

Summary report on the fourth session of the structured expert dialogue, Lima, Peru, 2 and 3 December 2014 and Geneva, Switzerland, 8 and 9 February 2015

Note by the co-facilitators

7 April 2015

I. Introduction

A. Mandate

1. At their thirty-ninth sessions, the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI) requested us, the co-facilitators of the structured expert dialogue (SED), to organize SED meetings in 2014 in conjunction with the fortieth and forty-first sessions of the subsidiary bodies.¹

2. In response to the above-mentioned mandate, we convened the 1st meeting of the fourth session of the SED (SED 4-1), on 2 and 3 December 2014, in Lima, Peru, during SBSTA 41 and SBI 41 to consider the Synthesis Report (SYR) of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5),² as well as other information from the sources referred to in decision 2/CP.17, paragraph 161 (b–d).³ Prior to SED 4-1, we provided Parties with an information note outlining our approach to the organization of the meeting.⁴

3. SBSTA 40 and SBI 40 requested the co-facilitators of the SED to convene an additional meeting of the SED after SBSTA 41 and SBI 41, in conjunction with a meeting of the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) and prior to SBSTA 42 and SBI 42, to consider further inputs referred to in decision 2/CP.17, paragraph 161, in particular its subparagraphs (b–d), with a view to closing the SED prior to SBSTA 42 and SBI 42 in accordance with decision 1/CP.18, paragraph 91.⁵ As indicated at SBSTA 41 and SBI 41,⁶ the 2nd meeting of the fourth session of the SED (SED 4-2) was held on 8 and 9 February 2015 in Geneva, Switzerland, in conjunction with the eighth part of the second session of the ADP. Prior to SED 4-2, we provided Parties with an information note outlining our approach to the organization of the meeting.⁷

B. General objective and approach of the meeting

4. SED 4-1 focussed on the AR5 SYR, which distilled and integrated the key elements of the contributions of the three IPCC Working Groups to the AR5, as well as the two IPCC special reports produced during the fifth assessment cycle, which are relevant to both themes of the 2013–2015 review, and information sources other than those of the IPCC identified in decision 2/CP.17, paragraph 161(b–d), with a view to complementing, summarizing and conceptualizing the information already discussed at previous SED meetings. At its final meeting, the SED aimed to complete its work by addressing, in a balanced manner, all remaining inputs to the 2013–2015 review and information that has been published after the cut-off dates of the IPCC AR5, and by identifying information gaps.

5. Accordingly, we organized SED similarly to previous SED meetings as a fact-finding exchange of views between experts and Parties. Experts from the IPCC, processes under the Convention, United Nations agencies

¹ FCCC/SBSTA/2013/5, paragraph 133, and FCCC/SBI/2013/20, paragraph 167.

² Available at <<http://unfccc.int/7521.php>>.

³ FCCC/SBSTA/2014/2, paragraph 74, and FCCC/SBI/2014/8, paragraph 193.

⁴ Available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/sed4_informal_note_14_nov.pdf>.

⁵ FCCC/SBSTA/2014/2, paragraph 75, and FCCC/SBI/2014/8, paragraph 194.

⁶ FCCC/SBSTA/2014/5, paragraph 46, and FCCC/SBI/2014, paragraph 109.

⁷ Available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/information_note_sed_4-2_final.pdf>.

and other organizations presented findings from their reports, and highlighted their relevance to both themes of the 2013–2015 review. In addition, regional research centres presented on observed impacts of climate change. These presentations were followed by a moderated discussion guided by questions prepared by the co-facilitators⁸ based on questions provided by Parties through their submissions,⁹ questions from participants and additional questions provided by some Parties before each part of the meetings.

II. Summary of the proceedings

6. SED 4 consisted of two meetings,¹⁰ while the deliberations were organized in four parts and were open to all Parties and observers. Part 1 was held on 2 December 2014 (3–6 p.m.), part 2 was held on 3 December 2014 (3–6 p.m.), part 3 on 8 February 2015 (3–6 p.m.) and part 4 on 9 February 2015 (10 a.m.–1 p.m. and 3–4.30 p.m.). SED 4-1 comprised parts 1 and 2, and SED 4-2 comprised parts 3 and 4. The meetings were chaired and moderated by us, the co-facilitators.

7. **SED 4** was opened by Mr. Manuel Pulgar-Vidal, President of the Conference of the Parties (COP) at its twentieth session and the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) at its tenth session. Noting that the United Nations Climate Change Conference held in Lima is a **key time and place to reconcile science and policy**, he said the AR5 SYR has already highlighted some topics and outlined options that we should take into account in order to “move the decision making process towards success”. While recognizing that the SED is still ongoing, he stated that it has already been effective in enabling a science-based management of the global pathway towards a climate-resilient future. Noting that this is the first time such a review has been carried out, he said that COP 21 is expected to take appropriate action on the basis of the outcomes of the 2013–2015 review and underlined that the meeting of the SED will be an essential part of this outcome as it aims to distill and conceptualize the available relevant information with a view to conclude the review. Mr. Pulgar-Vidal added that by the end of 2015 “we aim to have a solid and strong agreement”. Noting that citizens are aware of the science that has been delivered to policy makers, he said it is now up to them to show they are acting on that basis.

8. Mr. Andreas Fischlin, a co-facilitator of the SED, outlined the structure of the meeting, noting that the discussion would focus on the two themes of the review: the adequacy of the long-term global goal in the light of the ultimate objective of the Convention (theme 1), and overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention (theme 2), which will be addressed in a balanced manner. He explained that part 1 will focus on the AR5 SYR while part 2 will consider non-IPCC information sources. Although experts will make presentations on both themes, separate discussions will be held on each. Mr. Fischlin stressed the need to finish complementing and start conceptualizing the information considered by the SED in order to finish the dialogue soon. He encouraged IPCC experts to focus on information coming from the distillation of the contributions of the three Working Groups to the AR5 and the SYR, and invited Parties to make succinct interventions to allow for a fruitful dialogue.

9. **Part 1** of the meeting opened with an introductory presentation made by an IPCC expert on the overarching findings of the AR5 SYR that are relevant to both themes of the 2013–2015 review. Subsequently, two presentations focused on: the adequacy of the long-term global goal in terms of preventing unacceptable consequences for ecosystems and food production, and for sustainable economic development; and on the adequacy of the 2 °C upper limit of temperature rise in terms of risk management within planetary boundaries and progress towards the long-term global goal. The presentations were followed by a substantive discussion guided by questions.

10. **Part 2** of SED 4-1 focused on information from United Nations agencies and intergovernmental organizations relevant to the 2013–2015 review. A SED co-facilitator, Mr. Zou Ji, opened the meeting by explaining that presenters from United Nations organizations and intergovernmental organizations would address: the mitigation and adaptation gaps; food production and security; the health impacts of climate change and mitigation co-benefits; how to set the price of carbon; and the decarbonization of the energy system as well as related technology perspectives. He added that presenters would also describe relevant activities by their organizations to support progress towards achieving the long-term global goal, as well as best practices and

⁸ For the list of questions, please see the SED 3 agenda, available at <<http://unfccc.int/7521.php>>.

⁹ The submissions from Parties are available at <http://unfccc.int/science/workstreams/the_2013-2015_review/items/7590.php>.

¹⁰ See paragraphs 2 and 3 above.

lessons learned in streamlining support that can lead to effective mitigation of, and adaptation to climate change. Mr. Zou Ji stressed that although presenters would address both of the two themes of the review, their presentations would be followed by separate discussions on themes 1 and 2.

11. Part 2 started with presentations on key findings of the United Nations Environment Programme (UNEP) 2014 *Adaptation Gap Report*¹¹ and *The Emissions Gap Report 2014*,¹² followed by a presentation by the World Bank, which focussed on the need to reduce **net carbon dioxide (CO₂) emissions to zero**, elements common to all models that provide the emission reductions required to bring emissions to zero at the end of the century, the role of carbon pricing and climate change impacts in a world 4 °C warmer. The International Energy Agency (IEA) presentation focussed on the challenges and opportunities related to energy and climate change, describing: the current state of the energy sector, modelling results and five key actions to achieve a low-carbon energy sector, and issues related to technology risk and risk management. The World Health Organization (WHO) presentation focused on the health impacts of climate change and the Food and Agriculture Organization of the United Nations (FAO) presentation focused on agriculture, food security and climate change. The presentations were followed by a substantive discussion guided by questions.

12. **SED 4-2** took place on 8–9 February 2015 in Geneva, Switzerland. The meeting consisted of two parts. On 8 February, part 3 of SED 4 focused on information from United Nations agencies, international organizations and processes under the Convention. On 9 February, part 4 considered regional and emerging information. Mr. Zou Ji welcomed delegates and opened the meeting.

13. In his opening remarks, Mr. Tomasz Chruszczow, the Chair of the SBSTA, addressed the relationship between the SED and the joint contact group on the 2013–2015 review, which was established by the SBSTA and SBI. He said that the report on SED 4 and the final factual report on the SED (to be prepared by the co-facilitators) will constitute key inputs to the work of the joint contact group when it meets during the forty-second sessions of the subsidiary bodies in June 2015 to formulate recommendations to the COP on the 2013–2015 review, including on a possible decision and appropriate action for consideration by the COP.

14. Mr. Chruszczow then outlined some key messages emerging from the meetings of the SED so far, focusing on theme 1 of the 2013–2015 review, the adequacy of the long-term global goal:

(a) The first message was on the nature of the 2 °C and 1.5 °C limits to global warming. He emphasized that at SED 2, SED 3 and SED 4-1, many experts, notably from the IPCC, had explained that climate-related impacts are prevalent at the current degree of warming of 0.85 °C above the pre-industrial level and have increasingly significant adverse effects, and that additional magnitudes of warming will only increase the risks of severe, pervasive and irreversible impacts. He stressed that this is an indication that any upper limit for global warming can no longer be seen as a guardrail providing protection from dangerous anthropogenic interference, and called for a consideration of societally, or otherwise, acceptable risks of climate impacts;

(b) The second message was related to the adequacy of the upper limit for global warming. Mr. Chruszczow noted that at SED 3, IPCC experts stated repeatedly that assessing this adequacy in the light of Article 2 of the Convention involves both risk assessments and value judgments, and indicated that climate change related risks from extreme events and risks to unique and threatened systems are high with additional warming of around 1 °C. He stated that this provides a solid analytical framework that can provide a foundation for a collective agreement on how much global warming is acceptable;

(c) The third message focused on the limitations related to working with a temperature limit only. He emphasized that at SED 2 and SED 3, experts had pointed to some of these limitations, in particular in relation to the global mean sea level rise or ocean acidification, but underscored that such limitations do not change the basic finding emerging from an assessment of the temperature limit, namely that we need to take urgent and strong action, on the contrary as experts had pointed out. He suggested that in the long term, the scientific community should think about ways to integrate the climate (and climate modelling) component into a larger framework related to the climate, society and the economy, where the climate is not just the outcome of prescribed emissions, but where levels of impacts to be avoided can be translated into emissions and policies, and where climate change influences technology and societal choices on mitigation and adaptation;

¹¹ UNEP. 2014. *The Emissions Gap Report 2014*. Available at <<http://www.unep.org/publications/ebooks/emissionsgapreport2014/>>.

¹² UNEP. 2014. *The Adaptation Gap Report 2014*. Available at <<http://www.unep.org/climatechange/adaptation/gapreport2014/>>.

(d) The fourth message has to do with the need to translate the AR5 findings to regional and national levels. He added that understanding the implications of the 2 °C goal at the national level calls for, inter alia, a systematic observation system that has high spatial and temporal resolution to better support adaptation, a better understanding of how much climate change is taking place at the regional level and a focus on regions with the highest vulnerability.

15. After providing an overview of SED 4-2, he indicated he believes that the review process has already shown to be a successful and promising vehicle to inform and support policy formulation, taking into account various values, while recognizing that what constitutes an intolerable risk may differ across sectors, regions and countries. He also stressed that the review of the adequacy of the long-term global goal calls for science-based management of the emission pathway, including all the relevant dimensions of science. The collaboration between the SBSTA and the IPCC to ensure that such a science-based management of the pathway is carried out will be essential for this review and beyond. In this context, he remarked that the IPCC is currently discussing and agreeing on its future work, including on the terms of its next assessment cycle. He also mentioned decision 12/CP.20, in which the COP invited the IPCC to take into account the work of the UNFCCC in determining its future products and assessment cycles. He emphasized that this “may well bring about a further strengthening of the science–policy interface” enabling the science-based management of the pathway to a low-carbon, climate-resilient future.

