathways compatible with 1.5°C, compared to 2°C and higher as relevant, including short and long term, sectorial, regional, demand/supply-side; technological and socio-economic implications etc.
- Technological, environmental, institutional and socio-economic opportunities and challenges related to 1.5°C pathways

The first bullet serves to outline the framing of the chapter and how it approaches the topic of mitigation pathways and sustainable development. Breakout group and plenary discussions indicated that approaches to assessing mitigation pathways should be comprehensive, considering results from a broad set of models/model types and integration of top-down and national/sectoral bottom-up studies as well as case studies. The discussions also emphasized the need for clear communication of assumptions and choices, data, methods, model type, etc., that have been adopted by the assessed studies available in the peer-reviewed literature. Moreover, the framing of the chapter should introduce how the assessment is carried out with respect to selection and treatment of the available studies and scenarios. It should also explain the perspectives on spatial and temporal scales of the pathways and responses of the climate system, connected to the discussions of scales in Chapter 1.

The second bullet covers an update of relevant knowledge about the state and behavior of the climate system, and the resulting physical constraints on future pathways consistent with 1.5°C and 2°C. It implies a focus on climate sensitivity (Equilibrium Climate Sensitivity (ECS) and Transient Climate Sensitivity (TCR)) and the carbon cycle, sources, sinks, concentration levels and trends of gases and aerosols, carbon budgets, radiative forcing from $CO_2$ and non-$CO_2$ drivers (including short-lived climate forcers/aerosols, land use albedo), and the related uncertainties. In addition, potential responses of the Earth system to overshoot pathways should be assessed, including responses to net negative emissions. The discussions also pointed to the need for assessing how different definitions and interpretations of the 1.5°C and 2°C ambitions (in Chapter 1) will affect the mitigations pathways and their characteristics.

The next bullet addresses the need for assessing and explaining the broad set of characteristics of mitigation pathways, in the context of development pathways. The assessment can consider the level of collective mitigation ambition associated with climate stabilization to 1.5°C and 2°C as well as other pathways and reference levels of collective mitigation ambition when relevant, including incremental policy scenarios reflecting current levels of ambition. The chapter will need

to consider both overshoot and non-overshoot pathways as available in the literature. The importance of assessing the mitigation pathways on both global and regional scales was pointed out. The description of these pathways will need to cover energy use, land use, agriculture and food systems, different technologies and the various emissions by sector, and will assess the technological and socio-economic implications. The need for consideration of timescales of action, emissions levels and climate responses, timing of net zero emissions, including the interdependence between short- and long-term action and between extent of overshoot and end of century emissions levels, was emphasized. There is also a specific request from the UNFCCC to provide a 2030 emissions level for 1.5°C. The assessment should focus on sectors and across sectors and consider both demand- and supply-side. The discussion pointed to the importance of distinguishing the two concepts of "being consistent with 1.5°C" and "being required for 1.5°C" in the assessment of pathway characteristics.

The final bullet covers the aspects of mitigation pathways that go beyond the purely quantitative modeling approaches for which other types of studies are available in the peer-reviewed literature. This part of the chapter will also constitute a bridge to the assessments in the following chapters. It should consider the enabling conditions and constraining factors related to achieving 1.5°C and 2°C pathways, such as technical and political opportunities and challenges, as well as implementation requirements and costs, including distribution of costs. A balanced assessment is expected to address both opportunities and challenges in key dimensions. Those include issues around lock-in to particular technologies in the near term, socio-economic-environmental benefits and risks of rapid phase-out of fossil fuels, benefits and risks related to specific technologies (such as carbon dioxide removal technologies), and co-benefits and trade-offs with sustainable development goals, especially those related to equity, poverty, affordable energy and food security. Institutional /political risks and opportunities are key for a more insightful and comprehensive understanding of the mitigation options and will constitute a link to the following chapters.

In order to enable the required close collaboration between authors of this chapter and those from other chapters, one possibility could be introduction of a new type of "bridging authors", with specific responsibility for interaction and consistency with other chapters, either for specific cross-cutting issues, or related to the chapter as a whole.

**CHAPTER 3: Impacts of 1.5°C global warming on natural and human systems**

*Summarized by Carolina Vera, Wolfgang Cramer and James Ford*

- Methods of assessment.
- Observed and attributable global and regional climate changes and impacts and the adaptation experience.
- Key global and regional climate changes, vulnerabilities, impacts, and risks at 1.5°C, including adaptation potential and limits.
- Avoided impacts and reduced risks at 1.5°C compared to 2°C and higher as relevant.
- Timeframe, slow vs. fast onset, irreversibility and tipping points.
- Implications of different mitigation pathways for reaching 1.5°C, including potential overshoot for impacts, adaptation and vulnerability.

