INTEGRATED RESEARCH ON CLIMATE RISK AND SUSTAINABLE SOLUTIONS ACROSS IPCC WORKING GROUPS: LESSONS LEARNT FROM AR5 TO SUPPORT AR6

Stockholm, Sweden
29-31 August 2016

MEETING REPORT

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Co-organised by Future Earth, the Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) and the Stockholm Resilience Centre

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MEETING REPORT

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CONTENT

Acronyms

AR	Assessment Report
DC	Developing countries
EIT	Countries with economies in transition
IA	Integrated Assessment
IAV	Impacts, Adaptation, and Vulnerability
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
PROVIA	Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation
RCP	Representative concentration pathway
SDG	Sustainable Development Goal
Sendai Framework	Sendai Framework on Disaster Risk Reduction
SSP	Shared socioeconomic pathway
UNFCCC	United Nations Framework Convention on Climate Change
WG	Working Group

Preface

The Paris Agreement in December 2015 demands a reaction from the research community. An immediate priority is greater international coordination of climate research in support of the Intergovernmental Panel on Climate Change's Sixth Assessment Report (IPCC AR6) to inform future development pathways. The workshop, "Integrated research on climate risk and sustainable solutions across IPCC Working Groups: Lessons learnt from AR5 to support AR6," brought together experts from across the domains of the three IPCC Working Groups to discuss the major scientific issues associated with integrative risk management and sustainable solutions to the climate challenge. It aimed to explore the lessons learnt from AR5, such as identifying major gaps in understanding related to the climate system, adaptation, mitigation and vulnerability and examining the strategic research approaches to addressing these issues in the next 3-5 years.

The broad international event, scheduled nine months ahead of the first IPCC AR6 scoping meeting, attracted balanced participation from experts across the world, covering diverse disciplines, geographies, sectors and career stages. The workshop brought together 78 experts and stakeholders from 28 countries, covering all world regions. 58 participants were directly identified by the Scientific Committee and another 20, including eight Early Career Scientists, were selected from among over 70 applications from an open call.

The IPCC Trust Fund supported 24 experts from developing countries (DC) or countries with economies in transition (EIT), 11 experts from developed countries were supported from the Swedish funds, five American experts from the US Global Change Research Program, two early career climatologists from the World Climate Research Programme, and many others from their home institutions. Live streaming of plenary sessions allowed the participation of a larger audience, and remote participants were invited to ask questions via Twitter. Over the three-day workshop, 670 viewers either joined live or watched at their convenience. The senior leadership of IPCC participated in the workshop, including chair Hoesung Lee, vice chair Youba Sokona and the co-chairs/vice chairs of IPCC's three Working Groups. The Secretary of IPCC Abdalah Mokssit and Programme Officer Mxolisi Shongwe also attended. Stakeholders included high-level representation from United Nations Framework Convention on Climate Change and the Swedish Deputy Prime Minister Isabella Lövin. Videos of the plenary sessions are available here: http://futureearth.org/events/future-earth-provia-ipcc-risks-and-solutions-workshop

The meeting structure facilitated interaction across the entire scope of the IPCC assessment processes by organising work into five topics that cut across the IPCC Working Group structure. A dedicated Task Group addressed each topic throughout the workshop:

1. GAPS - knowledge gaps on climate-resilient and sustainable solutions to support AR6
2. SOLUTIONS - catalysing research, tools, methods and learning mechanisms to inform development and deployment of sustainable solutions
3. REGIONAL - sharing information on risks and solution strategies across local to global scales
4. SCENARIOS - facilitating consistent use of climate and development scenarios across the IPCC Working Groups
5. RISKS - consistent and effective risk characterisation, risk visualisation and sustainable solutions across IPCC Working Groups

IPCC chair Hoesung Lee mentioned in his opening speech that the political milestones of the COP21 and the SDGs will inevitably influence the shape of the IPCC AR6 assessment cycle and that the IPCC must expand its notion of risk to include these developments. He welcomed the workshop as a means to achieve this goal.

Discussions during the workshop explored a risk and solutions framework within the context of international policy developments such as the Paris Agreement, the Sendai Framework on Disaster Risk Reduction and the Sustainable Development Goals. Workshop participants called for greater integration across IPCC's three Working Groups. The need for more co-designed, co-produced research arose repeatedly, as were recommendations to include a broader range of expertise into the IPCC process.

This extensive report builds on the specific recommendations developed by each Task Group and complements the short summary report that had been submitted as an Information Document to the IPCC Panel for its 44th meeting in October 2016.

Key messages and recommendations

Cross-cutting messages

Recommendations to IPCC

- Enhance integration across IPCC's three Working Groups and include a broader range of expertise into the IPCC process
- Review the use of risk assessment across the Working Groups and develop guidance for incorporating a risk and response framing that applies to all Working Groups, considering spatial, temporal, sectoral, and socially differentiated implications
- Put more focus on understanding and addressing decision-making and implementation needs by different actors at different scales and levels
- Enhance consistent approaches to regions across the Working Groups that consider national and regional trends and circumstances (e.g. emissions, socioeconomic development pathways), their global context and interlinkages across scales
- Use the SSP-RCP matrix as an exploratory framework to link assessments of risk at multiple scales in a consistent way and ensure appropriate regional coverage
- Expand sources of evidence through regional collation of grey literature and local and traditional knowledge sources
- Consider uncertainties in a consistent manner for input into overall risk assessment and communicate and visualise them effectively
- Facilitate stronger engagement between the science community associated with IPCC and different stakeholders early in the AR6 process, whilst maintaining equitable access and the independence of the process
- Urge nations to fund research supporting the assessments, taking into account national circumstances, with the aim to close knowledge gaps on climate systems that otherwise constitute unaccounted risks towards societal goals of sustainability and resilience
- Ensure data exchange and use (e.g. CMIP data for WGII) between Working Groups and their consistent citation

Recommendations to the scientific community

- Develop an integrated risk framework for climate research which can be implemented consistently across Working Groups
- Advance research on substantial and pressing knowledge gaps related to our understanding of the climate system, our ability to predict risk of climate change on Earth's ecosystems and inhabitants and our ability to identify best options for mitigation and adaptation
- Promote research on integrated research questions, such as adaptation, mitigation, sustainable development and co-benefits
- Extend, downscale and improve the SSP-RCP framework to include specific scenarios for achieving the Paris Agreement, Agenda 2030 and other policy targets
- Assess the effectiveness of policies and distributional/equity implications of pathways
- Advance capacity on co-production of knowledge and decision-making on adaptation and mitigation, including risk perception and analysis, policy sciences, social learning, communities of practice, decision sciences, communication of risk, climate services, evaluation of co-production outcomes and technology innovation
- Evaluate the impact of decisions and what makes the underlying science useful and usable
- Develop the empirical basis for the assessment of conditions for sustained change through a meta-analysis of learning on transformation
- Define a typology of levels of success of responses to climate change, taking regional and national contexts into account, and assess success factors and support mechanisms for localisation and generalisation of solutions
- Review and further develop indicators and methods for evaluating adaptation and mitigation over different temporal and spatial scales and for different actors
- Develop methods for integrating multiple types of knowledge, such as top-down transformation pathways studies and meta-analysis of bottom-up case studies

- Identify regional hotspots for response actions with respect to rates of change, vulnerabilities, the costs and benefits of different responses, understanding the role of emergent risks at regional levels and defining the data resolution needed to support regional responses
- Promote and coordinate efforts to improve access to grey literature of high quality
- Encourage, promote and fund capacity building for research in developing countries and local communities that are currently underrepresented in climate change science, thereby gradually reducing existing information gaps in the scientific literature

Task Group 1

Key messages

- We emphasise the importance of decision-making contexts and the frames and tools used to enhance them (e.g. scenarios and modeling) as well as the role of actors in risk-framing designs, use and other related themes central to actionable solutions for climate change and variability both now and in the future.
- Given the urgency of a solutions-orientated science agenda, the 'business as usual' way of conducting assessments is being reviewed, including the valuation of different knowledge types in climate risk assessment. More critically, engagement from a range of decision-making perspectives (e.g. engineers, science and technology community, social sciences, humanities, civic society) on scenario development, climate forecasts and information, amongst other elements of climate decision making should be more carefully considered from the outset of the next IPCC Assessment Report.
- More specific recommendations include a focus on how knowledge is being produced in the IPCC and how to increase its use (e.g. effective co-production and co-design), on key knowledge gaps including uncertainties and time frames (near-term decisions must be informed by long-term consequences to avoid maladaptations and inappropriate path dependencies), and on how risk framing and scenarios for development pathways inform assessments that are coordinated across the three IPCC Working Groups.

Recommendations

- Create a consistent approach across all Working Groups, focusing on key concepts and framings (e.g. scenarios, risk frameworks, downscaling, development pathways, solutions).
- Enhance the focus on co-production, decision-making and implementation of solutions by including an IPCC AR6 chapter on:
    - Understanding the pathways from knowledge to actionable information, to decisions and their impact;
    - Understanding decision needs and creating typologies of uses and users;
    - Understanding which factors drive or constrain co-production; and,
    - Addressing the temporal and spatial scales at which decisions are most effectively implemented.
- The IPCC should urge nations to fund research to stimulate innovative and collaborative activities in support of the Paris Agreement to the best of their capacity, including:
    - The full range of physical, biogeochemical, ocean, environmental, social and engineering sciences;
    - Times scales from seasonal to millennial;
    - Spatial scales from local to regional to global;
    - Solutions based on nature, technology and geoengineering; and,
    - All components of the earth-ocean-climate-human system.

