

SIXTY-FIRST SESSION OF THE IPCC
Sofia, Bulgaria, 27 July – 2 August 2024

IPCC-LXI/Doc. 7. Add.1
(4.VII.2024)
Agenda Item: 6
ENGLISH ONLY

**OPTIONS FOR EXPERT MEETINGS AND WORKSHOPS FOR THE SEVENTH ASSESSMENT
CYCLE**

Expert Meeting on High Impacts and Tipping Points

(Prepared by the Co-Chairs of the IPCC Working Groups)

(Submitted by the Secretary of the IPCC)

OPTIONS FOR EXPERT MEETINGS AND WORKSHOPS FOR THE SEVENTH ASSESSMENT CYCLE

Expert Meeting on High Impacts and Tipping Points

Rule 7.1 on IPCC Workshops and Expert Meetings in the Appendix A to the Principles Governing IPCC Work establishes, inter alia, that “IPCC Workshops and Expert Meetings are those that have been agreed upon in advance by an IPCC Working Group, or by the Panel as useful or necessary for the completion of the work plan of a Working Group, the Task Force on National Greenhouse Gas Inventories or a task of the IPCC. Only such activities may be designated as “IPCC” Workshops or Expert Meetings. Their funding should include full and complete provision for participation of experts from developing countries and countries with economies in transition. [...]

An IPCC Expert Meeting focuses on a specific topic bringing together a limited number of relevant experts. The relevant Working Group/Task Force Bureaux, or the IPCC Chair, will identify and select participants to Expert Meetings.”

The topic of “High-impact events and tipping points” remains associated with large uncertainties and was addressed separately and to varying extents by the Working Groups (WG) during the Sixth Assessment Cycle. More detailed information and consensus is needed for assessing and responding to the risk associated with abrupt changes and threshold behavior in the climate system and cascading effects. This knowledge gap was also mentioned in the Global Stocktake Synthesis Report, and highlighted in government submissions on priorities for the Seventh Assessment Cycle (IPCC-LX/INF. 7, Rev.1).

Noting the specific nature of the topic, the recent growth in literature and the wide range of views in the scientific communities, as well as the urgency to address this in preparation for a consistent and comprehensive assessment in AR7, this proposal is to hold an Expert Meeting ahead of the AR7 start.

As coordination of this topic with the international climate science community is of high relevance, and since high-risk events are identified as a [key topic](#) by the World Climate Research Program (WCRP), this Expert Meeting is planned to be organized with the partial support of the WCRP. The proposal for an Expert Meeting on High Impact Events and Tipping Points contained in Annex 1 has been prepared jointly by the Co-Chairs of Working Groups I, II and III with the support of their respective Bureaux and the WCRP, under the leadership of WGI.

ANNEX 1

Proposal for an IPCC Expert Meeting on High-Impact Events and Tipping Points

1. Context

Earth System high-impact events and tipping points can induce substantial, impactful and potentially irreversible changes in the climate system, ecosystems or human systems. The IPCC Sixth Assessment Report (AR6) Glossary defines a “tipping point” as “*a critical threshold beyond which a system reorganizes, often abruptly and/or irreversibly.*” The nonlinearity of the underlying system typically creates this behavior. In mathematical terms, tipping points are well described by dynamical systems theory when the system has two stable states and an external parameter drives an abrupt change of state.

The AR6 Working Group I (WGI) has assessed tipping points in the Earth system, such as a potential collapse of the Atlantic Meridional overturning circulation and its possible consequences, abrupt changes in weather patterns and the water cycle, as well as strongly increased Antarctic ice sheet melt, and forest dieback. While the associated uncertainty is generally very high, there is also high confidence that such events cannot be ruled out and that they would cause severe consequences. Therefore, such events are essential to consider from a societal/ecological perspective. The recent IPCC AR6 Report has also highlighted the potential for unpredictable and unprecedented extreme events and outcomes. Major and sudden high impacts can also arise from co-occurring large-scale severe extreme events such as drought compounded by heat with potentially irreversible consequences on the land surface due to vegetation and societal responses. Also, concurrent extremes happening at different locations could lead to non-linear increases in impacts, for instance if all breadbasket regions of the world are affected concurrently by climate extremes, potentially impacting global food security (SRCCL; WGI AR6 Chapter 11).