The main objective of the chapter is to provide a concise account of existing knowledge about impacts of 1.5°C of warming over preindustrial levels, and adaptive capacity to manage such change, covering all world regions and all sectors. Impacts may be associated with the impacts of environmental change associated with greenhouse gas emissions consistent with 1.5°C, or impacts of mitigation of higher levels of climate change. Besides evaluating the emerging literature on 1.5°C, the chapter will also infer impacts from a consideration of the "mid-point" between current warming and impacts expected for 2°C.

The first bullet introduces the structure of the chapter and how the key concepts (e.g., impact, risk, vulnerability, adaptation) will be addressed. The scoping discussion highlighted the relevance of including the description of the most relevant methods of assessment, like those related with confidence, likelihood, reference to present-day as well as to "2°C warming and higher", etc. The basis of the chapter assessment will be AR5 plus any updates in scientific knowledge available.

The second bullet includes an integrated assessment of the observed and attributable climate changes and impacts, and the adaptation experience at both global and regional scales. In particular, the discussion pointed out the importance of including explicitly the perspective of impacts caused by extreme events and adaptation options available to them.

The third bullet provides an integrated assessment of the key climate changes, vulnerabilities, impacts and risks at 1.5°C above preindustrial. The scoping discussion recommended addressing both global and regional scales. Also, as in the previous bullet it is suggested to explicitly assess the issue of extreme events. Key climate changes refer those of the physical climate, as well as of both natural and human systems and their interactions. The bullet includes the assessment of adaptive capacity and limits in natural and human systems.

Regarding the assessments recommended in both second and third bullets, the discussion concluded that providing them in such integrated framework will facilitate the communication and understanding. There was concern about the large amount of the physical, natural and human information that such assessments include and thus the challenge to prioritize the key aspects. In particular, the discussion suggested the use of case studies to facilitate and complement the assessment. Case studies can be selected according to either both ecological and geographical aspects.

The fourth bullet focuses on assessing the avoided impacts and reduced risks at 1.5°C compared to 2°C and higher as relevant. It will be necessary to consider the possible extent of these differences and whether the temporal and spatial scales of impacts at 1.5°C can reliably be distinguished from those at 2°C.

The fifth bullet relates to timeframe, slow versus rapid onset[1] of impacts of 1.5°C, their irreversibility and the potential of tipping points.

The sixth bullet addresses the implications of different mitigation pathways for reaching 1.5°C for impacts, vulnerability and adaptation. It includes also the consequences of potential overshoot.

**CHAPTER 4: Strengthening the global response to the threat of climate change**

*Summarized by Aromar Revi and Frank Geels*

- Assessing current and emerging adaptation and mitigation options and associated opportunities and challenges
- The pace of the development and deployment of mitigation and adaptation options compared to pathways consistent with sustainable development and 1.5°C

[1] Slow onset events include sea level rise, increasing temperatures, ocean acidification, glacial retreat and related impacts, salinization, land and forest degradation, loss of biodiversity and desertification (Decision 1/CP.16. paragraph 25, footnote 3). A rapid onset event may be a single, discrete event that occurs in a matter of days or even hours, as defined by UNFCCC (FCCC/TP/2012/7).

- The potential and capacity for development and deployment of adaptation and mitigation responses to accelerate transitions and strengthen the global response to the threat of climate change within and across relevant scales and systems
- Challenges to and opportunities from strengthened response options (e.g. current & future lock in, adaptive mitigation, consumption and production, negative emissions, food production, socio-economic); synergies and trade-offs among adaptation & mitigation options

This chapter is aimed at identifying high-priority opportunities and assessing the set of current and emerging options for limiting warming to 1.5$^{o}$C and adaptation options related to that level of warming. It will limit its assessment to opportunities in alignment with strengthening the global response to climate change consistent with 1.5$^{o}$C warming. In doing so, it provides a logical link between: an assessment of 1.5$^{o}$C compatible mitigation and sustainable development pathways (Ch.2); the potential and avoided impacts of 1.5$^{o}$C warming on human and natural systems (Ch.3); and options for implementation (Ch.5). It seeks to identify systemic processes and factors that can enable accelerated transitions to 'bend the curve' towards global and regional climate-resilient development pathways and their consequent synergy with poverty eradication, reducing inequality and sustainable development (Ch. 5).