Knowledge gaps

- Understanding decision-making and the role of co-production of actionable knowledge
- Known and unaccounted gaps related to temporal and spatial scales
- Scenarios for decision-making, risk mitigation and the implied risks

Task Group 2

Key messages

- **Evidence points increasingly to the need for far more integration and coherency in addressing climate change. Therefore, in the context of solutions, there is a need for the IPCC to spell out precisely what is meant by 'integrated responses', to ensure consistency of use across AR6.** This means different things at different scales, and goes beyond 'integration across Working Groups' to a fuller appreciation of exactly what this would entail and how it would be operationalised. It also means going beyond the binary of 'adaptation and mitigation' to include reducing vulnerability and building resilience within the context of sustainable development and poverty reduction. Clear objectives for integration are required, learning from pilot projects about when and how integration needs to occur.
- **We need to think about the contextual settings of both solutions and risk**. Risk assumes a fixed rational world – logics of rationalities are different in different places. What are/should be the procedures and actors offering solutions? Tools for local consideration of risk are required, using own frameworks, inputs and outputs. The ways in which decisions are made in different places differs. Rationalities are not standardised across the board. We need to know more about the decision making behind vulnerability, such as why people live where they live and what their daily mobility patterns are.
- **Barriers are an issue that needs to be discussed and answered in the report**, because adaptation and mitigation will have barriers, but ways of overcoming them within different contexts can be assessed. This issue can be extended to consider the SDGs as well.
- **For public engagement of diverse societal stakeholders on mitigation, adaptation, and sustainable development, both science and cultural interventions are crucial.** This requires the involvement of civil society in as much of its diversity as possible, including NGOs, private and public foundations, museums, etc. Beyond science and top-down policy work we need to bring top-down and bottom-up efforts meaningfully into conversation in civil society (the amorphous and messy public sphere). This has enormous potential for feeding back positively into mitigation and adaptation processes.
- **Rescue of threatened cultural resources**: AR6 is advised to pay additional attention to the issue of cultural resources, including preservation of heritage under threat from climate change, such as archaeological data disappearing due to coastal erosion, in which valuable scientific data on past changes and on past human responses to regime shifts and climate-induced shocks can be preserved for future reference.
- **Reflexivity within the AR6 assessment process:** The structure of IPCC's assessment process, including the types of knowledge that are recognised, influences the outputs and outcomes that are generated and the solutions that are identified and evaluated. The IPCC as well as relevant stakeholders need to think critically about how best to conduct the assessment process in order to achieve desired outcomes in an equitable manner avoiding any bias.

Recommendations

- Assess the enabling conditions to reduce and manage current and future climate risks, under differing rates of change.
- Consideration should be given to the conditions for different actors, at different scales and within different contexts.
- Consider how agents of change at the science-policy-practice interface frame and utilise knowledge and methodologies to implement action (at scale) and interact with the public.
- Develop the empirical basis for the assessment of conditions for sustained change, through a meta-analysis of learning on transformation.
- Develop methodologies for integrating multiple types of knowledge: e.g. bringing top-down transformation pathways studies and meta-analysis of bottom-up case studies together.
- Review and further develop indicators and methodologies for evaluating adaptation and mitigation over different temporal scales and for different actors.
- Assess success factors and support mechanisms for localisation of solutions (and what may be generalised) in the follow-on process after AR6.

- Develop guidelines for how engagement between the IPCC science community and different change actors can be strengthened early on in the AR6 process, mindful of equitable access to and maintaining independence of the process.
- Explore and assess different modes of engagement between the research community and other stakeholders (for example civil society, vulnerable groups, practitioners, business, NGO, media, states, local governments) for developing relevant and coherent solutions to feed into AR6.

Task Group 3

Recommendations:

- **Consider regions consistently:** The treatment of regions was inconsistent in AR5, being most developed in WGII, and with notably diverse regionalisations used across the Working Groups. Aside from devising a consistent set of regionalisations to use across the Working Groups (Section 4.3.2), AR6 would benefit (i) from identifying the regional needs of the Summary for Policymakers at the start to ensure that these are delivered from the Working Groups, and (ii) from an explicit chapter about regional issues in each Working Group outline, with some common authorship across the Working Groups. In addition, in WGII, regions could be given consideration within each core chapter, working together with authors of regional chapters to ensure consistency. In general, the assessment process should consider how to integrate regional analyses during the preparation of the scoping document for the Working Groups and during the selection of authors who can work across Working Groups to bring the regional perspective in a consistent and comparable form.
- **Expand the sources of evidence:** Grey literature, literature in other languages than English, and indigenous and local knowledge are especially important for the regional component of the assessment, not only in terms of incorporation of relevant issues and databases, but also to understand how different groups are being affected, perceive impacts and design and implement solutions. Innovative approaches and initiatives are needed to ensure consideration of these sources. Engagement of IPCC authors with young scientists, practitioners and regional networks, including those of Future Earth, could be used to gather, organise and synthesise regional data, as well as to encourage local research to address regional gaps. Concepts such as the developing 'Science Brief Platform' could be extended to assist with this. Methods for integrating different forms of datasets and epistemologies need development.
- **Regionally sensitive communications:** Communication is also a central topic for the assessment process. Strategies should be developed to distill clear messages on regional perspectives in “plain language” (to go beyond regions, but have relevant regional ramifications, and allow for regional differences in values, cultures and ethics frameworks). After the AR5 release, some institutions or countries produced summary distillations of what the AR5 meant for their region. Such efforts could be pre-planned more systematically, including consistent engagement with local journalists. In general, a more interactive and innovative presentation of assessment outcomes is needed to communicate effectively with all users, especially practitioners outside of the science domain. There is a need for more people who can communicate about the big picture of the assessment implications; this should also be recognised by the community and by employers. Being realistic without being alarmist about tipping points and irreversible change (e.g. potential eventual loss of the Great Barrier Reef) will be an important balance to find. The opportunity/option/solution space should be generally explored through a regional lens.

Task Group 4

Key messages

Recommendations

- Utilise the SSP-RCP framework as an overarching exploratory framework
    - Use the comprehensive SSP-RCP scenario framework as the central ‘toolbox’ to link to the integrated risk assessment, at multiple scales in a consistent way and ensuring appropriate regional coverage in ongoing and future analytical work
    - Consider ways and means to map socio-economic developments analysed before or outside the SSP framework onto the SSP space. This means to bin and project where possible and needed, the existing scenario literature and data not adopting the SSP

framework onto SSP family terms, thereby enriching and harmonising the information base for assessment by the IPCC

- Bridge from scenarios to targets and implementation
    - Develop pathways[1], which explore different solutions (and how/when they may be implemented) for achieving future visions or policy targets (cf. the approach taken in IPBES through target-seeking scenarios, such as linking to achievement of SDGs, the Paris Agreement and other policy targets and processes)
    - Consider the effectiveness and robustness of actions/policies within pathways for achieving the targets/visions (possibly through linking the pathways to the SSP-RCP framework)
    - Enhance policy relevance: consider policy-case scenarios as a reference point in the assessment phase. For example: take (estimated) INDC results as reference when assessing reduced risks and incremental adaptation and mitigation efforts implied by the well below 2°C and 1.5°C targets
- Concrete suggestions to facilitate integration across Working Groups and scales
    - Develop guidelines and support for Lead Authors in their scenario and pathway assessment, including cross-Working Group coordination, as well as to facilitate the production of AR6 Synthesis Report
    - Consider a section/chapter addressing national/regional pathways (and their global context), and on linking scenario/pathways results across scales
    - Consider key areas to foster integration, for example in forthcoming Special Reports on impacts of global warming of 1.5°C , climate change and oceans and the cryosphere, and on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.
- Develop guidelines for scenario and pathway analysis for the research community, consider a workshop to discuss state-of-the-art, exchange experiences and identify opportunities
- Encourage the research community to use, extend, downscale, and further improve the SSP-RCP framework
- Ensure data exchange between Working Groups (e.g. CMIP data extracts for WGII), and ensure adequate referencing of data
- Encourage easy access of other communities to integrated model data availability (e.g. both socioeconomic and climate data)
- Development of an umbrella platform for documentation and guidance to facilitate data access will be a decisive improvement.
- Consider working on integrated research questions, particularly adaptation, mitigation, links with sustainable development, co-benefits, etc.; including assessing policy effectiveness for such complex, interacting issues and challenges (e.g. What are the full local, regional and global benefits of providing access to modern energy? How can local development be pursued while simultaneously achieving mitigation and adaptation objectives? What response strategies (encompassing multiple related interventions) most effectively manage the interactions and trade-offs between different ecosystem services under different trajectories of multiple drivers of change? Do current management and policy interventions provide sufficient system resilience given the uncertainty range of plausible futures? How does global change affect the natural environment and human society, and the interdependencies between them, and which pathways of responses lead to sustainable system-wide solutions which enhance synergies and minimise trade-offs? What are key tradeoffs and synergies in bioenergy/bioeconomy, sustainable land use and ecosystem protection?)
- Ensure consistent and comprehensive consideration of uncertainties for input into overall risk assessment
- Consider multi-scale analysis (trans-boundary, linking and ensuring consistency between global and local scales (teleconnections/spillover/leakage/off-site effects/displacement effects); and multi-sector analysis (multi-objective, trade-offs and synergies)
- Explore distributional/equity implications of scenarios and pathways: both intra-generational (regional, social) and intergenerational effects

[1] Compare the term pathways as commonly used in IAV; see definitions/clarifications in section 1

- Encourage under-represented research communities to provide results and data that allow for integration in IPCC assessments. This can lead to a further improved pluralistic quantitative base for the assessment. This includes communities using different modelling approaches than current mainstream Integrated Assessment models (such as evolutionary models, agent based models, Keynesian models, others), using different methodologies and/or different disciplines
- Initiate and undertake efforts to build modelling and other analytical capacity, as needed, in underrepresented regions
- Include stakeholders and end-users of analytical results in co-development of knowledge from early on in the process

Task Group 5

Recommendations

- Review the use of risk across all Working Groups and thoroughly review the literature of application of risk in a global change context
- Evaluate the AR5 WGII and Synthesis Report risk framework for its broader applicability to WGIII and WGI (prior to and during scoping the reports)
- Evaluate how far along the qualitative/quantitative continuum this framework can be applied, for consistent use across Working Groups
- Consider how to enable the framework to be embedded in the chapter structures, etc.
- Develop and implement the (matured) risk framework with attention to the characteristics that we identified above
- Consider what is needed in the expanded analytic and integrative “reasons for concern” approach, and its burning embers visualisation and communication
- Consider relevant spatial, temporal, sectoral, socially differentiated implications
- Consider plurality of knowledge systems, interests, values
- Mobilise inter- and transdisciplinary researchers to further develop and apply this integrating risk framework
- Advance methods for assessing the impacts and the probability of singular events and different metrics
- Organise arenas for consulting diverse stakeholders to give input and iteratively co-design and co-produce a more mature, more generally applicable version so it leads to more salient, credible and legitimate IPCC assessment

Task Group 1 "GAPS"

Task Group's full name: **Knowledge gaps on fundamental science, climate-resiliency, and actionable solutions to support AR6**

Co-Chairs: Coleen Vogel and Purnamita Dasgupta; *Co-Rapporteurs:* Maria Carmen Lemos and Bronwyn Wake; *Co-Conveners*: Kristie Ebi and Corinne Le Quere; *Participants*: Edvin Aldrian, Leif Andersson, Nina Bednarsek, Dave Carlson, Madhav Giri, Hans C. Hansson, Alan Mix, Naki Nakicenovic, Jean Palutikof, Sybil Seitzinger, Imran Shahid, Youba Sokona, Florin Vladu

Climatic change and variability exacerbate many stressors affecting humanity. Evaluation of these risks demands increased attention globally and locally (Rockström et al. 2013, Rockström et al. 2009, Dearing et al. 2015). Promotion of sustainable development pathways highlights the need to focus on research gaps and frame actionable knowledge to inform solutions. International initiatives including the Sendai Framework (WCDRR 2015), the UN Sustainable Development Goals (SDGs) (UN 2015), and the Paris Agreement, including the Intended Nationally Determined Contributions (INDCs) (UNFCCC 2015b), all offer an opportunity to reflect on what is needed now to support climate-resilient and sustainable transitions in the next iterations of the IPCC.