16. In closing, Mr. Chruszczow emphasized that the SED represents a significant and promising step forward in terms of bringing together the science and policy worlds.

17. Mr. Amena Yauvoli, SBI Chair, also delivered some opening remarks, focusing on theme 2 of the 2013–2015 review, the overall progress made towards achieving the long-term global goal. He stressed the timeliness of the review of the long-term global goal within the UNFCCC process and global climate policy in general, noting that 2015 will be a key year for global action on climate change. He underlined that the accelerating growth in CO₂ emissions that has occurred since 2000 has implications for the probability of limiting warming to 2 °C above pre-industrial levels, based on the cumulative emissions since 1750. He cited findings of the IPCC AR5 indicating that total anthropogenic emissions of greenhouse gases (GHGs) have continued to increase from 1970 to 2010, with larger absolute decadal increases towards the end of this period, despite a growing number of climate change mitigation policies, and that 40 per cent of the cumulative emissions were emitted since 1970.

18. Mr. Yauvoli stated that a message emerging from the review relates to the feasibility of the 2 °C limit in the context of a risk management approach to decision-making on climate change. He said that, as presented by the IPCC at SED 3, limiting warming below 2 °C is still both technically and economically feasible, but requires fundamental changes and entails risks associated not only with climate impacts but also, for example, with technology development and diffusion, since they are needed at an unprecedented scale. He underlined that the urgency of these changes is exacerbated in order to achieve a 1.5 °C limit and stressed costs, technology lock-in, and loss and damage among the consequences of delayed action.

19. He then focused on the imperative to track the development, adoption, implementation and effects of policies and measures undertaken by countries to advance their transition to a low-carbon economy, and the shift to a science-based management of the pathway to a low-carbon future. He underlined the importance of achieving a more seamless process in the scientific assessment of progress made towards limiting temperature increase below 2 °C, pointing to the need for countries to translate global numbers to the national level, as well as to aggregate national contributions and assess their impact on the global pathway. In this context, he emphasized the relevance of the multilateral assessment process conducted under SBI.

20. Mr. Yauvoli provided an update on the international assessment and review process for developed country Parties, noting that the first round of the multilateral assessment process was held in Lima, in December 2014, with the multilateral assessment of the progress of 17 Parties included in Annex I to the convention (Annex I Parties) towards their emission reduction targets. He explained that the Party records for these 17 Parties would be published at the end of February 2015, and that the remaining Annex I Parties would be assessed at SBI 42 and 43. On the multilateral assessment of developing countries, he explained that 10 Biennial Update Reports (BURs) by developing countries had been received and posted on the UNFCCC website, and that the process of international consultation and analysis (ICA) of BURs had been initiated, with the first round of the workshops under the SBI for the facilitative sharing of views expected in 2016–2017.

21. Among the objectives of the multilateral assessment, he cited: enhancing trust among countries regarding the extent of national action; determining the extent to which needed reductions are likely to occur as a result of existing approaches; improving targeting of international assistance and climate finance to address key barriers; and helping countries learn from one another’s experience.

22. Mr. Yauvoli also pointed to remaining challenges in bringing together under the 2013–2015 review the best available information from science and national information available in reports from Parties and other

processes under the Convention, noting that a number of reports from the multilateral assessment will not be available on time for them to be considered by the 2013–2015 review. He therefore called for carrying forward beyond the 2013–2015 review the link between national information and that from science, while expressing the hope that progress achieved under the 2013–2015 review could benefit future work relating to a science-based management of the global pathway towards a low-carbon and climate-resilient future, thereby strengthening the science–policy interface. Nonetheless, he said that the 2 °C goal has been catalysing many actions since Cancun, and that through the preparation by Parties of their intended nationally determined contributions (INDCs), action is expected to be further catalysed. Emphasizing the importance of transparency of national contributions for the robustness of the 2015 agreement, he said that the multilateral assessment process captures progress on emission reductions and that such a tracking system is needed. However the current tracking system for adaptation and means of implementation (MOI) is less mature than for mitigation, in part due to the scarcity of the needed information.

23. While noting that significant efforts have been made on adaptation, finance, capacity-building and technology transfer, he said they need to be strengthened. Mr. Yauvoli then reported on ongoing work on national adaptation plans (NAPs), which is carried out under the SBI. He explained that under the NAP process, each country determines the level of risk to which it seeks to adapt and coordinates the support required. NAPs will therefore be a key document on national adaptation needs and priorities, which may also include information on costs. He explained that the initial guidelines for the NAP process include a reporting, monitoring and evaluation element. It is therefore an ongoing process that will enable countries to formulate and update their adaptation plans and objectives regularly, in light of the emerging science. As such, he said, the NAP process will be part of the tracking of progress towards the long-term global goal as it relates to adaptation.

24. In closing, he stated that 2 °C is the internationally agreed upper limit for global warming that will guide and catalyse our future actions and raise ambitions, and that the review is a comprehensive process that looks at the climate ‘problem’ and ‘solutions’ in an integrated manner.

25. **Part 3** focused on information from United Nations agencies and international organizations, and from processes under the Convention. It started with a presentation by the Adaptation Committee (AC), which was followed by two presentations by: the Convention on Biological Diversity (CBD), addressing matters relating to the linkages between biodiversity and climate change mitigation and adaptation; and the United Nations Convention to Combat Desertification (UNCCD), focusing on desertification and land degradation and their impacts on natural ecosystems and food security. A final presentation illustrated the work of the SBI supporting adaptation and mitigation action through capacity-building including the role of education for mitigation and notably adaptation. The presentations were followed by a substantive discussion guided by questions.

26. SED co-facilitator, Mr. Fischlin, welcomed delegates to part 4 of SED 4 and explained that pursuant to a request by a group of Parties and Article 4, paragraph 8, of the Convention, this part would hear regional perspectives on the observed impacts of climate change. He emphasized that other organizations cannot compete with the IPCC in terms of the rigor of its review process, which is why the COP agreed to the AR5 being a key input into the 2013–2015 review.

27. **Part 4** focused on regional and emerging information. It started with presentations by regional centres in the Caribbean, Pacific and the Arctic, illustrating observed impacts of climate change in these regions, followed by a presentation on agriculture and food security in a changing climate with a focus on tropical regions. A final presentation by the World Meteorological Organization (WMO) illustrated emerging information on the state of the climate published after the AR5 cut-off dates. As in the previous three parts, the presentations were followed by a substantive discussion among experts and Parties guided by questions.

III. Summary of the discussion

A. Part 1: Introductory presentation on the Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

1. Presentations by experts

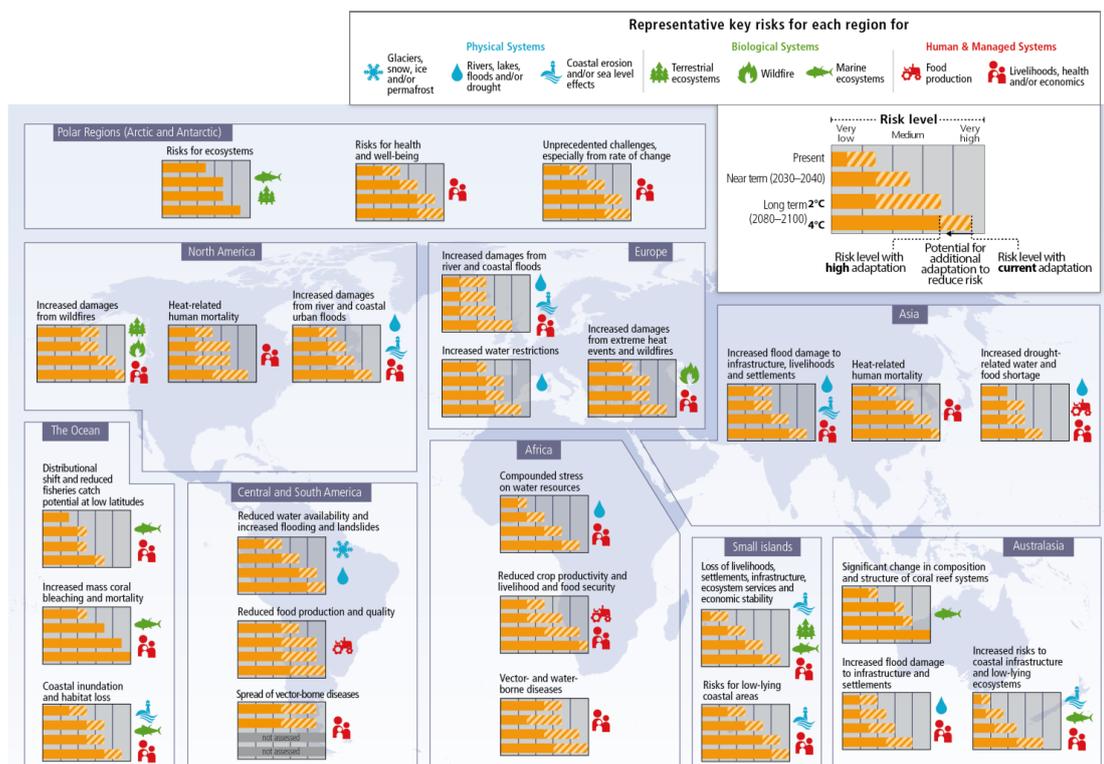
28. Ms. Renate Christ, Secretary of the IPCC, delivered a presentation on behalf of the Chair of the IPCC, which emphasized the added value of the integration and synthesis of the work of the three Working Groups of the IPCC. She outlined the key findings emerging from the AR5, including that: **human interference in the climate system is clear; the more we disrupt our climate, the more we risk severe, pervasive and irreversible impacts; and we have the means to limit climate change and build a more prosperous, sustainable future.**

29. Ms. Christ noted that **anthropogenic GHG emissions have increased** since the pre-industrial era, owing largely to economic and population growth.¹³ These emissions are now higher than ever, with atmospheric concentrations of CO₂, methane (CH₄) and nitrous oxide (N₂O) at levels unprecedented in at least 800,000 years. **Climate impacts are already occurring** and the changes in extreme weather and climate events observed since about 1950 have been linked to human influence and include a decrease in cold temperature extremes and an increase in warm temperature extremes, extremely high sea levels, and an increase in the number of heavy precipitation events.

30. She stressed that continued emissions of GHGs will cause further warming and changes in the climate system, and that continued warming increases the risks of severe, pervasive and irreversible impacts. She added that some risks are already considerable, even at a 1 °C global temperature increase above pre-industrial levels, and are high to very high for increases of 4 °C or more. People who are socially, economically, culturally, politically, institutionally or otherwise marginalized are the most at risk.

31. She explained that the **AR5 has assessed the risks at present, for the near term and for the long term**, considering, for the latter, warming of 2–4 °C above pre-industrial levels. This assessment of risks is presented by regions and by sectors, as well as for physical, biological, and human and managed systems. The IPCC has also assessed the potential for adaptation in terms of limiting the risks of climate change and the limits to adaptation (figure 1).

Figure 1
Representative key risks for each region, including the potential for risk reduction through adaptation and mitigation, as well as limits to adaptation



Source: Summary for policymakers in the Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.8. The figure shows representative key regional risks, assessed as very low, low, medium, high, or very high. Risk levels are presented for three time frames: present, near term (2030–2040), and long term (2080–2100). The long term is shown twice for a mean warming of 2 °C and 4 °C above pre-industrial levels.

32. Ms. Christ indicated that in the context of limiting temperature increase to 2 °C above pre-industrial levels, the AR5 has assessed that: a **combination of adaptation and substantial, sustained reductions in GHG emissions can limit climate change risks**; measures exist to achieve the substantial emission reductions

¹³ See figure.12 and paragraph 110 of the summary report of SED 3, available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/sed3_summary_report.pdf>.

required to limit likely warming to 2 °C above pre-industrial levels (**40–70 per cent reduction in GHGs globally by 2050, and near-zero or below-zero emissions levels in 2100**); implementing these GHG reductions implies various substantial technological, economic, social and institutional challenges; ambitious mitigation does not come without costs, but is affordable, and estimated costs do not account for the benefits of reduced climate change, and delaying mitigation will substantially increase the challenges associated with limiting warming to 2 °C above pre-industrial levels.