Like other chapters, this chapter will build on and go beyond AR5, with an assessment of the pace of development and deployment of emerging and current supply-side (e.g. renewables and negative emissions) and demand-side (e.g. energy efficiency, behaviour change, demand modification) mitigation response options that are consistent with 1.5$^{o}$C warming and sustainable development pathways. It will do so within and across key systems (e.g. energy, urban and regional, transport); at global, regional and local levels; and across various stakeholders, agents and coalitions. This will enable the identification of technological, economic and financial, governance, institutional and policy, social and no-cost, and environmental barriers, challenges, opportunities and co-benefits with sustainable development to strengthen the global response to climate change. It will also attempt to address relevant lock-in, sustainable consumption and production and food production concerns.

The chapter will also assess the pace of development and deployment of regional and global adaptation options in the context of: the dynamics of 1.5$^{o}$C consistent mitigation pathways - their potential uncertainty, transience, overshoot and stabilisation; exposure and vulnerability and known adaptation potential and limits. It will do so across key systems, levels and stakeholders. This will enable the identification of technological, economic and financial, governance, institutional and policy, social and no-cost, and environmental barriers, challenges, opportunities and co-benefits with sustainable development - to accelerate transformative adaptation and adaptive mitigation.

It will also examine the potential synergy and trade-off between 1.5$^{o}$C consistent mitigation and adaptation options and their potential to constrain or strengthen the global response to climate change. In summary, it provides the bridge between 1.5$^{o}$C impacts, emission and mitigation pathways and approaches to implementation and convergence with sustainable development.

**CHAPTER 5: Approaches to implementing a strengthened global response to the threat of climate change**

*Summarized by Bronwyn Hayward and Joyashree Roy*

The principal rationale for this chapter is to gather and assess the best available policy relevant knowledge from the available literature, including existing options and case studies, on what is known about the methods and approaches to implementation of possible mitigation and adaptation options, consistent with a strengthened global response to limit warming to 1.5$^{o}$C

above pre-industrial levels and related global greenhouse gas emission pathways, in the context of sustainable development and efforts to eradicate poverty. The chapter thus follows logically on an assessment of possible emissions pathways (Chapter 2), potential impacts of 1.5°C warming (Chapter 3), and the identification of priority mitigation and adaptation opportunities (Chapter 4) that could limit warming to 1.5°C. This chapter then would focus on existing mechanisms and on what is known about potential alternative implementation options and approaches through which the strengthened global response could be realized. To the extent the available literature allows, the chapter should assess how possible implementation approaches would impact the achievement of near-term (through 2030) sustainable development targets, and affect sustainable development pathways beyond 2030.

Drawing primarily on policy-related literature, the first bullet implies that this chapter examine the extent to which policy mechanisms, tools and approaches currently already deployed achieve emission reductions and meet adaptation needs consistent with warming kept to 1.5°C and assess current understanding of the opportunities and challenges associated with emerging and established adaptation and mitigation methods and approaches.

The second bullet is intended to go beyond already deployed, codified policy mechanisms, and look across relevant bodies of social science literature (e.g., policy sciences as well as behavioral, psychological, anthropological, economic, geographical, technology-focused disciplines and related fields) and published reports of practical experience to identify and critically assess the capacity, opportunity, costs and challenges associated with other ways to implement rapid and/or deep social changes consistent with the potential impacts of and emissions pathways to 1.5°C. The chapter should explore

- The role of various societal actors at different scales (individual, local, regional, national, global) and across levels of governance (incl. international cooperation)
- The opportunities and challenges with integration (e.g. private, government, civil society, partnerships, cross-sector)
- The range and design of possible tools, actions, processes, and programs available for implementing a strengthened global response
- The pace of the development and deployment of possible implementation mechanisms, including capacity needs, and the potential for acceleration and learning
- The possibilities of achieving far-reaching, equitable and sustained change through inclusive mobilization, social acceptance, and transparency
- The elements of a conducive enabling environment (e.g. social, educational, financial, institutional factors, the media); including synergies and trade-offs among adaptation & mitigation options

What is known about the opportunities for effective implementation of far-reaching and rapid change initiatives must be placed in the context of what is known about the potential implications of undertaking such initiatives, including the social, ecological, economic implications. The chapter should clearly articulate and assess the challenges involved in realizing a strengthened global response, including the challenges of reconciling near-term priorities and longer-term implications, as well as dealing with trade-offs.