The IPCC informs international and national discussions on (a) the risks of climate change, (b) possible adaptation and mitigation policies, and (c) measures to manage projected risks. In its evolution, the IPCC has fostered innovations in the scientific assessment process and made adjustments in each successive round to address new challenges. The AR5 assessment cycle integrated risks from physical, environmental, social and economic processes into a framework that identifies and supports the implementation of solutions. Yet knowledge gaps remain in fundamental science, as well as in the challenges of integrating and addressing issues of social justice, accountability, distribution and ethics, including who ultimately decides what knowledge is useful, practical and timely, and which approaches of science should be pursued, including, but not limited to, linkages between climate projections and socioeconomic scenarios (Pettinger 2007).

1.1 Co-production of actionable knowledge and decision-making

In recent years, calls have been made to dramatically increase the relevance of the IPCC for decision-making. While the IPCC is a co-designed framework between the UNFCCC member countries and the scientific community, there is widespread perception that (a) communication of the IPCC science needs to improve significantly and (b) co-production and use of IPCC knowledge must be accelerated and expanded to include a broader range of decision-makers, including businesses, different levels of governments and jurisdictions, NGOs and indigenous communities (Peterson et al. 2015, Ford et al. 2016, Black 2015, Barkemeyer et al. 2016). In this context, interest in co-production of knowledge (i.e. meaningful interaction between producers and users of knowledge to inform decision-making) has rapidly expanded. Although there is widespread acceptance of the need and value of co-production, the actual implementation is fraught with difficulty and when it is successfully achieved, it does not necessarily guarantee take-up by users. Nevertheless, examples of good practice do exist. Meta-analyses of the literature focusing on climate forecasts and projections (e.g. seasonal climate forecasting) provide robust evidence that co-production can increase climate information uptake (Lemos et al. 2012, Meinke et al. 2008).

In co-production, producers of knowledge (e.g. scientists, engineers, lawyers, policy analysts) and users (e.g. decision-makers in governments, businesses and other organisations) frame the problem together from the outset (Shackley & Wynne 1995). As a result, producers learn about users' needs and decision-making processes and users learn about how knowledge is produced and gain insights into its strengths and limitations (Lemos & Morehouse 2005, Meadow et al. 2015). This enables the empirical and expert knowledge, understanding, and experiences of users and producers of knowledge to be incorporated into the knowledge production process. Furthermore, producers of knowledge consider users in all phases of knowledge production and users understand that their needs may not always be met by current available knowledge (Briley et al. 2015).

A research agenda in support of increasing the usability and accessibility of the information assessed by the IPCC through co-production requires improved understanding of:

- Whether and how co-production increases uptake of research outputs and improves performance of climate change response projects;
- What drives effective co-production (e.g. design, level of iteration and sustained relationships, respect by the participants for all the parties involved, level of trust, communication, role of boundary organisations tasked with managing the relationship between science and decision-making, value-adding techniques such as customisation of knowledge, visualisation, accessibility);
- Opportunities and barriers to the establishment of co-production and reducing transaction costs (e.g. limitations of human and financial resources, time constraints, lack of trust, legitimacy) in different contexts and how to overcome them;
- How co-production shapes credibility and legitimacy in different contexts (e.g. north/south, scientific/indigenous knowledge, peer-reviewed/non-peer-reviewed modes of knowledge production);
- Co-production strategies, their outcomes and effectiveness (e.g. how co-production shapes perception of uncertainty, how co-production shapes decision outcomes in terms of determinism, acceptance and desirable solutions);
- The effectiveness of co-production in different stages of a science-policy process (e.g. knowledge production, agenda-building, implementation, evaluation); and,
- How evaluation of co-production can improve its outcomes.

1.2 Known and unaccounted gaps related to temporal and spatial scales

Knowledge of the climate and ocean systems has improved significantly since the IPCC First Assessment Report, but many gaps in knowledge remain (e.g. Doherty et al. 2009, Brasseur & Carlson 2015). High priority is placed on filling gaps that lead specifically to identification and quantification of risks which can be addressed by policies and actions toward mitigation and adaptation. Coordination between the Working Groups at the start of AR6 is required to place appropriate focus on actionable science and on appropriately informed prescriptive policy . Here we highlight specific knowledge gaps related to spatial and temporal scales, as special issues that AR6 should focus on.

Current agreements to limit global average warming to 1.5^{o}C (UNFCCC 2015a) implicitly apply to the 21st century, the range of most climate projections. Changes will however continue beyond 2100 AD, and if not adequately considered, counterproductive pathway dependencies generated by short-term solutions may create unintended long-term consequences. Projections of the slower-responding elements of the climate system, including the loss of polar ice in Greenland and Antarctica, the warming of the deep ocean and expected sea-level rise, highlight the risks associated with long-term climate trends. Even the most optimistic emissions scenarios suggest that global temperatures will continue to rise for centuries after net carbon emissions have ceased. Global average sea levels will also continue to rise for thousands of years by tens of meters, with peak rates of coastal inundation delayed due to the slow response of the large ice sheets and deep ocean (Clark et al. 2016, DeConto & Pollard 2016). Such large sea-level rises are consistent with sea level highstands known from past interglacial periods, caused by only modest warming (Dutton et al. 2015).

Impacts increase over time in part because atmospheric carbon dioxide will remain elevated for tens of thousands of years before it is eventually neutralised by slow-acting geologic processes (Archer et al. 2009, Eby et al. 2009). More research is needed on long-term amplifying feedbacks such as the warming-induced release of carbon from soils, permafrost and methane hydrates. Decisions made in the next decade will determine the future of the climate, sea level rise and their impacts not just for the 21st century, but also for millennia to come. Policies need to consider long-term effects, so that near-term adaptations do not become long-term maladaptations, such as seawalls increasing risk by encouraging development in low-lying areas (McGranahan et al. 2007).

Long-term projections also beg the question of whether the ongoing changes already initiated from past emissions will be reversible, for example by using active carbon capture to reduce atmospheric greenhouse gases (Committee on Geoengineering 2015). If climate or ecological tipping points are

crossed, the changes may become unstoppable, which radically changes the view on mitigation and adaptation strategies. Some glaciologists suggest that irreversible loss of ice from parts of Antarctica may already be underway (Rignot et al. 2014, Joughin et al. 2014). Threshold effects are difficult to constrain based on the relatively short record of modern instrumental records, with insights thus relying on the study of paleoclimatic archives (PAGES 2K Consortium 2013, Turney et al. 2016). IPCC AR5 recognised that the probability of crossing thresholds will increase with greater warming (Stocker et al. 2013). Economic models show increased value to early mitigation actions aimed at avoiding climate tipping points (Cai et al. 2016), although improved quantification of the probability of climatic, biogeochemical and societal threshold effects and their consequences is needed.

Similar scale uncertainty applies to projected changes in climate variability and the probability of extreme events under a changing background state (Hansen et al. 2016). Current climate models massively underestimate variability on the scale of decades to centuries (Laepple and Huybers 2014). The cumulative effects of persistent drought, heat or changes in the frequency of extreme events that last decades or longer will be much more challenging than brief disruptions in climate. Further work is needed on regional modeling and downscaling of global climate projections, which are essential for translating large-scale projections into local actions (Stocker et al. 2015).

Specific research needs related to knowledge gaps on spatial and temporal scales include:

- Better understanding of longer-term climate and ocean trends such as sea-level changes and orderly societal responses to such “slow-motion” hazards;
- Constraints on the risk of triggering “tipping points” after which change may become irreversible;
- Improved simulation of decadal-to-century scale variability under a changing climate baseline, and the attendant risks;
- Increased understanding of the changing probability of extreme impactful climate events under a changing climate baseline;
- Improved delivery of regional climate projections, on a scale relevant to specific local actions; and,
- Consideration of long-term trends in societal development pathways, to guard against the possibility that short-term solutions will create long-term risks.

1.3 Scenarios for decision-making and risk management

The new scenario framework is organised around a matrix architecture with three building blocks (van Vuuren et al. 2014, Riahi et al. 2016), (1) representative concentration pathways (RCPs), which specify carbon dioxide and other greenhouse gas emission pathways over the century and beyond and are developed to serve the needs of the earth system modeling community, (2) shared socioeconomic pathways (SSPs) that describe plausible major global developments that together could lead in futures representing different challenges for mitigation and adaptation and (3) shared climate policy assumptions that specify common mitigation and adaptation policies required to achieve a particular RCP and to cope with resulting climate change. These three building blocks can be used to co-design scenarios for use by all IPCC AR6 Working Groups, facilitating more effective links between climate science, societal risks and solutions that will enhance sustainability and resiliency.

Research needed to address limitations and gaps regarding the building and use of scenarios includes:

- Expanding SSPs, which were developed at the global scale, to regional and sectoral scales relevant to decision-makers;
- Assessing climate-resilient and sustainable development strategies, including evaluation of uncertainties (Sendai Framework, Agenda 2030, Paris Agreement);
- Broadening the frame within which AR6 assesses the literature on climate-resilient and sustainable development and evaluating how the SSPs fit within this broader frame, including identifying gaps in narratives and quantifications which adequately reflect uncertainty (Sendai Framework, Agenda 2030, Paris Agreement); and,
- Exploring approaches for incorporating threshold changes in the climate system and responses to these changes.