33. She outlined common **mitigation measures available**, such as: increasing: the efficiency of energy use; the use of low-carbon and no-carbon energy technologies, many of which already exist; improved carbon sinks such as bioenergy combined with carbon capture and storage (BECCS); and lifestyle and behavioural changes. She also mentioned the need to: **nearly quadruple zero- and low-carbon energy supply from renewable energy by 2050**, and to **reduce deforestation, improve forest management and plant new forests**.

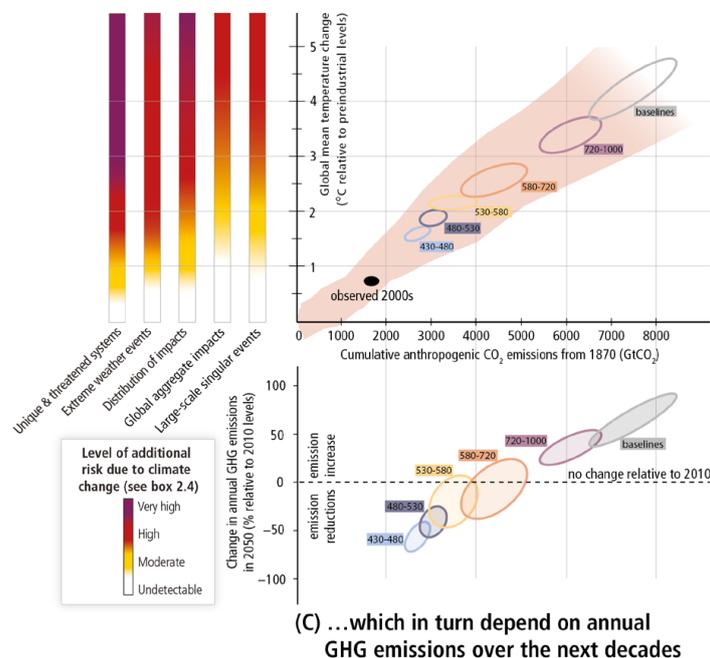
34. Ms. Christ emphasized that the link between **climate change and equity** has received a lot of attention and stressed the importance of assessing the issues of equity, justice and fairness raised by mitigation and adaptation action. In this respect, she highlighted different past and future contributions to the accumulation of GHGs in the atmosphere, different capacities to address mitigation and adaptation and varying challenges and circumstances. Capacities to address mitigation and adaptation vary, and insufficient adaptation would have a present impact on the potential for sustainable development. She added that options for equitable burden-sharing can reduce the potential for the costs of climate action to constrain development.

35. She introduced a graph illustrating the level of risks assessed by Working Group II (WGII) of the IPCC in its contribution to the AR5, including in regard to the five reasons for concern (RFC), for various levels of temperature increase (figure 2). Mr. Stéphane Hallegatte, IPCC, described how this figure connects actions with consequences for climate change by bringing together knowledge from the three IPCC Working Groups to illustrate that the risks from climate change depend on cumulative CO₂ emissions.

Figure 2

The relationship between risks from climate change, temperature change, cumulative carbon dioxide emissions and changes in annual greenhouse gas emissions by 2050

(A) Risks from climate change... (B) ...depend on cumulative CO₂ emissions...



Source: Summary for policymakers in the Synthesis Report the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.10. The figure shows the relationship among risks from climate change (panel A), temperature change and cumulative CO₂ emissions (panel B), and changes in annual GHG emissions by 2050 (panel C). See also figures 3, 4, 8, 9, 13 and 14 for additional explanations and considerations.

Abbreviations: GHG = greenhouse gas; 430–480 = scenarios leading to a concentration of 430–480 ppm CO₂ eq in 2100

36. He explained that limiting risks across the five RFC for a given increase in global mean temperature change (panel A) would imply:

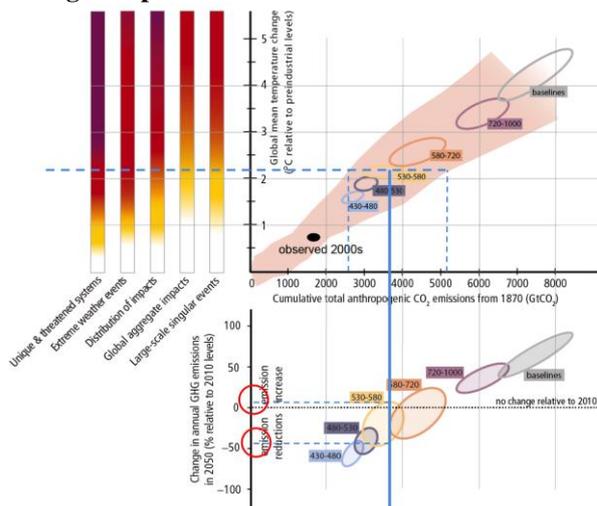
(a) In the **long term, a limit for cumulative CO₂ emissions** (panel B). This panel brings together information from: Working Group I (WGI) models (pink plume), which include the uncertainty from non-CO₂

gases and climate and carbon uncertainty, using likely ranges; and Working Group III (WGIII) models for different categories of scenarios (ellipses), which do not include climate and carbon cycle uncertainty but explore more comprehensively the scenario’s uncertainty for a range of CO₂ and non-CO₂ pathways, while considering cost effectiveness. While the carbon budget for a given increase in global mean temperature change could be estimated for average, high and low climate sensitivity (figure 3), the existence of a limited budget means that CO₂ emissions have to be reduced to zero to stabilize the global mean temperature;

(b) In the **near term, a constraint for changes in annual GHG emissions in 2050** relative to 2010 (panel C). This constraint depends on the sensitivity of the climate response (figure 4). For example, considering high climate sensitivity the emission reductions in 2050 would be in the range of -70 to -50 per cent (see also figure 14 that shows these correlations for 2 °C warming above pre-industrial levels).

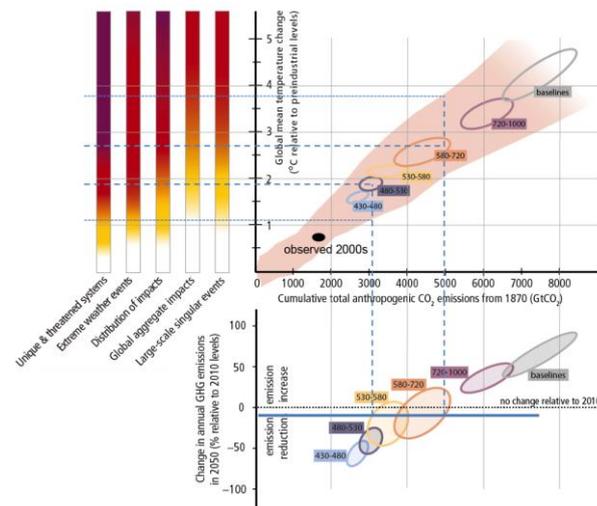
37. Mr. Hallegatte explained that figure 2 (IPCC SYR SPM.10) can also be used to determine, for a given level of reduction in the global emissions in 2050, the increases in global average temperature and the corresponding levels of climate risks. For example, figure 4 presents these values for 10 per cent emission reductions in 2050. He added that the figure does not show the likelihood of staying below a limit temperature for any particular range for GHG concentrations in atmosphere by 2100. This is shown in SYR table SPM.1 and is discussed partially in paragraph 63.

Figure 3
The carbon budget and the reductions in global emissions for a given level of increase in global average temperature



Source: Slide 16 of the presentation by Ms. Renate Christ (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed1-revisedrc_fin.pdf>. The figure illustrates how any levels of additional risks (top left, top dashed horizontal blue line) can be connected to GHG emission changes by 2050 (red circles) considering the best estimate (solid vertical blue line) and likely range of uncertainties from non-CO₂ gases, climate, and carbon cycle (dashed vertical blue lines). Added uncertainty arises from action on non-CO₂ gases, timing of pre-2050 action, and ambition of post-2050 action.

Figure 4
The global average temperature and the corresponding levels of climate risks for a given level of emission reductions in 2050



Source: Slide 22 of the presentation by Ms. Renate Christ (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed1-revisedrc_fin.pdf>. The figure illustrates how additional risks from climate change (top left, horizontal blue lines) depend on emission changes by 2050 (e.g. -10%, bottom horizontal solid blue line), but also on climate sensitivity and post-2050 action (here looking at average (dashed blue lines) and likely (thin dotted blue lines) range of climate sensitivity for ambitious (left vertical dashed blue line) and less ambitious (right vertical dashed blue line) post-2050 action).

B. Part 1: The adequacy of the long-term global goal in the light of the ultimate objective of the Convention and overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention based on the Synthesis Report of the Fifth Assessment Report

1. Presentations by experts

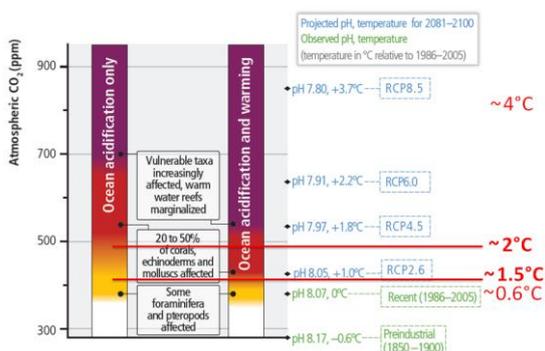
38. Mr. Hans-Otto Pörtner (IPCC) gave a presentation on the adequacy of the long-term global goal in terms of preventing unacceptable consequences for the adaptation of ecosystems and food production. He explained he would focus on Article 2 of the Convention, which contains its objective, including the stabilization of GHG concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate

system, and within a timeframe sufficient to allow ecosystems to adapt naturally to climate change and to ensure that food production is not threatened and economic development proceeds in a sustainable manner. He compared the affected sectors and long-term global goal with respect to key risks of impacts and avoided impacts.

39. At the **current level of warming of 0.85 °C** above pre-industrial levels, impacts have been observed on all continents and in all oceans, including: **displacements of marine, freshwater and terrestrial species; constrained increases in crop production; forest dieback due to drought and heat; and moderate risk from climate change to some unique systems**, which may rise if combined with other pressures. One of these systems is **warm water coral reefs**, which are under combined pressures, including the release of symbiotic algae and associated bleaching of coral due to warming. He cited the example of the Great Barrier Reef, which has already lost half of its live coral cover since 1985, due to cyclones, increased predation and bleaching.

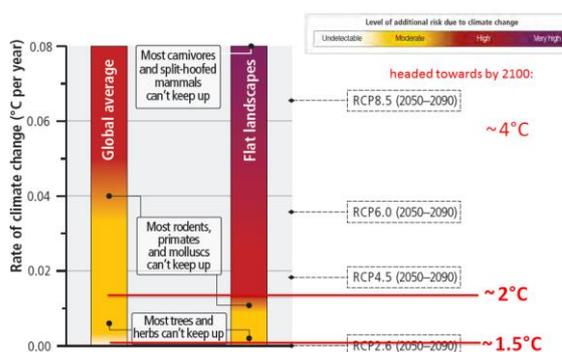
40. With regard to **latitudinal shifts of coral reefs** he noted that, while such shifts have occurred in the last interglacial period with temperature increases of less than 1 °, coral reefs will be under additional stress from acidification constraining redistribution. Mr. Pörtner explained that marine organisms in general are increasingly under **pressure, as the oceans are warming, acidifying and losing oxygen**. He added that the combination of ocean acidification with warming increases the risk levels for marine species (figure 5). In a world 1.5 °C warmer than in pre-industrial times, we are on the verge of moving to high risk for these organisms, while in a world 2 °C warmer than in pre-industrial times, the risk already becomes high for these ecosystems. For freshwater and terrestrial species, in a world 1.5 °C warmer, most trees and herbs would be at moderate risk from falling behind the moving climate zones. However, in flat landscapes, 2 °C warming means that climate change velocity would become too high for terrestrial and freshwater organisms to follow the moving climate zones (figure 6).

Figure 5
Risk for marine species impacted by ocean acidification only, or additionally by warming extremes



Source: Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 2.5, panel (B). The figure illustrates the increased risk for marine species when considering ocean acidification and heat exposure.