The last bullet points to a critical need for this chapter: to illustrate with case examples from across the world, what policy-relevant (not policy-prescriptive) lessons have been learned about how to implement change initiatives and knowledge about whether these options can be implemented rapidly and how they have been brought to scale. While critically assessing what is possible, based on the available evidence, the chapter should respond to the communicative need for examples of successful implementation of change initiatives, providing evidence of context-sensitive, diverse approaches taken across different contexts. Discussants were of the

view that there is no “one size fits all” approach to implementing initiatives that – cumulatively – constitute the strengthened global response.

In order to contain this chapter, authors should focus on the options, challenges, trade-offs and potential synergies of implementing mitigation and adaptation options closely associated with the potential impacts of and mitigation pathways to 1.5°C and other sustainability goals.

**CHAPTER 6: Sustainable development, poverty eradication and reducing inequalities**

*Summarized by Guy Midgley and Petra Tschakert*

- Linkages between achieving SDGs and 1.5°C
- Equity and ethical dimensions
- Opportunities, challenges, risks, and trade-offs
- Positive and negative impacts of adaptation and mitigation measures including response measures and strategies, economic diversification, livelihoods, food security, cities, ecosystems, technologies
- Knowledge and experience from local to global, including case studies and integrated planning as relevant to aforementioned bullets
- Climate-resilient development pathways

The first bullet explores the multidimensional linkages between the 17 Sustainable Development Goals (SDGs) (169 targets, minus the ones specific to SDG 13) and keeping the global warming to 1.5°C, including both small and significant as well as positive and negative impacts on the SDGs. The group proposed guiding authors to develop a comprehensive table or matrix that could illustrate the synergies and trade-offs between the two goals (e.g. some SDGs would be enhanced while others are likely to become more difficult to achieve for pathways compatible with 1.5°C warming). This table could also encompass a regional approach. The group drew attention to the different timelines of the goals and proposed to consult the Zero Poverty – Zero Emissions report that attempted a similar comparison.

The second bullet draws attention to the ethical and equity dimensions of efforts to limit warming to 1.5°C. This includes the potential erosion of a country’s right to development, especially from the perspective of Least Developed Countries (LDCs). The group agreed that it would be essential to synthesize other emerging dimensions on ethics and equity from the preceding chapters of the Special Report (SR). The group underscored the importance of equity as a goal that indeed can be reached, in contrast to equality which is likely to remain elusive.

The third bullet examines opportunities, challenges, risks, and trade-offs between limiting global warming to 1.5°C on the one hand and pursuing sustainable development and efforts to eradicate poverty on the other hand, while also reducing inequalities. The group drew attention to the different development pathways that individual countries and regions were pursuing, including different starting points as well as going in different directions, at a different pace, with distinct modes of development as overarching guidelines.

The fourth bullet examines specifically positive and negative impacts of climate policies and other measures for mitigation and adaptation. The group discussed various areas of major importance and opted for those now listed under the proposed bullet point (with ‘response measures and strategies’ added in the plenary), although these are not meant to be exclusive. The proposed areas are most likely to have relevant literature.

The fifth bullet is to be seen as a methodological priority. Multiple types of knowledge and (lived) experiences across all scales will need to be taken into account to adequately address the two previous bullets. The type of evidence to be considered here includes ‘bottom-up knowledge’

(ways of knowing) but is not limited to it. Much evidence will be contained in case studies, from local to regional and global, as well as integrated planning efforts.

The last bullet closes the arc that the SR opens in Chapter 1 and lays out options and barriers for climate-resilient development pathways.

## 9. TIME SCHEDULE

A call for nominations of Coordinating Lead Authors, Lead Authors and Review Editors will be issued after the 44th Session of the IPCC in October 2016. Approval and acceptance of the Special Report is planned for the 48th Session of the IPCC in September 2018. In order to achieve this, the timetable for the Special Report is as follows:

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| 31 October - 27 November 2016 | Call for author nominations |
| 29 January 2017 | Selection of authors |
| 6-12 March 2017 | 1st Lead Author Meeting |
| 5-11 June 2017 | 2nd Lead Author Meeting |
| 31 July - 24 September 2017 | First Order Draft Expert Review |
| 23-29 October 2017 | 3rd Lead Author Meeting |
| 5 January - 25 February 2018 | Second Order Draft Expert and Government Review |
| 9-15 April 2018 | 4th Lead Author Meeting |
| 4 June - 29 July 2018 | Final Government Review of Summary for Policymakers (SPM) |
| 24-30 September 2018 | IPCC acceptance/adoption/approval |