A research agenda in support of increasing knowledge to inform iterative risk management would include:

- New approaches aggregating INDCs to monitor and evaluate the extent of international progress on meeting global goals;
- More specificity in national adaptation goals considering transnational (regional and global) interdependencies;
- Realistic assessments of socioeconomic uncertainties in risk projections and how these evolve over time;
- Approaches to better capture emerging properties; and
- Evaluation and tracking of development pathways, taking into consideration possible path dependencies and their implications for sustainable and resilient development, while avoiding situations in which short-term adaptation yields long-term maladaptation.

Task Group 2 "SOLUTIONS"

Task Group's full name: **Catalysing research, tools, methods, and learning mechanisms to inform development and deployment of sustainable solutions**

Co-Chairs: Joyashree Roy and Benjamin Preston; *Co-Rapporteurs:* Penny Urquhart and Jasper Montana; *Co-Conveners*: Kristie Ebi and Corinne Le Quere; *Participants*: Oleg Anisimov, Kristin Dow, Thomas Elmqvist, Cicilia Githaiga, Camila Gramkow, Steven Hartman, Sirkku Juhola, Hoesung Lee, Roger Pulwarty, Mohammad Rahimi, Debra Roberts, Åsa Romson, Mark Schapiro, Claire Weill.

The IPCC engages in its sixth cycle of assessment reports with a new international policy context (the SDGs) and regime in climate negotiation (the Paris Agreement). In 2015, the SDGs were agreed upon by all the countries, developed and developing. The UNFCCC agreement that was reached at the COP 21 in Paris in 2015 emphasised stock taking of progress in regular intervals. A number of countries have already ratified the Paris Agreement and established national commitments to greenhouse gas mitigation targets while emphasising the important role of adaptation in addressing climate risk. The Paris Agreement reflected growing concern among policy-makers regarding the future impacts of climate change as well as those already being observed. The IPCC's scientific assessment process has been critical for establishing the knowledge foundation supporting UNFCCC policy development. Yet, the implementation of the Paris Agreement through national, sub-national, and local initiatives will place new demands on the IPCC assessment process. There is a growing need to place the objective assessment of current scientific knowledge in a decision context relevant to stakeholders in search of solutions to the challenges of climate change.

As the climate change response community orients itself toward solutions, it must recognise the importance of the SDGs for establishing a broader framework in which those solutions will be pursued. The pursuit of climate risk management in the context of sustainable development creates the need for a more holistic assessment framing for IPCC AR6 that integrates climate and non-climate drivers. To this end, the AR6 should identify and assess trade-offs between alternative policy and development pathways as well as the enabling factors and constraints associated with implementation based on the experiences from various actions already in trial on the ground. An enhanced focus of the AR6 on solutions creates a need to entrain interdisciplinary author teams with expertise not only in the state-of-the art for research, but also for policy and practice.

This new solutions orientation and its implications for the AR6 (including the process, content, authorship, and knowledge gaps in peer reviewed literature) established the context for Task Group 2's discussions over the course of the workshop. The different perspectives presented during the workshop and the key recommendations emerging from this Task Group will hopefully be beneficial in generating a new research agenda for a larger research community within and outside the IPCC process.

Task Group 2 recognised the need, both within and beyond AR6, for the climate change community to pay increased attention to the science-policy-practice interface, in order to enhance the relevance of AR6 findings and to operationalise them post-assessment. Furthermore, it was considered important to access, engage with and empower practitioners, given their essential role in contributing knowledge and expertise to a solutions-oriented assessment.

Given the complex solutions landscape, AR6 needs to develop a conceptual framework for the presentation of solutions that does not conflict with IPCC's mandate against policy prescription. Although stronger risk framing for AR6 is needed, if AR6 is to develop an integrated risk framework to be applied across all Working Groups, attention will need to be paid to mapping out the interconnections between the risk framework and the proposed solutions framework. This will entail considering a diverse range of possible metrics for assessing risks and solutions. Furthermore, assessment of solutions goes beyond just options to focus on an empirical basis for the conditions under which different options might be enacted (e.g. financing or societal conditions). Moving from an option matrix to a solution matrix that accounts more comprehensively for the diversity of societal conditions, risks and responses will require the inclusion of research that is not currently in the climate arena.

The urgency of climate change means it is essential to focus on what works with respect to policy and practice. Solutions have been, and will continue to be, implemented across multiple scales, including many local initiatives. This raises the question of how best to synthesise learning from observed practices. Furthermore, given the necessity for disaggregated and targeted implementation of solutions, answering the question of 'solutions for whom?' is important for maintaining procedural, distributive and inter-generational equity in both scientific assessments and policy implementation. The range of stakeholders, many of whom will be change agents, includes governments at all levels, the private sector, civil society (including individual citizens and various social groups), and the media. All of these stakeholders are connected, interact and learn through complex social networks that can be knowledge networks for the development and implementation of solutions. In particular, priority should be given to solutions for vulnerable and marginalised groups, and AR6 is advised to focus on the role of local government in creating an enabling environment for responses at scale.

There are important questions to be considered during the scoping and execution of AR6 regarding the role of scientists and scientific assessment in informing policy deliberations. There is an emerging debate regarding the potential responsibility, or even liability, of scientists for the success or failure of climate policy. This is particularly relevant to the growing calls for policy makers to think in transformative ways when deliberating over policy options. Hence, the IPCC, AR6 authors, and national governments must consider how to navigate the tensions between maintaining the credibility of scientific assessment and providing adequate guidance to stakeholders regarding solutions and their implementation. For example, in the context of transformation, a helpful framing is 'how to establish transformative pathways', rather than 'you need to transform'. The IPCC assessment process is considered by many to be a knowledge co-production effort between researchers and governments. However, greater investment could be made in the co-design and co-production of AR6 in recognition of the diversity of assessment stakeholders and scales of solution implementation. In addition, greater investment could be made in assessing the role of information systems in linking stakeholder capacity to the implementation of policy and practice.

Enhanced processes and procedures will be needed to integrate the new focus of the Paris Agreement and the SDGs into AR6. New procedures will be needed to draw out lessons from practice, such as through meta-analyses of grassroots and other initiatives. One recommended meta-analysis, also indicated in the work of the Regional Task Group, is to learn from recent experiences with community-based adaptation. Bearing in mind that access to knowledge is not sufficient to engender behaviour change, there is a need to explore and assess successful change processes, to understand conditions for change at different scales and within different contexts. There is a key role for the research community in developing a rigorous yet practical method of synthesis to draw out lessons from the grey literature in which emerging solutions are embedded, and to carry out various meta-analyses. Relevant questions include (i) what are the methodologies that have been used to evaluate and monitor transformation and what has worked? and (ii) how can we apply actions that will be faster than the currently observed rate of change? A key outcome for the research community would be to map the assessment and evaluation methods that link research to policies and practices that span the continuum from incremental to transformational.

A top priority gap is to make the report understandable to citizens so that civil society can understand the scientific basis for subsequent policies recommended for implementation by stakeholders on the strength of AR6. To this end, greater attention should be given to the public perception of climate change as well as alternative policy responses and pathways. It is important to understand the relationship between shared recognition of the problem amongst citizens and the ability to implement policies and practices. There is thus a need for targeted communications at multiple levels and reflection on the IPCC's roles and responsibilities relative to other organisations. Empowerment of diverse groups, including vulnerable communities, is a moral imperative, as well as being a necessary condition for action towards climate-resilient development. It will be important to explore the limits of AR6 in terms of implementation.

Task Group 3 "REGIONAL"

Task Group's full name: **Sharing information on risks and solution strategies across local to global scales**

Co-Chairs: Mercedes Bustamante and Mark Stafford Smith; *Co-Rapporteurs:* Sabine Fuss and Pablo Borges; *Co-Conveners*: Shobhakar Dhakal and Carolina Vera; *Participants*: Paolo Artaxo, Shobhakar Dhakal, Chris Gordon, Carla Gulizia, Jo-Ting Huang-Lachmann, Manfred Lange, Abdalah Mokssit, Jose Moreno, Rupa Mukerji, Zhai Panmao, Melinda Tignor, Carolina Vera, Mxolisi Shongwe

The AR6 aspires to emphasise responses to climate change, whether adaptation, mitigation or synergistic deployment of both. Since many responses occur at regional to local levels, this emphasis implies greater attention to regional differentiation of impacts and responses. It is well-known from AR5 and before that there is considerable regional differentiation in climate change, such that global average warming of +2°C will be expressed as up to +3-4°C over land at low latitudes, and up to +7-8°C at high latitudes. The consequential impacts may be even more differentiated; for example, cold areas at high latitudes where production is limited by temperature are likely to benefit in terms of agricultural production and forest growth whereas semi-arid areas may experience losses in production at even lesser levels of warming. Consequent adaptation and mitigation responses are also further differentiated by region; for example, areas of South America may experience disproportionate land use change as a result of ambitious mitigation interventions focused on forests compared to other regions. There will also be differentiation within regions; for example, adaptation may benefit a particular socioeconomic stratum or gender.

There are also framing issues which arise from regional considerations, including:

- WGII and WGIII need to become more quantitative and systematic in AR6, especially at regional resolution. Stakeholders need better evaluation of the socio-economic costs of impacts and the consequent costs and benefits of interventions
- Impacts differ greatly from region to region (and within regions) and can be advantageous or adverse. Despite improvements, climate projections remain relatively uncertain for changes in precipitation and in some extremes at the regional level. The relative importance of these uncertainties (in time and space) is substantially altered by looking at responses instead of impacts, helping prioritise research needs
- Although the primary audience for IPCC is nations, its analytical lens needs to encompass regional, national and local levels as appropriate. Many solutions will be regional or local, summing up to global outcomes
- Below the global level, it makes decreasing sense to look at mitigation and adaptation responses separately, especially in cities and in land-based responses; however, even if they interact, adaptation and mitigation do not always take place in the same place or through the same actors
- All aspects of the assessment need to consider the temporal dimension; timing and sequencing of responses in relation to timing of impacts and of interactions between adaptation and mitigation are increasingly important

We considered how both impacts and responses may be regionally differentiated, noting that there are strong links between the resolution needs of each, and consequently what resolution is needed in reporting climate change. A systematically designed suite of exemplary case studies should be considered as a modus operandi for research on these and the following matters.