Figure 6
Risk for terrestrial and freshwater species impacted by the rate of warming



Source: Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 2.5, panel (A). The figure illustrates the species composition limited ability of terrestrial and freshwater ecosystems to follow the moving climate zones due to rate of warming.

41. On food security, Mr. Pörtner stated that at 2 °C of warming, **fisheries** will be under pressure from ocean warming, which will combine with the present overexploitation of stocks and with acidification and loss of oxygen. Although there is capacity to increase **crop production**, this has already been reduced because of climate change. In addition, in a world 2 °C warmer, even high adaptation will not be able to reduce risk to the currently low level.

42. He then turned to the **Arctic** summer sea ice and associated sea life, which is projected to be marginalized by mid-century in 'business as usual' scenarios. In an ambitious scenario, some of that sea ice may be preserved. As for **sea level rise**, with high mitigation and adaptation scenarios, we may limit global sea level rise to 1 m. Otherwise, sea level rise beyond 2100 may challenge natural and human systems, affecting habitat, freshwater resources and human society through flood events. He underlined that the sea level rose more than 7 m when the atmosphere had reached 400 ppm of CO₂ in the Pliocene (3–5 million years ago).

43. In concluding, he summarized the key findings of his presentation, highlighting that:

(a) **In a world 1.5 °C warmer** than in pre-industrial times: climate change velocity would be slow enough for most terrestrial and freshwater organisms to follow; up to half of coral reefs may remain intact; sea level rise may remain below 1 m; some Arctic summer sea ice may remain; ocean acidification impacts would stay at moderate levels; the capacity to increase food production would be reduced, but some scope would exist

for adaptation; some unique systems would be at high risk; and the risks of combined ocean acidification and warming would become more prominent;

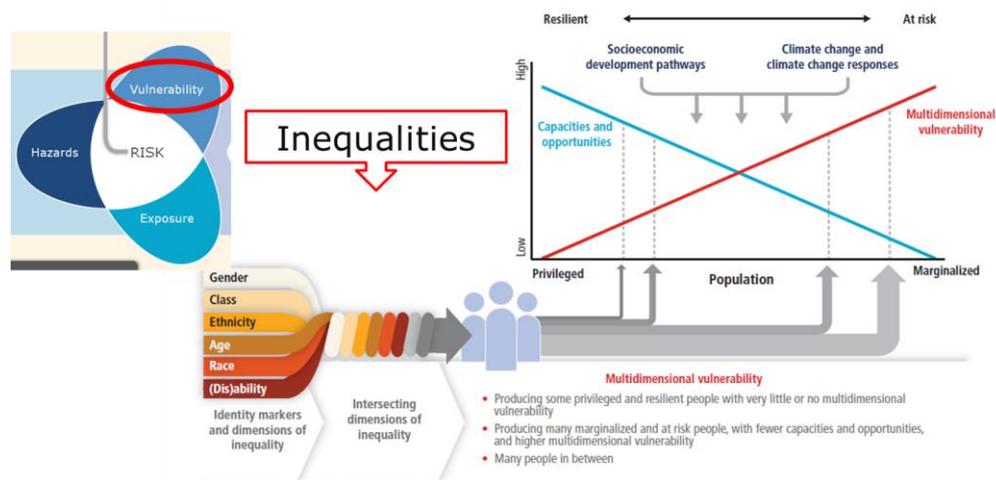
(b) In a world 2 °C warmer than in pre-industrial times: climate change velocity would become too high for some species to move sufficiently fast and follow their preferred temperatures; long-term sea level rise may exceed 1 m; Arctic summer sea ice may be lost; some unique systems would be at high risk; the risks of combined ocean warming and acidification would become high; and crop production would be at high risk with some potential for adaptation;

(c) In a world 4 °C warmer than in pre-industrial times: most projected climate risks for ecosystem would become impacts; biodiversity would be lost, and the catch potential of fisheries would be highly reduced; crop production would be at high risk; climate change velocity would be much too high for terrestrial and freshwater species to move sufficiently fast; long-term sea level rise would far exceed 1 m; Arctic summer sea ice would be lost; some unique systems would be marginalized; and the risks of combined ocean warming and acidification would become very high.

44. Ms. Petra Tschakert (IPCC) gave a presentation on the adequacy of the long-term global goal in terms of preventing the unacceptable consequences of climate change on sustainable economic development. She underlined that **sustainable economic development** can be **seen through** the lenses **livelihoods, food security, and economics**, and is **not only an outcome of climate change, but also shapes vulnerability to climate change**.

45. Differences in vulnerability and exposure to climate change arise from non-climatic factors and from multi-dimensional inequalities, which are often produced by uneven development processes. Development shapes inequalities and these inequalities shape differential risks from climate change (figure 7). **People who are socially, economically, culturally, politically, institutionally or otherwise marginalized are especially vulnerable to climate change** owing to multidimensional vulnerability, as well as owing to lack of capacities and opportunities for adaptation (right-hand side of figure 7).

Figure 7
Multi-dimensional inequalities



Source: Slide 3 of the presentation by Ms. Petra Tschakert (Intergovernmental Panel on Climate Change (IPCC)), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed4_tschakert_2.pdf>. The figure illustrates that multidimensional vulnerability is driven by intersecting dimensions of inequality, socioeconomic development pathways, and climate change and climate change responses (see also contribution of Working Group II to the Fifth Assessment Report of the IPCC, figure 13.5).

46. Ms. Tschakert stated that **climate-related hazards exacerbate other stressors**, such as socio-economic and environmental stressors, and have a negative impact on people and livelihoods, with the emergence of critical thresholds, when **all stressors converge**.

47. Regarding **future risks**, she noted that: climate change will amplify existing risks and create new risks for natural and human systems; risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development; and increasing magnitudes of warming increase the likelihood of severe, pervasive and irreversible impacts for people, species and ecosystems. She pointed to those risks that are relevant to sustainable development, such as ill health, water insecurity, service and infrastructure, violent conflicts or poverty traps (see figure 1 for representative key risks and the potential for adaptation for human and managed systems in various regions).

48. Ms. Tschakert then detailed the RFC, with a focus on human and managed systems. **At the current 0.8 °C of warming** above pre-industrial levels, aggregated risks to **unique and threatened systems** indicate that

indigenous people or other unique communities of peoples, such as Arctic communities and the Bolivian highlands, are already impacted by climate change.

49. For a **level of warming of 2 °C** above pre-industrial levels:

(a) **Unique and threatened systems:** many more moderate and high risks would emerge; indigenous people would be at risk of the loss of land, cultural and natural heritage; and cultural practices embedded in livelihoods would be disrupted (figure 8).

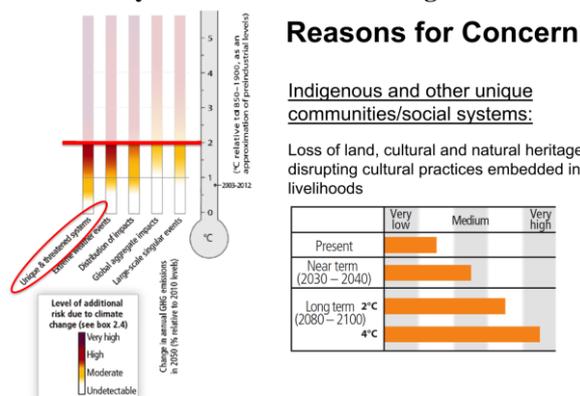
(b) **Extreme weather events:** high risks would exist for megacities in relation to the urban heat island effect, air pollution and differential vulnerabilities; urban housing and human health; displacement and permanent migration; livelihood struggles and conflict in resource-dependent livelihoods, such as agriculture and pastoralism; and high livelihood damage. She emphasized that ‘trapped’ populations are more vulnerable to environmental change because of their inability to move (figure 9, right-hand side of the figure);

(c) **Distribution of impacts:** she stressed that risks are increasingly unevenly distributed, affecting in particular: low-latitudes and low-income countries; shifts from transient to chronic poverty, and related social marginalization and food insecurity; and the elderly, children, the socially marginalized and outdoor workers, who are disproportionately at risk from heat stress;

(d) **Global aggregate impacts:** she underscored that while aggregate economic damages are quite moderate, these aggregates mask impacts across sectors and regions. She explained that the poor “are too poor to come up in the statistics” as they do not make a dent in the economic analysis. The evaluations are therefore incomplete, in part because they do not take into account large-scale singular events.

Figure 8

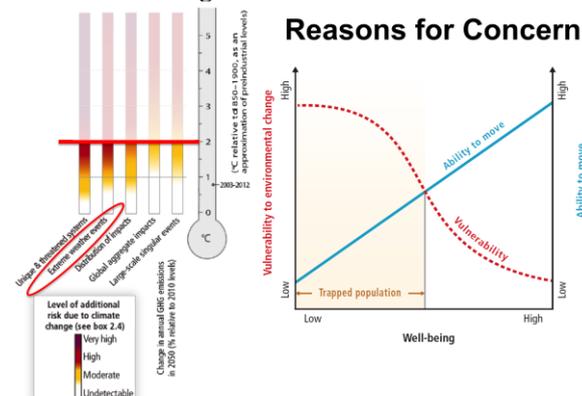
Reasons for concern due to impact on unique and threatened systems at 2 °C of warming



Source: Slide 8 of the presentation by Ms. Petra Tschakert (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed4_tschakert_2.pdf>. The figure shows the level of additional risk due to climate change for large and unique systems, at 2 °C of warming above pre-industrial levels.

Figure 9

Reasons for concern due to extreme weather events at 2 °C of warming



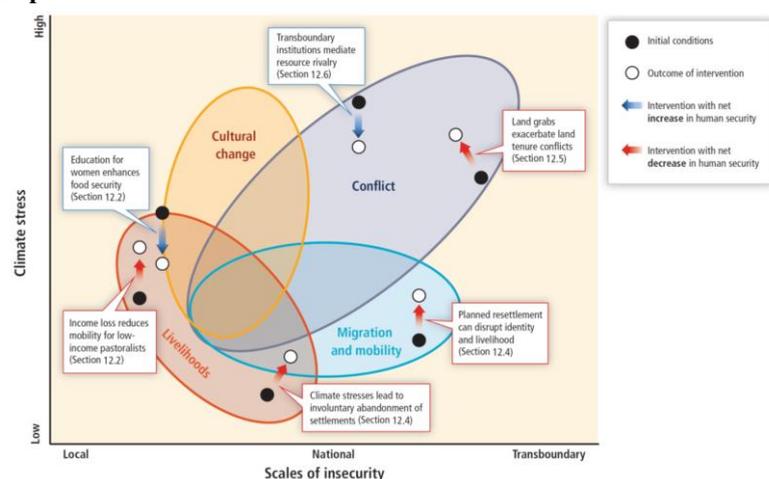
Source: Slide 10 of the presentation by Ms. Petra Tschakert (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/sed4_tschakert_2.pdf>. The figure illustrates the level of additional risk due to climate change for extreme weather events, at 2 °C of warming above pre-industrial levels.

50. For a **level of warming of 3 °C** above pre-industrial levels, she mentioned limits to adaptation in relation to: urban water supply systems, heat-sensitive people, productivity, food security and the loss of cultural identity. In particular, she referred to the declining adaptation potential in case of conflict over land acquisition and displacement. There are few estimates of the economic costs of a **warming of 3 °C** above pre-industrial levels.

51. Ms. Tschakert emphasized the multiple interactions between climate stress and the scale of insecurity at the local, national and transboundary levels, highlighting the effects of, for example, income loss on mobility, education of women on food security, and planned resettlements on livelihoods (figure 10).

52. In concluding, she emphasized that: **climate change is a threat to equitable and sustainable development**; averages and aggregates mask disproportional impacts and risks; critical thresholds for communities and society exist and are not visible from a global average; critical thresholds of climate stressors in combination with other stressors exacerbate livelihood struggles, especially among disadvantaged people; **a possible yardstick to assess the level of risk would be the transition from acceptable to unacceptable at the local level**; and **limiting the effects of climate change is necessary to achieve sustainable development and equity, including the eradication of poverty**.

Figure 10
Interactions at multiple levels



Source: Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 12.3. The figure shows the synthesis of evidence on the degree of impacts of climate change (climate stress) and scales of human security as they interact for livelihoods, culture, migration, and conflict.

53. Mr. Chris Field (IPCC) and Mr. Ottmar Edenhofer (IPCC) delivered a joint presentation on the adequacy of 2 °C in terms of risk management within planetary boundaries and progress towards the long-term global goal.