Tipping points also exist in ecosystems, such as warm water corals and forest ecosystems. Recent review papers have analyzed tipping elements and highlighted their consequences, including on the carbon cycle. The impacts of climate tipping points require specific attention, including possible adaptation measures and preparedness and issues of governance. They can create large-scale disruptions such as, for instance, on food production, or water resources, with cascading effects on humans and ecosystems. Lastly, although not as widely researched, the application of the tipping points concept to analyze processes of nonlinear change in human systems has been increasingly debated in recent years ([Milkoreit, 2022](#)).

The Earth system has undergone tipping point crossings in the past, from rapid changes in the Earth's history to severe extreme events in more recent periods, with consequences on the biosphere and humans. These past examples call for a systemic vision and understanding of climate-ecosystem thresholds, feedbacks, multiple time scales involved and resilience to face such transitions. However, the occurrence of abrupt changes linked to tipping points that could occur under the current extent and rate of human-induced climate change are difficult to constrain based on paleoclimate data because of the unprecedented nature of on-going climate change. It is thus also difficult to assess if some tipping points may already have been crossed or are close to being crossed.

In response to a call to governments to identify priorities and products for the Seventh Assessment Cycle in October 2023, many countries highlighted tipping points and low-likelihood, high impacts (LLHI) events as an important issue to cover, including 18 countries suggesting a Special Report dedicated to topics related to tipping points (IPCC-LX/INF. 6, Rev.1), underscoring the high relevance of this topic. The Panel decided not to have any additional Special Report beyond the Climate Change and Cities Special Report. However, the subject remains essential to characterize climate risk relevant for adaptation and mitigation strategies, and with abundant literature being produced, it is anticipated that this topic will be considered in the AR7 WGs Reports.

There are, however, different views on what exactly is covered by “tipping points”, in the perception of their importance for climate risk, and in the way to communicate scientific knowledge and uncertainties to the public and media ([Stocker et al., 2024](#)). There is also uncertainty in the extent to which Earth system models can resolve tipping point risks or processes of relevance for some global tipping points (e.g. [Liu et al. 2023](#)).

An Expert Meeting would take stock of all these developments and range of views, work towards consensus building on how to best evaluate risk of high impact events and tipping points, encourage scientific exploration of this topic and publications to inform the AR7, and prepare recommendations for the assessment in each WG of the AR7, including on ways to ensure effective common understanding and communication across WGs.

Ongoing challenges related to these topics are:

- Lack of homogeneity on what definitions of what high impact events and tipping points cover across all Working Groups;
- Lack of homogeneity on definitions on the thresholds on all Working Groups;
- Uncertainty of tipping points in relation to timing and global warming levels;
- Uncertainty in the scale and intensity of (possibly compound) extreme events in the near term and the cascading effects of climate tipping points in ecosystems and human systems;
- Lack of early warning indicators for systems at risk of irreversible change or tipping, and potential adaptive/mediating action;
- Limits of adaptation measures to cope with high impact events and tipping points, highlighting adaptation to irreversible changes;
- Lack of adaptation and mitigation policies taking sudden and/or irreversible high-impact events into account.

2. Progress during the Sixth Assessment Cycle, and previous cycles

Even though high-impact or abrupt events were not always approached in the framework of “tipping points”, IPCC has addressed this topic since its third cycle. One of the reasons for concern, established during the Third Assessment Report (TAR) and since used to communicate aggregate risk at different global warming levels, refers to “future risk from large scale discontinuities”.

In the TAR WGI Assessment, potential “*Rapid climate change*” was identified as arising from nonlinearity, creating possible “*surprises in the climate system*”, or “*abrupt events*”, as what has been observed during the last glaciation. Two examples cited are “*a possible reorganization of the thermohaline ocean circulation in the North Atlantic resulting in a more southerly course of the Gulf Stream, which would have a profound influence on the climate of Western Europe, a possible reduction of upper-level ocean cycling in the Southern Ocean, or a possible but unlikely rapid disintegration of part of the Antarctic ice sheet with dramatic consequences for the global sea level*”.