3.1 Definition of regions

The different Working Groups in AR5 used different definitions of regions, creating problems with synthesising findings geographically across the Working Groups. This is particularly important when seeking to disaggregate impacts and responses regionally. Of course, different regionalisations suit different purposes (e.g. geopolitical, cultural, climatological, ecological), and issues of scope and resolution may be different for analyses and for reporting. For example, Integrated Assessment Models often use a very coarse set of economic regions which are not compatible with analysing the effects of land use changes or the effectiveness of adaptation responses. Equally, distributional effects by socioeconomic stratum or gender may be vital, but reporting these at the country level may be too fine for

the IPCC. However, we need a set of regionalisations that meet each of these purposes and are then used consistently across all IPCC Working Groups. Further, these need to be defined and promulgated urgently, as the underpinning research and climate modelling efforts need to report to these regionalisations. It is also important to interact with similar global efforts such as the IPBES in defining regions, looking at joint and potentially comparable assessment work.

A related issue is to ensure that there is an understanding of how to aggregate across levels and types of scale in consistent ways across the Working Groups, and in the scenarios.

Note: This issue also relates to the process concern of ensuring that regions are considered in all Working Groups (see below) and to how scenarios are constructed and indicators chosen to be compatible between global and regional levels.

3.2 Resolution of climate outputs to support regional responses

Past ARs have tended to focus on climate model resolutions needed to drive impact assessments, which tends to lead to a demand for indefinitely greater detail. The growing experience of implementing adaptation and mitigation is that further resolution is not always needed to assist decision-making, sometimes because other essential inputs to the decision (for example socioeconomic or institutional data) are poorly resolved or more uncertain than the climate information. We now need to understand what resolution and reliability in time and space in what variables is needed for different forms of decisions in order to help prioritise the efforts of climate science in the face of limited resources. This may include the need of regional decision makers to integrate different combinations of climate variables (e.g. extreme winds, flood risks and storm surges) for their particular concerns. Efforts are needed to ensure that the resulting climate and impacts information is of direct value to these decision makers, requiring engagement with local people and decision makers to understand and systematise their needs. Integration of local or regional traditional and indigenous knowledge into decision-making should also be considered, particularly where other forms of information are not available. These factors affect the selection of observations, modelling resolution, downscaling methods, and the interpretation into impacts.

3.3 Identification of hotspots for response actions

The concept of a hotspot for action needs to be elaborated. This goes beyond the classic framing of impacts and vulnerability to incorporate the net benefits of action, and includes both mitigation and adaptation actions. A “hotspot for action” is conceived as the intersection of three dimensions for places or systems:

(i) the rates of change in drivers and exposure, including climate but also other factors such as population, infrastructure development and environmental change;
(ii) levels of vulnerability and coping capacities; and
(iii) an integrated view on the costs and benefits of action (i.e. including social and environmental as well as economic outcomes).

These concepts raise many issues. The assessment of vulnerability needs to recognise the interaction of multiple dimensions such as poverty, culture, gender, etc. Costs and benefits of actions must account for the implications of power, justice and the distribution of outcomes. Consideration must be given to timing, such as swift action on current vulnerabilities relative to longer-term building of resilience. All of these issues require co-design and co-production of the understanding of hotspots with relevant stakeholders. A formal analysis of the interaction between climate risks (SDG 13) and all other SDGs may be a useful framing to ensure that this breadth of concerns is accounted for.

Note: the approach to this analysis should be an input to defining the overarching risk framework.

3.4 Emergent risks and responses at regional levels

AR5 started to explore the impacts and implications of emergent risks, and this needs substantial elaboration, including a regional perspective. Aspects of emergent risks include: implications of teleconnections and value and supply chains; issues of transboundary management of natural resources within and between regions; multiple synchronised impacts or interventions across the world; and tipping points and irreversible impacts.

Teleconnections encompass, for example, effects of mitigation strategies (on both demand and supply sides), attribution (linked to the ethics dimension and legal aspects), human migration, value and supply chains, embodied emissions in consumption, virtual water (and other resources) trades, indirect land use change, spread of epidemics, and water management of shared aquifers. Are different regions subject to different types of teleconnections, and does the same type of teleconnection have different impacts in different regions (e.g. because the population's exposure to an impact is higher)?

Whilst tipping points and irreversible effects are usually considered globally so far, are there regional tipping points that individually may not trigger a global impact, but which are critical to regional responses (and of course may add up across many regions if synchronised)? Are there also opportunities to learn across regions in this regard?

3.5 Variations in level of success of responses across contexts

A key challenge for AR6 is to assess the success of implemented adaptation and mitigation measures. This raises multiple challenges – much material on implementation is reported in grey literature or local reports and may not be in English; it is usually not explicitly labelled as adaptation or mitigation. It is also challenging to find comprehensive evaluations of success: success is genuinely difficult to appraise in some cases where outcomes may be decades away; methods of assessing the level of success that include social and environmental aspects are not well-developed or commonly applied; and the same actions may be more or less appropriate in different contexts. Nonetheless, researchers must deliver insights on these issues to AR6.

There is a need to collate a large set of examples of implemented actions with some consistent measures of their success; a systematic, informative appraisal implies the need to create typologies of responses and contexts, linked by how successful different responses are in different contexts. There are many research issues embedded in this statement of need. These include understanding the diversity of potential adaptation and mitigation responses and their combinations; developing and deploying metrics of success; accounting for the temporal dimension (e.g. assessing lock-in, flexibility, impacts of inaction, opportunity of leapfrogging, committed emissions, distributional outcomes over time) in the assessment of success; and understanding and collecting data across a diversity of types of actors (e.g. policy, private sector, civil society, individuals, etc.; including community-based adaptation) and at various levels of organisational scale. Linking the success of responses to their context will require considering dimensions of that context, such as aspects of the physical context (e.g. urban vs rural, landscape productivity, industry sector, complexity of stakeholders, degree of divergence in values, response urgency, and governance quality, among others). One issue that deserves greater focus is the understanding of who wins and who loses from particular interventions, so that barriers created by those who perceive that they will lose are addressed explicitly.

These assessments need to account for a range of levels of adaptation and mitigation, from incremental to systemic to transformational. Moving from incremental through to transformation responses requires a change in governance approaches to encompass more coordination and participation, so that a complementary typology of governance structures may also be needed. In addition, actions to manage emergent risks (5.3.4) generally require systemic implementation, which may need recognising in any typology and which also imply even more complex governance challenges.

3.6 Intended Nationally Determined Contributions as a lens for research

The Paris Agreement has driven the INDCs and these provide important opportunities for analysis to (i) identify what research is needed in different countries (and hence regions) in order to enable them to meet their INDCs (both mitigation and adaptation); (ii) to understand what the implications of achieving the INDCs would be, on outcomes as broad as regional climate, albedo, water availability and use, biodiversity loss or indigenous people; and (iii) explore what the best pathways may be to responding to the Paris Agreements' mechanism for building 'increasing ambition' over time.

Note: Politically, this may be hard for IPCC to take up in detail but the research community should do it anyway; note there is a temporal dimension to how these issues play out. This could be explicitly linked with the SDGs at national/regional levels – see comment under Section 5.3.2.3.

3.7 How are responses influenced by ethics and values?

This issue is picked up in other task groups, and needs to be taken into account systematically. It would be useful if the approaches elaborated elsewhere in the report incorporated a regional perspective, recognising that values differ between regions and have different dynamics of change; that there are ethical issues of equity across regions, leading to different forms of action at times in both adaptation and mitigation; and that even ethical systems may differ among regions. One key recommendation is that research findings and consequent assessment should report distributional effects (geographic, social, gender, vulnerable groups, etc) wherever possible, rather than simply report changes in means. The use and interpretation of Indigenous and Local Knowledge, as well as information from other stakeholder groups, must also consider ethics and values.

Task Group 4 "SCENARIOS"

Task Group's full name: **Facilitating consistent use of climate and development scenarios across the IPCC Working Groups**

Co-Chairs: Jia Hua Pan and Tom Kram; *Co-Rapporteurs:* Piers Forster and Joeri Rogelj; *Co-Conveners*: Jean-François Soussana, Ramon Pichs-Madruga and Kristie Ebi; *Participants*: Wendy Broadgate, Paula Harrison, Michael Hayne, Mulako Kabisa, Elmar Kriegler, Sebastian Leuzinger, Valérie Masson-Delmotte, Elvira Poloczanska, Belinda Reyers, Markku Rummukainen, Martina Stockhause

While the prime focus of Task Group 4 was to make recommendations on the role of scenarios in AR6, in the course of the discussions also other related issues arose. These issues are also considered here, for possible consideration in the AR6 cycle and its products. Task Group 4's recommendations for the use of scenarios are made with two audiences in mind: the IPCC assessment process and the research communities producing material for the assessment.

4.1 Integration of science across the IPCC Working Groups

Foster comparable understanding and language

In AR5 (and in earlier assessments) terminology and language used was not consistent across the Working Groups, which hampers overall integration and induces confusion among readers and user communities of the IPCC products. From an early stage, the IPCC community[2] should make a concerted effort to reduce lack of consistency by addressing and clarifying issues such as:

- Which users are targeted by the various IPCC products?
  For example: first and foremost policymakers (Summary for Policymakers), but also analysts, practitioners, NGOs, business, media, educational institutions (Summary for Policymakers, Technical Summary), researchers (AR reports), the general public, others (outreach material).
- Which integration is pursued and for what purpose?
  For example: integration across systems (human and natural), across audiences (science and policy), across scales (from global to local), across sectors (multi-sector), and across Working Groups (disciplines/modelling approaches). Main reasons for more focus on integration are:
  - To ensure multi-scale consistency and understand cross-scale impacts (up/down-scaling of drivers, impacts and responses, displacement effects, teleconnections)
  - To understand system-wide impacts (co-benefits, potential detrimental side-effects, synergies, trade-offs)
  - For understanding alignment or dissonance with other political agendas, such as SDGs, other UN Conventions and other intergovernmental bodies, e.g. IPBES
- Common definitions/clarifications, as different communities adhere to their own naming conventions[3], and the same term can be understood differently in other communities and disciplines. Examples include:
  - Pathways (normative in Impacts, Adaptation and Vulnerability (IAV) analysis: a dynamic trajectory from present to meet future (policy) targets, target seeking; more generic in climate science and integrated assessment: any trajectory or projection from current to some future year)
  - Scenarios (in IAV: exploratory, spanning the full range/scope; in climate science/Integrated Assessment (IA): just one interpretation, can also be a normative or other specific (model based) projection)
  - Visions (and their relationship to policy targets/aspirations)
  - Risks, vulnerability (what risk and risk management framework)
  - Uncertainties (types of uncertainty have to be made explicit in line with literature; propagation of different uncertainties needs to be considered)
  - Reference (reference scenario, what definition? Can RCP4.5 be used to reflect the impact of INDCs as starting point for assessing climate change risks and efforts to/benefits from reducing risks?)