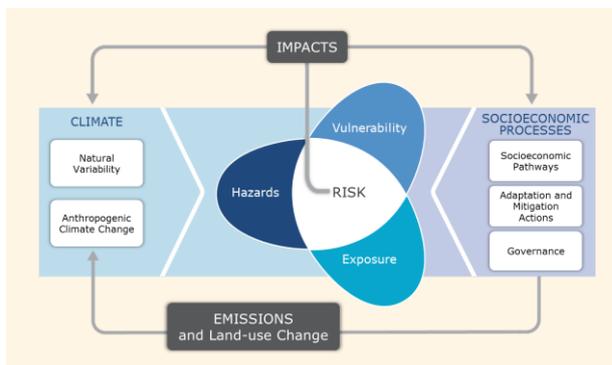
54. Mr. Field introduced the concept of a ‘**black elephant**’, which was described in an editorial by Mr. Thomas Friedman published in the *New York Times*. A ‘black elephant’, he explained, is a cross between a ‘black swan’, i.e. an unlikely, unexpected event with enormous ramifications, and the ‘elephant in the room,’ i.e. a problem that is visible to everyone, but that no one wants to address, even though we know that one day it will have vast, black-swan-like consequences. Mr. Field explained that climate change is a ‘black elephant’ problem as it combines: black swan risks, such as the collapse of the Antarctic ice sheet, which is a low-probability, high-impact event; and the elephant in the room, since it involves some elements that are difficult to assess, such as human population size, weak institutions and poor governance, inequality in income that marginalizes people, etc.

55. Ms. Katharine Mach (IPCC) briefly explained the concept of climate risks as introduced in the contribution of WGII to the AR5 (figure 11). She outlined key risks and the assessment of risks at present, near-term (approximately equivalent to a warming of 1.5 °C), and long-term (at 2 °C and 4 °C) with current and high adaptation. She also restated the WGII findings that an increasing magnitude of warming increases the likelihood of severe and pervasive impacts.

56. Ms. Mach stated that WGII assessed 102 key risks with low and high levels of adaptation. The SYR features 25 key risks across the regions of the world (see figure 1 for representative key regional risks). These risks are tied to physical, biological and human systems. She then introduced the concept on ‘**one unit of risk**’, as being the transition of a risk from one level to the next (e.g. from very low to low or from medium to medium-high). Noting that, using such a concept, **some 0.5 additional units of risks were estimated at 2 °C of warming above pre-industrial levels compared with 1.5 °C**, she stressed that for the latter, there is more scope for adaptation (figure 12). This type of analysis could extract additional information across regions and sectors for these two levels of global warming.

57. Ms. Mach pointed to an important caveat: the **near-term (2030–2040) and 2 °C in 2080–2100 are not strictly comparable**; some non-climate trends exacerbate risks; some non-climate trends moderate risks; and the risk assessment was not conducted by WGII for comparing the 1.5 °C and 2 °C targets. Mr. Field added that the **IPCC did not systematically assess risks due to warming levels between 1.5 °C and 2 °C above pre-industrial levels** owing to a lack of information, yet an analysis of the comparison between 1.52 °C and 2 °C shows that there are **consistent differences of about half of a risk unit or more**. In the light of the difficulty of predicting the black elephant risk, there is a value in **taking a precautionary approach and adopting a more stringent target**. Mr. Field underscored that across the risk analysis, investments in adaptation and the propensity for risk reduction are at risk of being overwhelmed.

Figure 11
Illustration of the core concept of Working Group II in the Fifth Assessment Report



Source: Summary for Policymakers in the contribution of Working Group II (WGII) to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change, figure SPM.1. The figure illustrates the constituents of risk being a combination of climate hazards, vulnerability, and exposure – the fundamental concept used throughout AR5 by WGII.

Figure 12
Reasons for concern due to extreme weather events at 2 °C of warming

Regional Key Risk Map
25 Key Risks

	Key Risks Assessed	Risk at 2°C > Risk 2030-2040 (current adaptation)	Risk at 2°C > Risk 2030-2040 (high adaptation)
Physical Systems	11	0.6	0.6
Biological Systems	5	0.7	0.7
Human Systems	9	0.6	0.6

Global, Regional, and Sectoral Key Risks in WGII Report
102 Key Risks

	Key Risks Assessed	Risk at 2°C > Risk 2030-2040 (current adaptation)	Risk at 2°C > Risk 2030-2040 (high adaptation)
Physical Systems	14	0.6	0.6
Biological Systems	27	0.3	0.4
Human Systems	61	0.6	0.5

Source: Slide 6 of the presentation by Ms. Katharine Mach (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/field_for_sed_12-2014.pdf>. The figure shows the increase in risks for key, global, regional and sectoral risks at 2 °C of warming above pre-industrial levels, with current and high adaptation (expressed in units of risks).

58. Mr. Edenhofer focused on a future pathway for adaptation, mitigation and sustainable development. In this context he emphasized that: (i) the **optimal balance among mitigation, adaptation and residual impacts cannot be determined with current knowledge**; (ii) **risks from adaptation and mitigation can be identified and managed through appropriate mitigation and adaptation measures**; and (iii) **mitigation and adaptation are complementary approaches for reducing climate change impacts over different time scales**.

59. Mr. Edenhofer added that if current emissions trends continue, even with adaptation, warming by the end of the twenty-first century will lead to high to very high risk of severe, widespread and irreversible impacts globally. Figure 13 shows these risks for a range of temperature increases corresponding to a ‘business as usual’ scenario and a median climate response. He then noted that, considering the full climate uncertainty, the minimum temperature increase might be lower, but the maximum temperature increase might also be much higher and significantly beyond what was assessed by IPCC (figure 13, top red arrows).

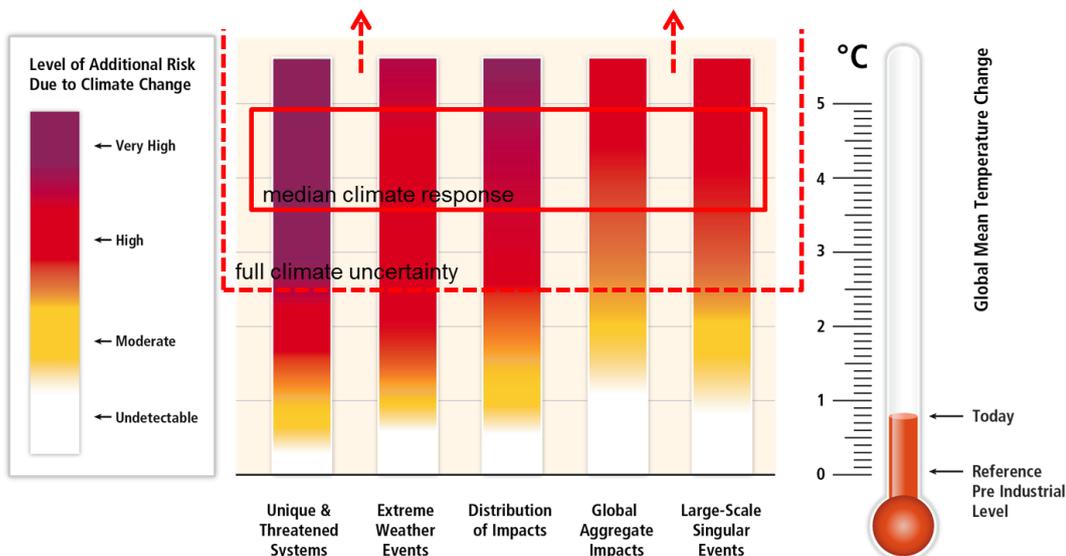
60. Mr. Edenhofer then explained that the IPCC explored the implications of a world warmer by 4 °C and 2 °C above pre-industrial levels, noting that the **1.5 °C limit is similar to the 2 °C one, but calls for additional scaling up of the challenging features** (see also paragraph 66).

61. Substantial cuts in GHG emissions over the next few decades, which would limit global warming below 2 °C, can significantly reduce risks of climate change by limiting warming in the second half of the twenty-first century and beyond (figure 13, risks at a 4.7 °C level of warming above pre-industrial levels compared with a 2 °C warming). Mr. Edenhofer stressed that mitigation action has co-benefits, but also risks. However, the **risks of mitigation do not involve the possibility of severe, widespread and irreversible impacts, as do the risks from climate change impacts**. He added that stabilization of atmospheric concentrations requires moving away from the baseline, or the ‘business as usual’ scenario, even for a less ambitious mitigation goal.

62. Mr. Edenhofer emphasized that cumulative emissions of CO₂ will largely determine global mean surface warming by the late twenty-first century and beyond. Limiting risks across RFC would imply a limit for cumulative emissions of CO₂. He underscored that the IPCC had found with high confidence that such a limit would require that **global net emissions of CO₂ decrease to near zero or below by 2100** and would constrain annual emissions over the next few decades. He cautioned, however, that some risks from climate damages are unavoidable, even with mitigation and adaptation.

63. Mr. Edenhofer then illustrated how figure SPM.10 of the AR5 SYR could be used to determine the reductions in **global emissions by 2050 needed to limit global warming to 2 °C, with a likely probability**. Considering the 430–480 category of scenarios in figure 14, this indicates an emission reduction range of **40–70 per cent in 2050 compared with 2010 levels**, clarifying that use of CO₂ removal technologies will be much more needed for a 40 per cent than a 70 per cent reduction.

Figure 13
Climate risks for ‘business as usual’ scenarios

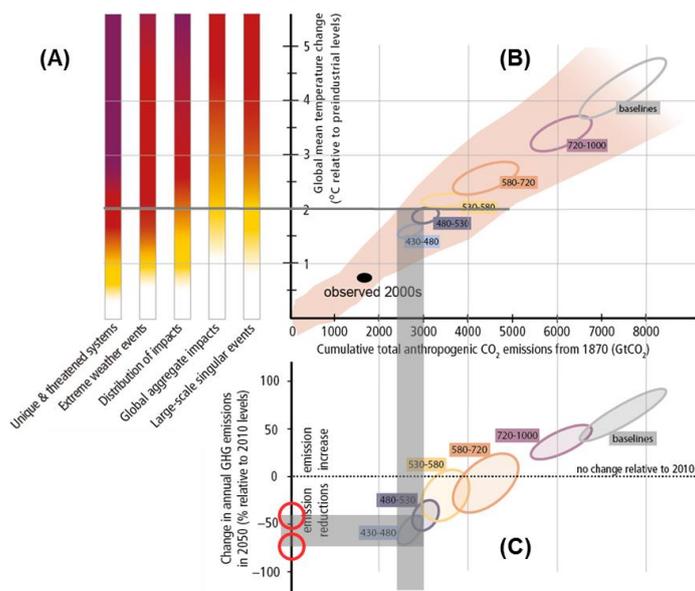


Source: Slide 2 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141202_sed_edenhofer_lima_final4.pdf. The figure shows the level of risks associated with reasons for concern without additional mitigation efforts beyond those in place today, and even with adaptation. Mr. Ottmar Edenhofer emphasized the uncertainties contained in these risk estimates, if fully considered mean possibly lower risks (bottom horizontal dashed line) but also very much higher risks (top red arrows) that even reach beyond what was assessed by IPCC.

Abbreviations: BAU = business as usual

64. With regard to **stabilization of atmospheric concentrations**, he stressed that this requires moving away from the baseline, regardless of the mitigation goal (figure 15). Both the scenarios for limiting global warming below 2 °C and below 3 °C require a fundamental departure from the ‘business as usual’ scenario and, in the short term, similar global emission reductions are needed. Scenarios leading to 1.5 °C warming (being consistent with the lowest range of the blue strip) would require more negative emissions.