The future fate of monsoons under different ENSO influences could be reassessed. The Fourth Assessment Report (AR4) re-assessed this topic with focus largely on these two examples, emphasizing that while some outcomes are unlikely they cannot be excluded. The WGI Fifth Assessment Report (AR5 WGI) addressed tipping points more generally, together with irreversibility more specifically. It identified the irreversible changes in all climate system impacts but reported the fact that the studies were not really numerous at that time to warrant a deeper consensus finding process during the Fifth Assessment Cycle. The potential of rapid ice loss, and a sustained decline in the AMOC were mentioned in the Summary for Policymakers but highlighted as highly uncertain. In contrast, extreme events have been highlighted as a climate risk across Assessment Reports, focusing on change in intensity and frequency. AR5 WGII assessed that with rising temperatures, certain physical systems or ecosystems could face abrupt and irreversible changes, with risks increasing with global warming level. Dieback and degradation in the boreal forests and the Amazonian rainforest were identified as potential tipping elements in the Earth's system due to their

extensive size and potential feedback with the carbon cycle. WGII AR5 assessed that although regional-scale ecosystem tipping points have not been observed in recent history, there is substantial evidence of their occurrence in the distant past, raising concerns that they could happen in the near future. In the socio-ecological systems, reducing the risk of reaching tipping points due to climate change can be achieved by maintaining ecosystem services through controlling the extent and pace of climate change, alleviating additional pressures like overgrazing, overfishing, habitat destruction, and pollution.

The Sixth Assessment Cycle gave a significant focus on tipping points as a topic by itself. The Special Report on Global Warming of 1.5°C (SR15) first identified a list of potential tipping points that bear enhanced risks for either the climate system, ecosystems or human systems (SR15, Chapter 3, Table 3.7). The risk of crossing critical thresholds associated with those tipping points were assessed for different warming levels, highlighting in particular the lower risk for a global warming level of 1.5°C relative to others. The Special Report on Oceans and Cryosphere had a dedicated chapter assessing extremes and abrupt or irreversible changes in the ocean and cryosphere in a changing climate, to identify regional hot spots, cascading effects, their impacts on human and natural systems, and sustainable and resilient risk management strategies. The possibility of critical thresholds associated with tipping points, and, more generally, the possibility of “low-likelihood, high-impact events” was also recognized in the WGI Report: *“Low-likelihood, high-impact outcomes could occur at global and regional scales even for global warming within the very likely range for a given GHG emissions scenario. The probability of low-likelihood, high-impact outcomes increases with higher global warming levels (high confidence). Abrupt responses and tipping points of the climate system, such as strongly increased Antarctic ice-sheet melt and forest dieback, cannot be ruled out (high confidence).”* A specific box in the Technical Summary (Box TS.9) was devoted to “Irreversibility, tipping points and abrupt changes”, and concluded in most cases to low confidence in the occurrence of studied events, in particular due to limited evidence.

AR6 WGII gave a significant focus on ecosystems and human systems’ tipping points that could be created by the cascading effects of adverse impacts from climate hazards, in particular along coasts, in urban centers and in the mountainous regions. It assessed that *“these hazards and cascading risks also trigger tipping points in sensitive ecosystems and in significantly and rapidly changing social-ecological systems impacted by ice melt, permafrost thaw and changing hydrology in polar regions (high confidence)”*. The Report also confirmed risks due to climate “large-scale singular events” as one the five main Reasons for Concern, citing amazon forest dieback and the rapid mass loss in ice sheets. The report assessed with high confidence that adaptation cannot reduce harm in fragile ecosystems such as coral reefs, some forests, sea ice and permafrost systems that reach critical thresholds or tipping points.