[2] Community in a broad sense, from the bureau to author teams and Technical Support Units

[3] See IPBES: Methodological assessment of scenarios and models of biodiversity and ecosystem services, where the types of scenarios include: "exploratory " and "target-seeking (normative)" scenarios

- Metrics were observed to be inconsistent in AR5, leading to confusion: both radiative forcing, global mean temperatures and CO_2-equivalent or gas-by-gas atmospheric concentrations were employed to pinpoint levels of climatic change; also improved comparability of cost and impact indicators across chapters and reports

Greater visibility and transparency of assumptions on non-climate drivers
Both WGII and WGIII could be fostered by the use of a consistent, documented and publicly accessible socio-economic scenario framework.[4]

Involve communicators from early on in the process
Both for outreach to other research communities working within the IPCC process, and for communication outside these research communities, including audiences currently not well represented. Develop common language from the start.

[4] Compare IPBES which developed and employs a common list of multiple indirect and direct drivers

Task Group 5 "RISKS"

Task Group's full name: **Consistent and effective characterisation and visualisation of risks and sustainable solutions across IPCC Working Groups**

Co-Chairs: Asun St. Clair and Linda Mearns; *Co-Rapporteurs:* Sarah Cornell and Rafaela Flach; *Co-Conveners*: Johan Rockström and Thorsten Kiefer; *Participants*: Noemi Chacon, Deliang Chen, Koji Dairaku, Joydeep Gupta, Ahmad Mokbul, Sonali Narang, Hans-Otto Pörtner, Mxolisi Shongwe, Jana Sillmann, Anna Sörensson

The IPCC's characterisation of risk is critically important to policy makers, economists and business leaders and warrants particular analysis and scrutiny given the high societal and economic stakes. Aspects of climate risks cut across all IPCC Working Groups and function as integrating dimensions of climate assessments. Meaningful IPCC climate change assessment reports require an integrated approach to risk analysis and risk assessment. IPCC AR5 put forward a risk framework that partly served to create an overarching narrative in the Synthesis Report, but the three Working Groups all offered a different perspective on climate risks. WGI does not use the term "risk", but rather focuses on the physical aspects of climate changes and climate events that can be characterised quantitatively, together with assessments of probability and associated uncertainty. WGII defines risk in terms of the probability of an event multiplied by its impact, and also as a function of vulnerability, exposure and hazard. The WGII risk framework usefully linked a broad range of risk contexts (disasters, emergent risks, key climate change risks), but did not generate continuity from the knowledge identified in WGI. In WGIII, risk is framed in terms of probability and impact, which may be assessed qualitatively and quantitatively.

Climate risks cross spatial scales from local to global as well as temporal scales (e.g. daily to decadal). Interactions and feedbacks between climate and biosphere processes generate risks of crossing thresholds resulting in abrupt and irreversible Earth system change. A gap in earlier IPCC reports is indicated by the fact that an analysis of risks as the factor of probability and impact does not work well for non-linear or "tipping point" occurrences (such as the collapse of the West Antarctic Ice Sheet). We need a different framework for analyzing those highly uncertain low probabilities but high impact events. Moreover, in the Anthropocene, climate risks are interconnected to other risks relating to health, economic development and ecological impact. Climate risk management must therefore also incorporate understanding of complex social-ecological risks, such as the potential interplay between geopolitical instability and climate induced volatility (e.g. on food markets). Solutions to reduce risk must be cognizant of this interconnectivity, and also of resilience approaches to managing risk.

AR5 attempted to integrate climate with development issues, but there was little integration of other relevant issues that are now extensively captured by the SDGs. Also there were few connections between climate risks and the opportunities emerging from climate solutions in both mitigation and adaptation.
The Risk Task Group proposes to further develop the AR5 risk framework and associated conceptual visualisations (in particular the new and improved burning embers) and to generate an overarching framework that better incorporates the science from all Working Groups and that at the same time makes climate risk more salient to users.[5] Such widening of the concept is already reflected in the evaluation of risk in relation to metrics other than temperature (e.g. rate of change, ocean acidification, and sea level rise (IPCC AR5 Synthesis Report). This framework thus can serve as the key approach to better integrating the science of all three Working Groups. A more integrated framework may be able to provide connections between the assessment of quantifiable climate risks with the more qualitative resolution of risks identified in WGII regional and sectoral analysis. It could also contribute to defining the opportunity space for mitigation options and their risks. Combining mitigation and adaptation strategies will give a more complete picture of potential risk reduction. A more developed framework could also enable the consideration of large-scale singular events, irreversibility, tipping points and other phenomena that are not well covered in quantitative and probabilistic assessment, along with other important factors that are

[5] See IPCC AR5 WGII and Synthesis Report.

difficult to include in monetised risk assessments, such as loss of biodiversity, or the loss of culturally valuable factors.

5.1 Diverse conceptions of risk and different degrees of quantification

A critical starting point for an integrated approach to climate risk is recognising the multiple definitions of risks that emerge in diverse contexts and from other areas of work besides climate change. It is important for both IPCC and the research community to review these different conceptions of risk. Lessons can be learned from other frameworks, for example the Sendai Framework, and from the conceptualisation of climate risks emerging from the private sector, finance and insurance. While risk is a common language in the decision-making contexts of industry, climate risks require translation into different categories. It will be important to identify ways to capture subjective perceptions of risk, reflect different ethical perspectives, and give specific attention to the risks of those most vulnerable. This may entail including valuation scales that are not economic, such as the cultural issues associated with the value given to nature by some Indigenous groups. The consideration of Indigenous and traditional knowledge (UN 2016), gender (UNFCCC 2016) and other perspectives is not just about vulnerability assessment – it is contributory knowledge to the issue of risk, and relevant for the framing of climate risk.

A further development of the AR5 risk framework will require work and creativity in terms of new quantifications, different parameters, and hybrid indicators that are able to capture multiple dimensions of risks. For many contexts, quantification is of central importance, but some issues are not suitable for quantification. Our recommendation is neither to forget nor to force issues that are not quantifiable. Qualitative risk perspectives need to be further investigated, and plural approaches may be appropriate. There is a wealth of literature on these issues. In fact, some key risk assessments offered in earlier IPCC reports are a hybrid of quantitative and qualitative information, such as the visualisations of reasons for concern (burning embers). Risks can also be linked to solutions. Ongoing work identifying appropriate indicators for the SDGs could offer important lessons for IPCC and may need to be explored, to better align climate change solutions with sustainable development outcomes, their tradeoffs and potential co-benefits.

Characteristics of this ideal risk framework (to be matured by further research & consultation)**:**
A summary recommendation made by the Risk Task Group is to consider the following characteristics for producing a mature and integrative climate risk framework:

- Assesses the knowledge base of risk, not just the risk
- Enables different degrees of quantification
- Broadens the view of risk, but still remains within IPCC boundaries
- Enables better WGI/WGII coordination to produce probabilistic information on climate events that is useful for risk calculations
- Expands on the application of risk assessment to WGIII topics, such as the risks of application of new technologies to mitigation
- Gives visibility to the human and social factors and the social impacts, especially the risks to the most vulnerable people, including ethical considerations
- Speaks to (and listens to) many stakeholders – including the business community, including finance and insurance
- Considers the flipside of risks – *opportunitie*s, and enables inclusion of solutions to climate risk problems
- Combines mitigation and adaptation measures as means of reducing risk

5.2 Expand the AR5 WGII Risk Framework & Burning Embers visualisation

The Risk Task Group proposes to take the AR5 risk framework and the already impactful and integrative burning embers visualisation as the point of departure for further elaboration and integration of the issues outlined above. This creative effort will require mobilisation of the research community, and interactions and consultation with diverse stakeholder groups. It will be necessary to explore how to expand the use value of both the framework and the visualisation. For the latter, many other potential *reasons for concern* may emerge from the assessment of regional and sectoral issues, or from a focus on specific vulnerable groups. The color shading can be combined in consistent ways with quantification, and used to display measures of uncertainty. Expanding the usefulness may also require integration of compound events,

such as the ecological impacts of both acidification and warming in oceans, or a human heat index comprised of changes in both temperature and humidity. Complicating a figure often leads to problematic interpretations. It will therefore be essential to ensure that all the potential new versions of the burning embers be accompanied by a clear explanatory narrative of the knowledge basis and associated uncertainty underlying the risk assessment in a way that both the graphics and labeling make sense to all the likely readers.

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Appendix 02: Scoping Paper approved by the ExCom (4 May 2016)

Future Earth/ PROVIA/ IPCC Workshop on Climate Change Impacts, Adaptation and Vulnerability: Lessons Learned from AR5

'Assessment to Inform Risk Management in a Changing World'

Scoping Paper

Co-organised by Future Earth and the Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA).

Co-sponsored by the Intergovernmental Panel on Climate Change (IPCC).

Background

The recently published Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) highlights the character and severity of climate change impacts on human and natural systems that result from the interaction among physical hazards, exposure of people, ecosystems, and assets, and their vulnerability or susceptibility to harm. Working Group II (WGII) in the AR5 increased the focus on risks of climate change and on the role of interacting stressors and responses to these risks through adaptation. The WGII AR5 combined quantitative and qualitative evidence using multi-criteria processes of expert judgment to evaluate changing risks. The successful implementation of this approach in the AR5 highlighted opportunities for extending these approaches to make them deeply embedded and more sophisticated for the AR6.