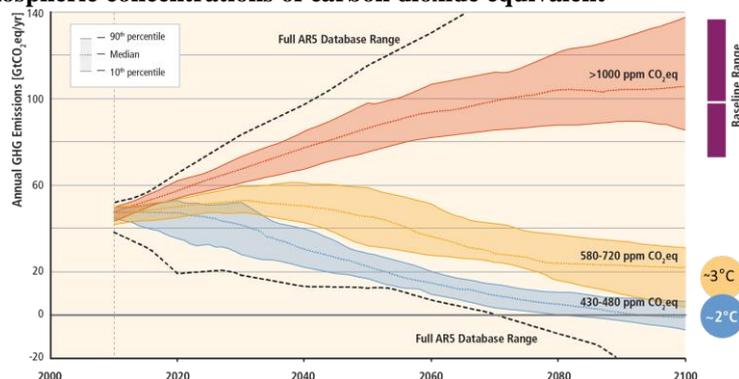
Figure 14
The relationship between risks from climate change, temperature change, cumulative carbon dioxide emissions and changes in annual greenhouse gas emissions by 2050 for 2 °C warming



Source: Slide 6 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141202_sed_edenhofer_lima_final4.pdf. The figure shows the relationship among risks from climate change (panel A), temperature change and cumulative CO₂ emissions (panel B), and changes in annual GHG emissions by 2050 (panel C), here illustrating a 2 °C of warming above pre-industrial levels (horizontal grey line) that corresponds to a 40 per cent to 70 per cent reduction in GHG emissions by 2050 (red circles) while implying a GHG concentration of 430–480 ppm CO₂ eq in 2100 through suitable post-2050 action.

65. Mr. Edenhofer highlighted the increased challenges of delayed mitigation pathways – particularly between 2030 and 2050. He stressed that **immediate action** before 2030 would widen options for multiple cost-effective mitigation pathways (figure 16, left-hand side panel) that are characterized by average annual CO₂ emissions reductions of about 3 per cent (middle panel) and would require roughly a doubling of the share of low-carbon energy technologies between 2030 and 2050 (right-hand side panel). **Delaying mitigation** increases the difficulty and narrows the options for limiting warming to 2 °C above pre-industrial levels. Scenarios with delayed mitigation action that can still achieve the 2 °C limit require a more ambitious mitigation profile after 2030. Average annual CO₂ emission reduction requirements increase to about 6 per cent between 2030 and 2050, and the share of low carbon energy technologies need to be more than tripled, which has significant risks. In this context, he emphasised that for reaching the 2 °C limit the Cancun pledges are only consistent with emission pathways that show such increased mitigation challenges.

Figure 15
Stabilization of atmospheric concentrations of carbon dioxide equivalent



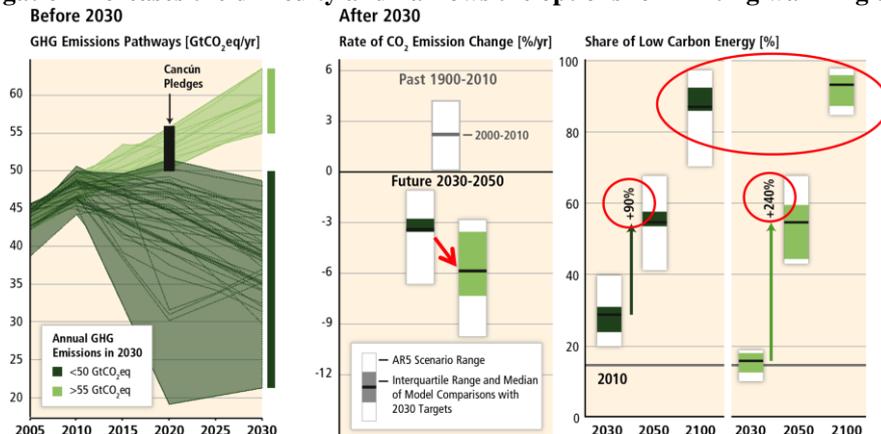
Source: Slide 7 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141202_sed_edenhofer_lima_final4.pdf>. The figure shows the GHG emission pathways up to 2100 for a ‘business as usual scenario’ (red), and for 3 °C (yellow) and 2 °C (blue) of warming above pre-industrial levels.

Abbreviation: GHG = greenhouse gas

66. **On the 1.5 °C limit**, he underscored that scientific evidence remains limited. While recognizing that a comprehensive assessment of this limit is difficult in the absence of multi-model comparison studies and with the overall limited number of studies, he outlined four characteristics of the existing studies of this limit, namely: (i) temperature overshoot and large-scale application of CO₂ removal technologies; (ii) immediate mitigation action; (iii) rapid scaling up of the full set of technologies; and (iv) the development along a low-energy demand pathway.

67. **On the costs of mitigation**, Mr. Edenhofer stated that although cost estimates vary significantly, they do not strongly affect global gross domestic product (GDP) growth; therefore, climate policy can be reconciled with economic growth. Global costs rise with the ambition of the mitigation goal.

Figure 16
Delaying mitigation increases the difficulty and narrows the options for limiting warming to 2 °C



Source: Slide 13 of the presentation by Mr. Ottmar Edenhofer (Intergovernmental Panel on Climate Change), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141202_sed_edenhofer_lima_final4.pdf>. The figure summarizes the implications of greenhouse gas emission levels in 2030 (left) for the subsequent rates of CO₂ emission reductions (middle) and scaling-up of low-carbon energy (right) needed for mitigation scenarios reaching 450–500 ppm by 2100 comparing Cancun Pledges (light green) with more ambitious mitigation actions by 2030 (dark green).

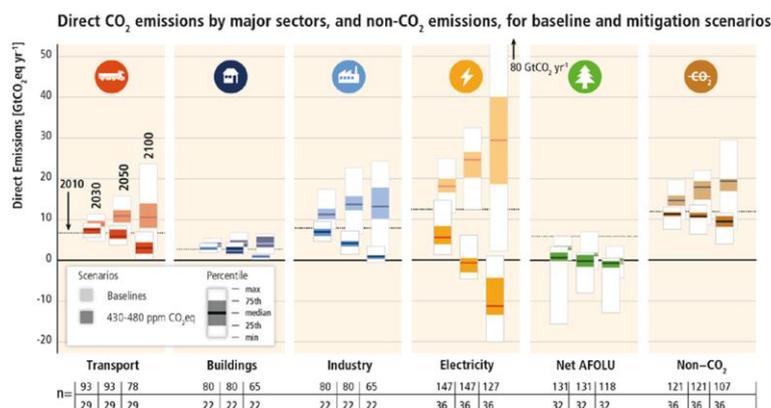
Abbreviation: GHG = greenhouse gas

68. In concluding, he emphasized that climate change is a global commons problem, which requires international cooperation and coordination. He stressed that for the twenty-first century, the limiting factor is not the amount of fossil fuel in the ground, but the limited disposal space in the atmosphere, which is why low-stabilization pathways are so demanding in terms of technological and institutional requirements.

69. Mr. Ramón Pichs-Madruga (IPCC) presented key findings summarized in the AR5 SYR on climate policies, technologies and finance. He emphasized that the previous presentations had shown that: a combination of adaptation and substantial and sustained mitigation can limit climate change risk; there are important technological, economic, social and institutional challenges related to climate response; and delaying mitigation will substantially increase challenges and costs related to limiting warming. He emphasized that **well-designed systemic and cross-sectoral mitigation strategies are more cost-effective in cutting emissions than a focus on individual technologies and sectors** (figure 17).

Figure 17

Cross-sectoral mitigation strategies are more cost-effective than a focus on individual technologies or sectors



Source: Summary for policymakers of the Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure SPM.14. The figure shows CO₂ emissions by sector and total non-CO₂ greenhouse gas emissions (Kyoto gases) across sectors for the baseline (faded bars) and mitigation scenarios (solid-colour bars) by 2030, 2050, and 2100 that reach about 450 ppm CO₂ eq concentrations in 2100.

Abbreviation: GHG = greenhouse gas

70. Emphasizing that **adaptation and mitigation are complementarity response strategies**, Mr. Pichs-Madruga said substantial emission reductions over the next few decades could reduce climate risks in the twenty-first century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the long term, and contribute to climate-resilient pathways for sustainable development.

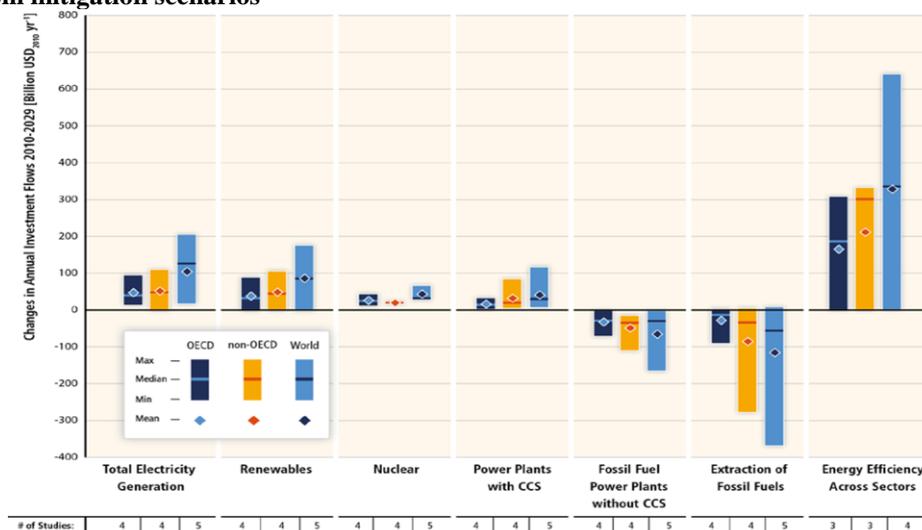
71. He added that while many adaptation and mitigation options can help address climate change, **no single option is sufficient by itself**. He listed common enabling factors that underpin adaptation and mitigation responses: effective institutions and governance, innovation and investments in environmentally sound technologies and infrastructure, sustainable livelihoods, and behavioural and lifestyle choices.

72. He emphasized that limiting the effects of **climate change** is necessary to achieve **sustainable development and equity, including poverty eradication**. He pointed out that countries' past and future contributions to the accumulation of GHGs in the atmosphere are different. Countries also face varying challenges and circumstances, and have different capacities to address mitigation and adaptation.

73. Mr. Pichs-Madruga then addressed the questions of **equity, justice and fairness** related to climate change responses, such as those related to the fact that: many of those most vulnerable to climate change are those who have contributed the least to this challenge; delaying action shifts the burden to future generations; insufficient adaptation responses to emerging impacts are already eroding the basis for sustainable development; and evidence suggests that outcomes seen as equitable can lead to more effective cooperation. He stated that cooperative responses, including international cooperation, are therefore required to effectively mitigate GHG emissions and address other climate change issues. Furthermore, he emphasized that the effectiveness of adaptation can be enhanced through complementary actions across levels, including international cooperation.

74. **On policies, technologies and finance**, Mr. Pichs-Madruga stated that effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and subnational. Policies across all scales, supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation. Substantial reductions in emissions would require large changes in investment patterns (figure 18).

Figure 18
Change in annual investment flows from the average baseline level over the next two decades for 430–530 ppm mitigation scenarios



Source: The Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, figure 4.4. The figure shows change in annual investment flows from the average baseline level over the next two decades (2010 to 2029) for mitigation scenarios that stabilize concentrations (without overshoot) within the range of approximately 430–530 ppm CO₂ eq by 2100.
Abbreviations: CCS = carbon capture and storage; OECD = Organisation for Economic Co-operation and Development.

75. In concluding, Mr. Pichs-Madruga focused on the relationship between climate change responses and sustainable development, emphasizing that comprehensive strategies in response to climate change that are consistent with sustainable development take into account the co-benefits, adverse side-effects and risks that may arise from both adaptation and mitigation options. He stressed that the IPCC found with high confidence that there are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses. The IPCC also found with medium confidence that successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond.

2. General discussion

76. The ensuing discussion was guided by the following questions on theme 1 of the review:

(a) What are the salient messages from the AR5 SYR relevant to the 2013–2015 review? What are the strategies for risk reduction and for managing adaptation and mitigation? What is the relationship among risks of climate change, cumulative CO₂ emissions and annual GHG emissions over the next decades?

(b) How does the AR5 contribute to operationalizing Article 2 of the Convention, including with regard to anthropogenic interference with the climate system and associated risks or dangers to food production, sustainable economic development and ecosystem adaptation? How do these risks grow as we move from 1.5 °C to 2 °C of global warming? What does the AR5 SYR tell us about limiting global warming to 2 °C?

77. Mr. Fischlin suggested Parties focus on how the SED operationalizes Article 2 of the Convention, and addressed questions such as: what does dangerous interference mean? If value judgment has to be introduced to determine the acceptability of risk, how adequate is the long-term global goal? By when, and by how much, do we have to mitigate and foster adaptation? Are there barriers or enablers we should pay attention to?