AR6 WGIII included an assessment of the long-term economic benefits of mitigation from avoided climate change and emphasized the importance of considering climate tipping points (e.g., Box TS.7) and thresholds of irreversible and abrupt changes. The risks of climate tipping points have also supported analytical frameworks for understanding mitigation response strategies and feedback. The need for increasing the pace, depth, and breadth of emissions reductions within mitigation response strategies has been also associated with possibilities for positive changes in social norms and behaviour change. In this scope, the possibility of averting climate tipping points has been linked to positive societal shifts, public acceptance, and dynamics for mitigation action. Since AR6 WGIII, there have been reviews calling for a need to better define system boundaries and scales of analysis of this concept, its contextualization within existing social theories of change, and the need for the identification of empirical evidence. The complexity of societal systems also elevates the need to consider agency and navigational capacities. While mitigation is expected to lower the risk of climate tipping points being reached, current socio-economic scenarios and models have limitations in representing non-linear change and shock events, both related to (climate) risk and mitigation, for example in the context of overshoot scenarios for 1.5°C.

Overall, the Sixth Assessment Cycle has progressed on many key topics, but also identified many knowledge gaps. Since the literature cut-off dates in AR6, literature has increased considerably on

high-impact events and tipping points. Recent review papers highlight the importance (e.g., Amstrong McKay et al., 2022) and uncertainty (e.g. Wang et al., 2023) of tipping points and their need to be considered in communication with policymakers (Stocker et al., 2024).

3. Goals of the Expert Meeting

The goal of this Expert Meeting is to prepare consensus for the WG-specific assessments addressing this important topic subject to intense research and debates in the community. The meeting, ahead of LAM1, will discuss definitions and latest research, ways of assessing research that acknowledge the range of views on this topic and identify engaged communities and experts, and therefore also potential authors, with regional diversity. The meeting will also serve to prepare effective communication across Working Groups on the topic of high impact events and tipping points. This is important, since even for climate-only tipping points, impacts reach into society and economy.

4. Participation

We are proposing that 60 experts attend the Expert Meeting, with equal participation from developing and developed countries. The composition of participants will reflect the relevant range of scientific, technical and socio-economic expertise and views, aim at gender balance and representation across geographies, mindful of the specific perspectives of vulnerable regions and communities, and include experts both with and without previous experience in IPCC.

The following areas of expertise are required:

- Tipping points and severe events in the ocean, their impacts including on ocean biosphere and carbon cycling and tipping in ocean biosphere;
- Tipping points, cascading shocks and severe events in land systems, including vegetation changes and transitions, fire, and carbon cycle implications;
- Abrupt and large changes in monsoon systems, and impact on breaching thresholds in the land system;
- Permafrost and their regional impact (water cycle; forests) and the global carbon and methane budget;
- Rapid ice sheet loss and rapid sea level rise;
- Societal risks and impacts, including economic impacts, of abrupt climate change and compound events; risks of economic shocks linked to rapid decarbonization; risks to food system from severe events and circulation changes; multiple storm hits; polycrises; compound risks;
- Applicability of the tipping point concept for social transitions and transformations, including role of behavioral change in accelerating mitigation in diverse cultural settings;
- Limits to adaptation;
- Early warning signals and assessment tools that can inform policy making and promote societal preparedness;
- Dynamical systems and modeling tools.

The experts need to cover changes reconstructed from paleoclimatic changes to evaluate evidence of tipping or stability in systems from significantly different climates, instrumental and satellite retrieved stability or vulnerability of systems to enable characterization of risk and early warning, and evidence from models, including earth system modeling, land and food system modeling and societal and integrated impact modeling, as well as the theoretical and empirical social science research on transitions and transformations. It is important that perspectives cover global experiences including those in developing countries and by vulnerable populations.

5. Timing and format

We propose that the Expert Meeting takes place in 2025 before the LAM1 and, if possible, over three days in April 2025.

6. Hosting

The Co-chairs are seeking a host for this Expert Meeting.

7. Budget and Funding

The Co-Chairs suggest an addition of a budget line to the 2025 IPCC Trust Fund budget for an Expert Meeting on Tipping Points (60 participants). The requested provision is an increase in budget of CHF 140,400, which comprises DC/EIT support of CHF 120,000 (30 journeys) and Other expenditure of CHF 20,400. This budget request will be complemented by WCRP which indicated they were willing to support in-kind (scientific input, operational support) and financially (exact budget still to be defined).