The combination of quantitative and qualitative evidence, plus expert judgment, provided the foundation for the WGII findings on detection/attribution, regional and sectoral key risks and global reasons for concern. This approach also supported an improved conceptualisation of risk and mechanisms for managing it, embracing the concept that values and priorities almost always play a major role in specific risk assignments.

Several challenges limit the ability of risk assessments to inform policy decisions. Prominent challenges include (1) limited information on the 'tails' of possible outcomes (including risk due to both climate and societal components), (2) spatial resolution of hazard, vulnerability and exposure, (3) multi-sector interactions that constrain ability to model risks, (4) limits to comparability among diverse metrics of risk, and (5) deep uncertainty about future dynamics of vulnerability and exposure, especially many decades in the future. All of these challenges have exciting opportunities for improvement through future research.

The IPCC received proposals from PROVIA and IGBP to organise workshops on lessons learnt from the AR5, in particular the WGII contribution to the AR5. IGBP proposed a workshop that would deliberate on cross-cutting issues, spanning the physical climate system, climate change impacts, vulnerability and adaptation, and mitigation. PROVIA expressed interest in a meeting that would reflect on the AR5 assessment, paying particular attention to knowledge gaps identified in the WGII AR5. At the 40th Session of the IPCC, the IPCC Panel approved a combined event to be held focusing on lessons learnt from the WGII AR5, and a budget was approved to cover the required costs. Because IGPB officially dissolved at the end of 2015, IPCC invited Future Earth, which continues several of the IGPB projects, to join as a co-organiser.

After further consultations among the three organisations it is suggested that the workshop will be organised by Future Earth and PROVIA and would be co-sponsored by the IPCC.

Objectives

The overall objective of the co-sponsored workshop is to reflect on the lessons learnt from the AR5, centered on WGII and its interfaces with WGI and WGIII, and to collect the best available scientific ideas required to advance research on multi-criteria expert judgment, integrating quantitative and qualitative information on climate change risks and responses in a multi-stressor world. The goal is to make these

approaches more powerful, deeply embedded, and sophisticated for the AR6, as well as integrated in terms of the inputs needed and the potential co-benefits that may be achieved across the Working Groups.

The specific aims include:

- Identifying limits on available data and how those limits might be addressed in order to improve scientific knowledge and better inform decisions on adaptation and mitigation measures;
- Considering opportunities for enhancing the effectiveness of the scenario approaches used to frame future risk;
- Assessing prospects for improving the methods used that integrates quantitative and qualitative information on climate change risks in a multi-stressor world, inter alia multi-criteria expert judgment ;
- Exploring options for increasingly quantitative characterisations of vulnerability, exposure and multi-sector interactions;
- Explore responses to climate risks emphasising the opportunities for co-benefits through identification of strategies that address simultaneously adaptation, mitigation and sustainable development;
- Understanding how the assessment and response to risk varies at a regional level.

Content and Agenda

The workshop will involve plenary sessions with invited presentations, organised panels, breakout groups, and general discussions, with an emphasis on discussion. The Programme will be set by the Scientific Steering Committee. Participants will include experts from disciplines that span the topics of the WGII assessment, with additional input from relevant areas covered in WGI and WGIII, including experts on decision support, risk management approaches, systems, scenarios and other tools relevant to decision making.

Scientific Steering Committee

The Scientific Steering Committee will be led by the Co-Chairs of Future Earth, PROVIA, and IPCC WGII for the AR6 and will include experts from AR5 from all three working groups, representing the full range of relevant expertise. The Scientific Steering Committee will be supported by the WGII TSU for the AR6 and the secretariats of Future Earth and PROVIA.

Outcomes

A workshop report will be prepared under the guidance of the Scientific Steering Committee with inputs from meeting participants. This report will provide a summary of the meeting discussions and present options for the research community to address all of the meeting objectives. The proceedings of the meeting will be delivered on time to inform the scoping process of AR6. These proceedings will:

- include a full list of participants;
- indicate when and by whom they were prepared;
- indicate whether and by whom they were reviewed prior to publication;
- specify all sources of funding and other support;
- prominently display the following disclaimer at the beginning of the document:

"IPCC co-sponsorship does not imply IPCC endorsement or approval of these proceedings or any recommendations or conclusions contained herein. Neither the papers presented at the Workshop nor the report of its proceedings have been subject to IPCC review"

Location and Timeline

The meeting will be held in Stockholm, Sweden. The proposed duration of the workshop is three days in September or early October. Events leading and following the co-sponsored workshop and their proposed timelines are shown below:

March 2016	Planning calls between PROVIA, Future Earth and IPCC WGII Co-Chairs
April 2016	Scoping paper discussed by the IPCC Executive Committee, pending decisions still to be made on other near-term IPCC products

April 2016	Scientific Steering Committee established, including experts from Future Earth, PROVIA and all three IPCC Working Groups
June 2016	Invitations sent to participants
June/July 2016	Finalise Programme, including speakers/chairs/rapporteurs
September 2016	Co-sponsored Workshop held
October 2016	Co-sponsored Workshop Report prepared

Participants

The workshop will include approximately 70 participants with expertise relevant to the theme of the workshop, including 30 experts from developing countries or countries with economies in transition (DC/EIT) to be supported by the IPCC Trust Fund. Participants will include government experts as well as experts from non-governmental organisations participating in the work of the IPCC.

Financial Implications

The budget includes travel for 30 experts from DC/EITs who are eligible for travel support from the IPCC Trust Fund. The numbers could increase to accommodate more experts from DC/EITs if additional funding from the co-organisers is made available. Funds for the meeting venue and associated expenses will be raised by the organisers and the IPCC would contribute up to 20,400 SFr to meet these costs.

Appendix 03: Workshop programme

Monday, August 29th 2016

08:00 *Depart from hotel (guide at each hotel foyer)*

08:30 *Registration and coffee in the Beijer foyer*

Beijersalen

09:00 **Opening of meeting**
Welcomes
Wendy Broadgate, Director Future Earth Global Hub, Sweden
Göran Hansson, Secretary General Royal Swedish Academy of Sciences, Sweden

Climate research and assessment following the Paris Agreement
Patricia Espinosa, UNFCCC Executive Secretary (pre-recorded video) *Hoesung Lee*, Chair of the IPCC

Framing of the meeting
Johan Rockström, Stockholm Resilience Centre, Sweden
Kristie Ebi, School of Public Health, Univ. Washington, USA

09:45 **Plenary: IPCC Fifth Assessment Report: gaps identified, and needs for AR6**

A Perspective from WGI: *Sonia Seneviratne*, Institute for Atmospheric and Climate Science at ETH, Switzerland (pre-recorded video)

A Perspective from WGII: *Jose Moreno*, University of Castilla-La Mancha, Spain

A Perspective from WGIII: *Ramon Pichs-Madruga*, Centre for World Economy Studies, University of Havana, Cuba

10:30 *Coffee and Tea in the Beijer foyer*

11:00 **Panel discussion: research gaps and needs for the Sixth Assessment Report.**

Panellists:
Valerie Masson Delmotte, Climate and Environment Sciences Laboratory (LSCE) France
Jose Moreno, University of Castilla-La Mancha, Spain
Ramon Pichs-Madruga, Centre for World Economy Studies, University of Havana, Cuba
Moderator: *Corinne Le Quéré*, Tyndall Centre, University of East Anglia, UK

11:45 **Proposed outcomes and products of the meeting**
Johan Rockström, Stockholm Resilience Centre, Sweden
Kristie Ebi, School of Public Health, University of Washington, USA

12:00 *LUNCH at "Klubbvillan" next to the Academy*

13:00 *After lunch walk through the Bergianska Botanical Gardens (departure from the steps of the Academy at 13.00 sharp)*

13:30 **Plenary: Introducing the Task Groups.**

	Moderator: *Thorsten Kiefer*, Director Future Earth Global Hub Paris, France
13:40	Task Group 1. GAPS - *Kristie Ebi*, School of Public Health, Univ. Washington, USA
13:50	Task Group 2. SOLUTIONS - *Debra Roberts*, Environmental Planning & Climate Protection Department eThekwini Municipality, Durban, South Africa
14:00	Task Group 3. REGIONAL - *Shobhakar Dhakal*, Asian Institute of Technology, Thailand
14:10	Task Group 4. SCENARIOS - *Ramon Pichs-Madruga*, National Institute for Agricultural Research (INRA) France
14:20	Task Group 5. RISKS - *Johan Rockström*, Stockholm Resilience Centre, Sweden
14:40	Open Conversation with the floor (15 mins)
15:00	*Coffee and Tea in the Foyer*
15:30	**Task Groups work in parallel**
17:30	***End of Day 1***
18:00	*Buffé dinner in "Klubbvillan" next to the Academy*
	Tuesday, August 30th 2016
08:30	Fruit and water available in the Beijer foyer
Beijersalen	
09:00	**Plenary: Science and design needs at the interfaces between the IPCC Working Groups - focus on risks and solutions** *Jean Palutikof*, National Climate Change Adaptation Research Facility, Griffith University, Australia *Nebojsa Nakicenovic*, International Institute for Applied Systems Analysis (IIASA), Austria *Carolina Vera*, Center for Atmosphere and Ocean Sciences, Univ. Buenos Aires, Argentina *Michael Hayne*, 2 degrees Investing Initiative, UK Moderator: *Kristie Ebi*, School of Public Health, Univ. Washington, USA
09:40	Panel discussion with the above four speakers, including discussion with audience. Moderator: *Kristie Ebi*, School of Public Health, Univ. Washington, USA
10:30	*Coffee/Tea and Early Career Speed Dating in the Beijer Foyer*
11:00	**Plenary: Reporting Back from Task Group discussions** 10 minute reports from each of the Task Groups.
11:00	Task Group 1: GAPS
11:10	Task Group 2: SOLUTIONS
11:20	Task Group 3: REGIONAL

11:30	Task Group 4: SCENARIOS
11:40	Task Group 5: RISKS
11:50	Moderated discussion about how they relate to or influence each other. Moderator: *Ramon Pichs Madruga*, Centre for World Economy Studies, Univ. of Havana, Cuba
12:30	*LUNCH in "Klubbvillan" next to the Academy*
13:30	**Task Groups work in parallel**
15:30	*Coffee and Tea in the Foyer*
16:00	**Task Groups work in parallel**
17:30	*End of Day 2*
18:30	*Welcome drink at Grillska Huset* *Venue: Grillska Huset, a house from 1600 in the main square of the old town, just a couple of minutes walk from the hotels. Address: Stortorget 3-5*
19:00	*Dinner at Grillska Huset*