78. A Party welcomed the **comparison of impacts between 1.5 °C and 2 °C** of warming above pre-industrial levels. She asked **why in aggregate there is only a one half point increase in risk between a 50 per cent (at 1.5 °C) and a complete loss (at 2 °C) of coral reefs**. The expert clarified that he was talking about a marginalization of coral reefs, not their total disappearance, and the degree of this marginalization. Some organisms may not become completely extinct but may not be able to provide the services they are currently providing. He added that this can mark a difference between the local and the global views, as the degree of risk change between 1.5 °C and 2 °C may be much greater for the affected regions than at the global level.

79. One Party noted that “we are already facing a lot of trouble”, emphasizing that even at 1.5 °C of warming above pre-industrial levels, risks to unique and threatened systems are assessed as high. He added that climate impacts are catastrophic for his country, and that **qualifying the risks related to the distribution of impacts as “moderate” is not convincing**. An expert explained that in the regional chapter of AR5 (the Oceans and Australasia), the IPCC has assessed the risks to coral reefs as high in the near term and very high for the two regions in the long term at 2 °C of warming, emphasizing the regional differences in the assessment of risks to

these ecosystems. In response to a request for clarification on the level of risk associated with the distribution of impacts, the expert explained that the level of risk is related to the number of causal links that the IPCC was able to assess in developing the RFC. For a given country, coral reefs may be essential to the lifestyle pursued, but the IPCC would not be able to make the necessary connections because the assessment is not carried out at that level. Furthermore, the analysis does not allow characterizing every possible combination of risks that has potential impacts.

80. One Party commented that we know from WGI that for representative concentration pathway (RCP) scenario 2.6 of the IPCC the mean increase in temperature at the end of the century will be 1.6 °C (0.9–2.3 °C) and for scenario RCP4.5 2.4 °C (1.9–4.2 °C). Given the overlaps between these temperatures, he asked how the **differential level of impacts for 1.5 °C and 2 °C of warming can be quantified with any level of certainty, and what the scientific community needs for more certainty in the next assessment cycle of the IPCC for a more accurate result in terms of differential impacts**. An expert replied by emphasizing the importance of the caveat mentioned in his presentation on the different timeframes of impacts. He explained that WGII “took a cut” at specific examples where risk levels could be ascertained for a warming of 1.5 °C and 2 °C above pre-industrial levels. He added that there are currently few examples in the literature to characterize risks between these two levels of warming, and that WGII made some extensions beyond the published literature. For future assessment, the scientific community needs to focus more on differential impacts. He stressed that at the present stage, we have few examples and some interesting conceptual links that suggest the differences, but they are only documented in a few cases.

81. On Ms. Tschakert’s presentation, one Party asked about the **impacts of climate change on poverty reduction** and, quoting chapter 13 of the WGII report, he stated that climate change is expected to slow down economic growth and make poverty reduction more difficult for a warming of 2 °C, in particular in vulnerable countries. He then asked for a confirmation that a warming of 2 °C represents a substantial threat to the sustainable development of most the vulnerable countries. In response, the expert confirmed this finding of the WGII report.

82. Another Party asked if literature published after the IPCC cut-off dates on the **possible collapse of the West Antarctic Ice Sheet** may alter the assessment of the IPCC in relation to the risk of this large-scale singular event. An expert replied that it is too early to draw conclusions as there is no assessment of this literature yet. Another expert added that the current understanding is insufficient to make the assessment, and that the AR5 findings would not change with the few articles published after March 2013.

83. One Party asked the **extent to which risk can be reduced through adaptation**, noting that **other stressors also impact vulnerability and exposure**, such as socioeconomic pathways and governance. An expert responded that some risks have a lot of space for adaptation, while others have little. Key risks that have less adaptation potential relate to ecosystems where human interventions lead to reaching a limit, or when a relatively low physical or biological boundary was reached. Those are areas where addressing vulnerability or exposure has little prospect to make a difference. He added that assessing prospects for adaptation is still “a very imprecise science”.

84. One Party asked, in the context of the options for staying under 2 °C of warming and of global GHG emissions approaching zero or below zero in 2100 for scenarios limiting warming below 2 °C, **what will be the pathways for non-CO₂ emissions**. He also asked how agricultural emissions and non-CO₂ gases should be considered when determining the desired level of emissions in 2100. An expert explained that although reducing non-CO₂ emissions can be an important element of mitigation strategies, the cumulative budget of CO₂ emissions determines the temperature, and long-term warming is mainly driven by CO₂ emissions.

85. In response to a question by one Party on how the IPCC is emphasizing the role of **indigenous knowledge** in adaptation, an expert stressed that while adaptation can relate to infrastructure, there are other approaches to adaptation such as structural institutional and social measures (see table SPM.1 of AR5 WGII). Among social measures, there are specific adaptation measures referring to learning and knowledge sharing, with use of indigenous knowledge and participatory action. She added that the IPCC emphasized the importance of a co-production of knowledge that includes indigenous knowledge. Another expert underlined that, to date, the application of indigenous knowledge has been “spotty”.

86. One Party noted the need for a process to assess progress towards the long-term global goal, and asked how one should consider the adequacy of the long-term global goal in the light of **past and present contributions**. He suggested assessing the adequacy of the long-term global goal, including long-term perspectives, based on a **temperature increase approach**, and considering past and future contributions. One expert underscored that the IPCC provided information consistent with its mandate, and cannot go beyond this mandate to determine what the long-term goal should be or how to translate this goal into risks. Another expert added that the IPCC cannot make a value judgment related to historical responsibility. He pointed to the AR5 chapter on historical emissions, ethical issues and equity. On the choice of appropriate metrics and the global

warming potential, he explained that the IPCC has evaluated the pros and cons of various metrics, referring to chapters 2, 3 and 6 of the contribution of WGIII to the AR5.

87. The ensuing discussion was guided by the following questions on theme 2 of the review:

(a) We heard from the IPCC that increasing magnitudes of warming will increase severe, widespread and irreversible impacts of climate change. In the light of this, what are the risks assessed by your organization on human health, food production and other ecosystem services at a 2 °C or 1.5 °C level of global mean warming compared with pre-industrial levels, and how does your organization contribute to reducing and managing these risks?

(b) What is the gap between current mitigation and adaptation efforts and those required to achieve the long-term global goal as characterized by a 2 °C or 1.5 °C level of warming relative to pre-industrial levels? How can this gap be bridged?

(c) What policy options has your organization identified for the decarbonization of the energy system called for by pathways consistent with limiting warming below 1.5 °C or 2 °C compared with pre-industrial levels? What are the economic and technological risks associated with this decarbonization?

(d) How effective have the steps taken by your organization been in terms of supporting national activities aimed at minimizing the impacts of climate change? What barriers have your organization encountered and how has it succeeded in overcoming them?

(e) Which policies and measures has your organization identified as effective to bridge the emissions and adaptation gap, and how can these policies and measures be emulated?

88. One Party asked if the information presented came from the various contributions of the Working Groups, or only from the SYR. Pointing to **differences between the carbon budget and emission reductions for remaining under 2 °C of warming presented by WGI (14–96 per cent in 2050 below 1990) and WGIII (40–70 per cent in 2050 below 2010)**. He also asked how this information can be used for decision-making. An expert clarified that the requirement to reduce emissions by 40–70 per cent by 2050 to reach the long-term global goal is to be read with the “cost effectiveness” qualifier. He added that the main difference between WGI and WGIII findings comes from the fact that WGIII focused on cost-effective emission reduction profiles while considering explicitly societal uncertainties, such as delaying actions or availability of technologies. Another expert clarified that the uncertainty range (14–96 per cent in 2050 below 1990 with median 50 per cent) shown in the figures presented by WGI is related to the uncertainty in geophysical response and is based on the assessment of one scenario (scenario RCP2.6). While these uncertainties are taken into account in the assessments reported in the SYR, WGIII and the SYR further report an uncertainty range (40–70 per cent in 2050 below 2010) that is based on scenario and societal uncertainties while considering cost effectiveness. Further hedging against the geophysical uncertainty range reported by WGI would then imply deeper emission reductions by 2050 than those ranges currently reported by WGIII.

89. The same Party also asked **why observed impacts of climate change were not presented at this meeting** and if IPCC experts had presented graphics showing the amount of emissions of countries according to different development levels. An expert indicated that there is no slide on impacts that have already occurred, although these are relevant to the assessment of future risk, but these are changes that occurred at global warming of less than 1 °C. Further, he noted that the set of impacts that have been attributed so far to climate change is strongly constrained by the available studies. Another expert said no graphics relating to different levels of development had been presented.

90. **On managing risk**, one expert explained that it involves **reducing vulnerability and exposure** through, for example, human development, increasing livelihood security, poverty alleviation, ecosystem management or disaster risk reduction.

91. One Party asked **how the assessment of the RFC on distribution of impacts could be moderate if climate risks for Africa in the regional chapter are assessed as high or moderate**. An expert explained that RFC are an average or an aggregate of risks, and do not refer to any specific region. She pointed to the AR5 chapter on Africa, which confirms that any regional summary cannot be captured in the global summary because of the strong regional and sectoral differences (the aggregate level masking regional and sectoral differences) (see also para. 49 and 52 above).

92. One Party referred to the mapping of cumulative CO₂ emissions, commenting that about 275 Gt CO₂ could be further emitted while limiting temperature rise to 1.5 °C, which according to their calculation would mean that **only 7.9 years of emitting GHGs at current levels remains**. One expert said that when the temperature bar is lowered, there is a double change, more action is required to reduce emissions sooner, and more action is needed to achieve negative emissions. The calculation of the number of years of emissions disregards the possibility to have negative emissions, and makes the challenge look more difficult than it

probably is. The same Party then asked about the likelihood of achieving such negative emissions. One expert underscored that WGIII presents scenarios without likelihoods and that achieving negative emissions is an underlining requirement for 1.5 °C stabilization pathways. He added that if some technology is not yet available, the IPCC drew the consequences in terms of increased costs and of the feasibility of limiting warming. Another expert underlined that some technologies can come with trade-offs on land use, and that the scenarios also depend on the choices made regarding these trade-offs, not only on the availability of technologies.

93. One Party asked about the **practicality of achieving negative emissions at the end of the century**. He also queried whether making no assumptions on this practicality would affect the scenarios. An expert responded that achieving negative emissions depends on costs, trade-offs and the feasibility of various scenarios. He stated that WGIII did not come up with a conclusion regarding trade-offs, including on biodiversity, as it is up to decision makers to take into account factors related to bioenergy, which are outlined in an annex to the WGIII report. If bioenergy with CCS is not available (BECCS), mitigation costs increase. Furthermore, the more stringent the target, the more one needs to rely on other carbon removal technology. With respect to energy supply, the most risky part related to the technology availability of CCS relates to storage technologies, which have not been assessed in detail. Another important element is the fact that if CCS is available, agriculture emissions reductions can be more moderate. If BECCS is not available at a large scale, the land use and forestry sector has to make a larger contribution to the mitigation effort.

94. One Party asked about the **global costs associated with adaptation and loss and damage**, and if an assessment of the **costs of MOI** had been carried out. An expert underlined the difficulty of distinguishing between the costs of adaptation and the costs of residual impacts. He added that directly comparing the cost figures in WGII and WGIII reports would be “very misleading”, since the cost of climate change in WGII is for limited warming (2 °C), i.e. for scenarios in which ambitious mitigation takes place, at a cost. So mitigation and climate change costs need to be added, more than compared. Moreover, these two estimates have their limits and problems, and should be used with care. The IPCC consensus is that these numbers are insufficient to determine the appropriate objective of global climate policy.

95. One Party commented that in order to consider the adequacy of the long-term global goal, one needs to consider at least three aspects, namely **risks at a certain temperature goal, avoided impacts** that would be achieved and the **feasibility** of this long-term global goal. She requested a clarification as to why he had used scenario RCP2.6 to identify the impacts of 1.5 °C of global warming, considering that this scenario was usually representative of the 2 °C limit. She added that there is limited likelihood of achieving the 1.5 °C limit. The expert explained that he used scenario RCP2.6 because it is the closest to 1.5 °C limit, despite exceeding it. The expert added that he also based the presented findings on other scenarios and sources, not only using scenario RCP2.6 based data. Another expert added that WGI provided a likely range for each scenario, and that for scenario RCP2.6, it gives a likely range of not exceeding 2 °C. He emphasized that WGI did not assess the likelihood of staying below 1.5 °C.