Wednesday, August 31st 2016

08:30	*Fruit and water available in the Beijer foyer*
Beijersalen	
09:00	**Plenary: Mobilising the science community for IPCC AR6** *Jaydeep Gupta*, Journalist, The Third Pole India *Corinne Le Quéré*, Tyndall Centre, Univ. East Anglia, UK *Florin Vladu*, UNFCCC Secretariat Moderator/host: *Youba Sokona*, The South Centre, Mali/Switzerland
09:40	**Plenary: Report from Task Groups**: outline of main points for report/paper Moderator: *Carolina Vera*, Center for Atmosphere and Ocean Sciences, Univ. Buenos Aires, Argentina
9:40	Task Group 1: GAPS
9:50	Task Group 2: SOLUTIONS
10:00	Task Group 3: REGIONAL
10:10	Task Group 4: SCENARIOS
10:20	Task Group 5: RISKS
10:30	*Coffee and Tea in the Foyer*
11:00	**Plenary: Moderated discussion on the interactions between Task Groups.** Moderator: *Carolina Vera*, Center for Atmosphere and Ocean Sciences, Univ. Buenos Aires, Argentina

11:30 **Parallel sessions: Task Groups resume**
Incorporate feedback from other Task Groups

12:45 *LUNCH with COFFEE in "Klubbvillan" next to the Academy*

14:00 **Final plenary: Conclusions, recommendations and workshop outputs**
Moderator: *Rebecca Oliver*, Future Earth Global Hub, Sweden

Task Group Summary
Conversation between Task Group representatives

Science Policy Conversation
Isabella Lövin, Minister for Climate and Development and Deputy Prime-Minister of Sweden and workshop co-chairs *Johan Rockström* and *Kristie Ebi*

Karin Wanngård, Mayor of Stockholm

Conclusions and way forward
Johan Rockström and *Kristie Ebi*

15:45 ***End of Workshop*** *(Cofffe Tea and cake)*

Appendix 04: List of Participants

Surname	Name	Affiliation	Gender	Country	Task group
Aldrian	Edvin	Center for Research and Development, BMKG	M	Indonesia	1
Andersson	Leif	Department of Marine Sciences, University of Gothenburg	M	Sweden	1
Anisimov	Oleg	State Hydrological Institute, St Petersburg	M	Russia	2
Anson	Lesley	Global Sustainability Journal editor	F	UK	
Artaxo	Paolo	University of Sao Paolo	M	Brazil	3
Bednarsek	Nina	IPCC WGII Technical Support Unit	F	Germany	1
Bondre	Ninad	Elevate Scientific	M	Sweden	
Borges	Pablo	Federal University of Santa Catarina	M	Brazil	3
Broadgate	Wendy	Future Earth Secretariat	F	Sweden	4
Bustamante	Mercedes	Department of Ecology, University of Brasília	F	Brazil	3
Carlson	Dave	World Climate Research Programme, WMO	M	Switzerland	1
Chacon	Noemi	Venezuelan Institute for Scientific Research	F	Venezuela	5
Chen	Deliang	Department of Earth Sciences,University of Gothenburg	M	Sweden	5
Cornell	Sarah	Stockholm Resilience Centre	F	Sweden	5
Dairaku	Koji	National Research Institute for Earth Science and Disaster Resilience	M	Japan	5
Dasgupta	Purnamita	College of Basic and Applied Sciences	F	India	1
Destouni	Georgia	FORMAS	F	Sweden	
Dhakal	Shobhakar	Asian Institute of Technology	M	Thailand	3
Dilley	Maxx	WMO	M	Switzerland	5
Dobrota	Susanna	Future Earth Secretariat	F	Sweden	
Ebi	Kristie	School of Public Health, University of Washington	F	USA	1
Elmqvist	Thomas	Stockholm Resilience Centre	M	Sweden	2
Flach	Rafaela	Hamburg University	F	Brazil/ Germany	5
Forster	Piers	Priestley International Centre for Climate	M	UK	4
Fuss	Sabine	Mercator Research Institute on Global Commons and Climate Change	F	Germany	3
Gaffney	Owen	Future Earth Secretariat	M	Sweden	

Giri	Madhav	PROVIA	M	Nepal	1
Githaiga	Cicilia	National Environment Management Authority in Kenya	F	Kenya	2
Gordon	Chris	Institute for Environment and Sanitation Studies, University of Ghana	M	Ghana	3
Gramkow	Camila	Tyndall Centre for Climate Change Research	F	UK	2
Gulizia	Carla	Center for Atmosphere and Ocean Sciences, University of Buenos Aires	F	Argentina	3
Gupta	Joydeep	Journalist, The Third Pole	M	India	5
Hansson	Göran K.	Royal Swedish Academy of Sciences	M	Sweden	
Hansson	H-C	Department of Env Science and Analytical Chem, Stockholm University	M	Sweden	1
Harrison	Paula	Centre for Ecology & Hydrology, Lancaster Environment Centre	F	UK	4
Hartman	Steven	Mid Sweden University Eco-Humanities Hub	M	Sweden	2
Hayne	Michael	2 Degrees Investing	M	France	4
Huang-Lachmann	Jo-Ting	Faculty of Economics and Management, TU Dresden	F	Germany	3
Iverfeldt	Åke	MISTRA, The Swedish Foundation for Strategic Environmental Research	M	Sweden	
Juhola	Sirkku	Department of Environmental Sciences, University of Helsinki	F	Finland	2
Kabisa	Mulako	Indaba Agricultural Policy Research Institute	F	Zambia	4
Kiefer	Thorsten	Future Earth Secretariat	M	France	5
Kram	Tom	PBL Netherlands Environmental Assessment Agency	M	Netherlands	4
Kriegler	Elmar	Potsdam Institute for Climate Impact Research	M	Germany	4
Lange	Manfred	Science and Technology in Archaeology Research Center, The Cyprus Institute	M	Cyprus	3
Le Quere	Corinne	Tyndall Centre, University of East Anglia	F	UK	1
Lee	Hoesung	Intergovernmental Panel on Climate Change	M	Korea	2
Lemos	Maria Carmen	GLISA, University of Michigan	F	USA	1
Leuzinger	Sebastian	Institute for Applied Ecology	M	New Zealand	4
Masson-Delmotte	Valérie	LSCE, Climate and Environment Sciences Laboratory	F	France	4
Mearns	Linda	National Center for Atmospheric Research	F	USA	5
Mix	Alan	College of Earth, Ocean, & Atmospheric Sciences, Oregon State University	M	USA	1

Mokbul	Ahmad	Asian Institute of Technology	M	Thailand/ Bengladesh	5
Mokssit	Abdalah	Intergovernmental Panel on Climate Change Secretariat	M	Switzerland	3
Montana	Jasper	Department of Geography, University of Cambridge	M	UK	2
Moreno	Jose	Department of Environmental Sciences, University of Castilla-La Mancha	M	Spain	3
Mukerji	Rupa	Institute of Rural Management, India and HELVETAS Swiss Intercooperation	F	India	3
Nakicenovic	Naki	International Institute for Applied Systems Analysis	M	Austria	1
Narang	Sonali	Panjab University	F	India	5
Oliver	Rebecca	Future Earth Secretariat	F	Sweden	
Palutikof	Jean	National Climate Change Adaptation Research Facility, Griffith University	F	Australia	1
Pan	Jia Hua	Chinese Academy of Social Sciences	M	China	4
Panmao	Zhai	China Meteorological Administration, Beijing	M	China	3
Pichs-Madruga	Ramon	Centre for World Economy Studies, University of Havana	M	Cuba	4
Pihl	Erik	Future Earth Secretariat	M	Sweden	
Poloczanska	Elvira	IPCC WGII Technical Support Unit	F	Germany	4
Portner	Hans-Otto	Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research	M	Germany	5
Preston	Benjamin	Climate Change Science Institute, Oak Ridge National Laboratory	M	USA	2
Pulwarty	Roger	NOAA	M	USA	2
Rahimi	Mohammad	Semnan University	M	Iran	2
Reyers	Belinda	Stockholm Resilience Centre	F	South Africa/ Sweden	4
Roberts	Debra	EThekwini Municipality, Durban	F	South Africa	2
Rockström	Johan	Stockholm Resilience Centre	M	Sweden	5
Rogelj	Joeri	International Institute for Applied Systems Analysis	M	Austria	4
Romson	Åsa	Swedish Ministry of the Environment	F	Sweden	2
Roy	Joyashree	Global Change Programme, Jadavpur University	F	India	2
Rummukainen	Markku	Centre for Environmental and Climate Research (CEC), Lund University	M	Sweden	4
Schapiro	Mark	Environmental Journalist and Author	M	USA	2

Seitzinger	Sybil	Pacific Institute for Climate Solutions, University of Victoria	F	Canada	1
Shongwe	Mxolisi	Intergovernmental Panel on Climate Change Secretariat	M	Switzerland	5
Sillmann	Jana	CICERO	F	Norway	5
Sokona	Youba	The South Centre	M	Mali/ Switzerland	1
St. Clair	Asun	DNV GL	F	Norway	5
Stafford Smith	Mark	Commonwealth Scientific and Industrial Research Organisation	M	Australia	3
Stafström	Sven	Swedish Research Council	M	Sweden	
Stockhause	Martina	World Data Center for Climate	F	Germany	4
Sörensson	Anna	Center for Atmosphere and Ocean Sciences, University of Buenos Aires	F	France/ Argentina	5
Tignor	Melinda	IPCC WGII Technical Support Unit	F	Germany	3
Urquhart	Penny	Independent analyst: Climate resilient development	F	South Africa	2
Weill	Claire	Future Earth Secretariat	F	France	2
Wake	Bronwyn	Nature Climate Change	F	UK	1
Vera	Carolina	Center for Atmosphere and Ocean Sciences, University of Buenos Aires	F	Argentina	3
Vladu	Florin	UNFCCC	M	Germany	1
Vogel	Coleen	University of the Witwatersrand, Johannesburg	F	South Africa	1