96. One Party asked if in the figure 14 representing the levels of risk for the various **RFC**, the IPCC had **considered adaptation**. An expert explained that the graph does not make specific assumptions on adaptation, and that the purple colour in the figure is associated with the difficulty of making progress on adaptation. Another expert added that all RFC take into account autonomous adaptation as well as limits to adaptation in the case of RFC1, RFC3 and RFC5, independent of the development pathway, as detailed in the caption to figure 19.4 of the WGII report.

97. **On figure 2** (figure SPM.-10 in the AR5 SYR), one Party asked if **the numbers had been set without considering uncertainties**, such as the likelihood for achieving a temperature limit and the availability of technologies and technology transfer. An expert pointed to references in the AR5 to technology policy and how it complements other policies. The AR5 includes assessments of the costs of various technologies, which could serve as input in considering these technologies and their risks.

98. In response to a question on the **adverse effects of various mitigation technologies**, an expert drew attention to the fact that in the AR5, the IPCC had considered various enabling factors for technology transfer, including institutional arrangements, the provision of finance and the capacity to absorb the technologies adapted to each region.

99. On risk framing and the concept of high adaptation, one Party said that he understood from SED 3 that **high adaptation only has physical and not social or economic constraints**; hence it refers to transformational adaptation, which includes measures such as forced relocation. He added that such a measure is not an option for his country, as it implies fundamental changes in livelihoods and cultural values. An expert clarified that there was no WGII-level guidance that prevented authors from considering relocation as an adaptation option. The definition of a highly adaptive state was left with the writing team to assess, depending on the cultural environment.

100. On the **different costs of achieving the 1.5 °C and 2 °C limits**, one Party noted that the 1.5 °C scenarios require a faster deployment of low-carbon technologies, which imply a higher cost, but that the IPCC had not assessed the costs of these mitigation scenarios. An expert replied that IPCC cost-effective scenarios start with effective mitigation scenarios before 2020. Delayed mitigation action translates to more mitigation costs. He added that the IPCC only reported on the mitigation costs for stabilisation levels analysed in a multi-model, inter-comparison exercise. Since no such multi-model exercises were available for the 1.5°C limit, the mitigation cost was not provided.

101. A representative of civil society asked if it is correct to assume that **if optimal conditions are not achieved in terms of the availability of technologies, zero net emissions would have to be reached earlier than 2050**. She added that CCS is much discussed and not much deployed, prompting questions regarding the implications of its unavailability. An expert pointed to AR5 SYR table SPM.-2, which indicates that mitigation costs increase where CCS is unavailable. He underscored that not all models are successful in carrying out a scenario reaching the 2 °C limit without the wide-scale deployment of CCS. The limited availability of technology leads to the infeasibility of the target or a cost increase.

C. Part 2: The adequacy of the long-term global goal in the light of the ultimate objective of the Convention and overall progress made towards achieving the long-term global goal, including a consideration of the commitments under the Convention based on information from United Nations organizations

1. Presentations by experts

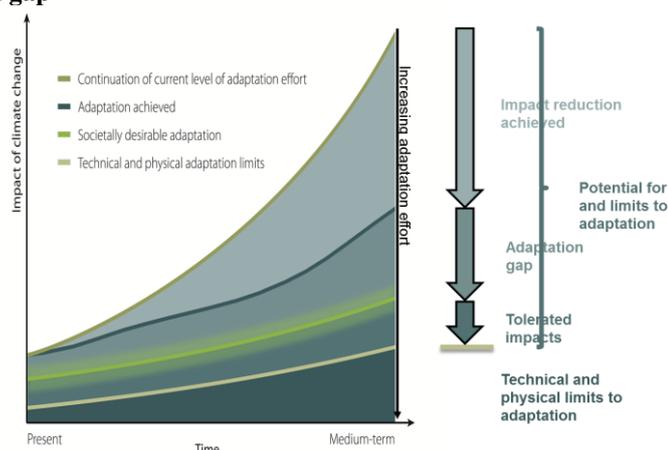
102. Mr. Keith Alverson (UNEP) presented the 2014 *Adaptation Gap Report*, which proposed a **framework for defining adaptation gaps**, as well as a preliminary assessment of the gap between adaptation needs and reality. He explained that UNEP has been producing the *Emissions Gap Report* for several years, and that based on the request from Parties, UNEP carried out a preliminary analysis of a similar assessment for adaptation. He noted that **estimating the adaptation gap is far more challenging than calculating the emissions gap** because of the lack of a globally agreed goal or metrics for adaptation, and due to the fact that adaptation is a response to specific climate risks and impacts that are local in nature and vary over time.

103. He described a graph defining adaptation gaps (figure 19), which shows the difference between the present to medium-term impacts of climate change given present adaptation measures (or the business as usual trajectory) and a trajectory with additional adaptation measures (or a societally desirable adaptation trajectory). He underlined that the gap is therefore the difference between what can be achieved with enhanced adaptation action and what society deems as the goal in terms of adaptation. He added that this societal goal is not zero because **society is ready to tolerate some amount of impact of climate change**, which is determined by local cost-benefit analyses, and some impacts are beyond our technical or physical ability to adapt.

104. On the **financial gap**, he pointed out that a major adaptation funding gap is likely, particularly after 2030, unless new and additional finance for adaptation becomes available. Many global estimates of this funding gap for developing countries exist. According to the World Bank, they range from USD 70 to 100 billion per year globally by 2050.¹⁴ In 2014 *Adaptation Gap Report*, the authors assessed existing estimates global, sectoral and national estimates, which indicate that the costs of adaptation are likely, at a minimum, to be two to three times higher than World Bank estimates by the 2030s; and could be four to five times higher towards 2050 when results of global, regional, national and sectoral studies are aggregated. He stressed that adaptation costs grow very rapidly over time and are emission dependent. By 2050, adaptation costs could be **around twice as high in a 4 °C warming scenario than in a 2 °C warming scenario**, underlining that the best way to adapt to the impacts of climate change is to mitigate global warming (figure 20).

¹⁴The World Bank. 2010. Economics of Adaptation to Climate Change - Synthesis Report. Available at <<http://documents.worldbank.org/curated/en/2010/01/16436675/economics-adaptation-climate-change-synthesis-report>>.

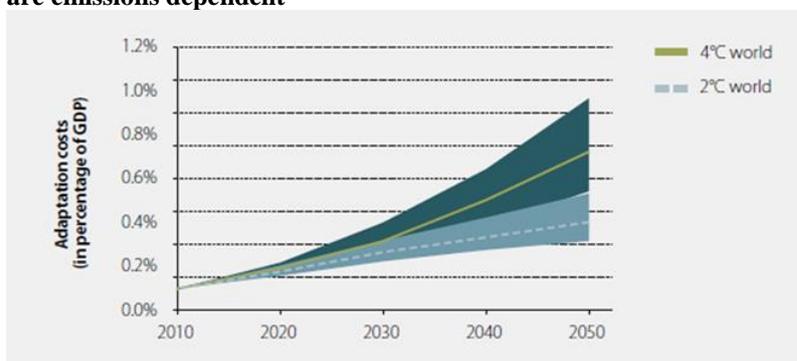
Figure 19
Defining the adaptation gap



Source: Slide 3 of the presentation by Mr. Keith Alverson (United Nations Environment Programme), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_alverson.pdf. The figure illustrates, in a schematic form, the concept of the adaptation gap used in the United Nations Environment Programme *Adaptation Gap Report*, which can be defined at the global or local level. The adaptation gap for any point in time is here the remaining difference between already implemented adaptation (dark green line at the bottom of the top grey area) and the potentially achievable adaptation as determined by technical and physical limits (yellow top of bottom dark area). The gap can then further be reduced by the tolerated impacts (difference between light lines in the middle).

105. Mr. Alverson underscored the difficulty of distinguishing between finance made available for adaptation and that for development or other purposes. Public finance committed to activities with explicit adaptation objectives ranged between USD 23 and USD 26 billion in 2012–2013, of which 90 per cent was invested in developing countries. He indicated that adaptation finance flows have increased in recent years across all sources of finance and are increasingly mainstreamed in development cooperation. He pointed out that only about two per cent of total adaptation finance came from multilateral mechanisms (USD 0.6 billion committed to developing countries in 2013), but noted an increasing trend.

Figure 20
Adaptation costs are emissions dependent



Source: Slide 5 of the presentation by Mr. Keith Alverson (United Nations Environment Programme), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_alverson.pdf. The figure shows that by 2050, adaptation costs could be around twice as high in a 4 °C world scenario (solid green line and dark green area) than they are in a 2 °C scenario (dashed line, grey area). The areas show the likely (66 per cent) range of costs.
Abbreviation: GDP = Gross Domestic Product

106. While stressing the **need to urgently scale up climate adaptation finance flows**, he underlined that: the Green Climate Fund (GCF) can play a central role in bridging the adaptation funding gap and its capitalization is close to reaching USD 10 billion; adaptation costs and finance needs are emission dependent and will rise more quickly under higher emission scenarios; risks and needs are not equally distributed, and least developed countries (LDCs) and small island developing States (SIDS) are likely to have much higher adaptation needs; and current analyses underestimate finance flows, as they do not include private sector and domestic spending.

107. On the **technology gap**, estimates are largely drawn from the technology needs assessments communicated by Parties, as well as the technology made available through mechanisms such as the Climate Technology Centre and Network (CTCN) of the UNFCCC and others. Mr. Alverson underlined that the most appealing technology solutions are those that serve a variety of purposes above and beyond climate adaptation. There is a trade-off between the need to measure adaptation and the use of these integrated measures, which are

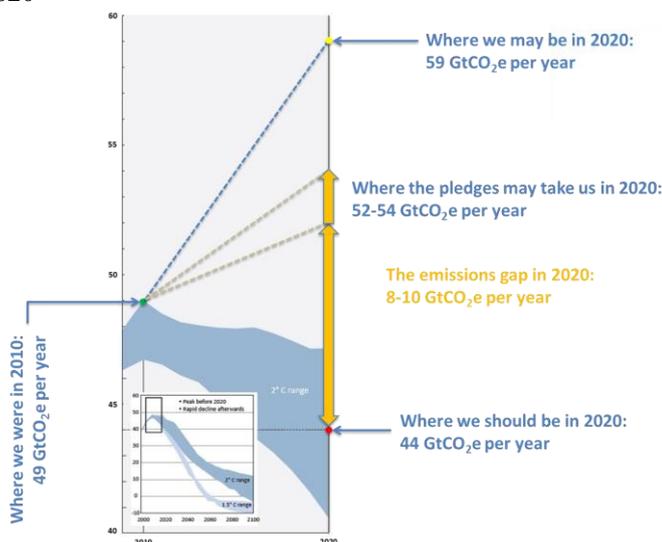
more difficult to quantify than those solely targeting climate adaptation. He also underscored the importance of the acceleration of the diffusion of existing technologies and the role of research and development in adjusting existing technologies to local conditions. He identified scope for addressing gaps in knowledge production, knowledge integration, and knowledge transfer and uptake through a more efficient use of existing knowledge, systematic approaches and analysis, and improved monitoring and evaluation. To sum up, **there is significant potential to reduce the overall adaptation gap in the short and medium term through knowledge and technology.**

108. On the **knowledge gap**, he stated that a large portion of this gap is likely to be related to the transfer of knowledge. He referred to an article published in November 2014 in *Science*, which argues that **universal education is the key to adaptation**. The article points out that countries with the highest level of education are those that are best adapted to extreme climate events. In the *Adaptation Gap Report*, the authors have attempted to define a knowledge goal, particularly in assessing the effectiveness of adaptation action. He described the Adaptation Knowledge Initiative, carried out by UNEP, the UNFCCC Nairobi Work Programme and other partners, which aims to quantify and rank knowledge gaps regionally and by sector in an attempt to close the knowledge gap.

109. Mr. John Christensen (UNEP) presented on *The Emissions Gap Report 2014*. He explained that the origins of the report go back to COP 15 at which 141 Parties signed the Copenhagen Accord. Among the provisions of the Accord was a call to Parties to submit voluntary emission reduction pledges for 2020 and the setting of a temperature target. These two provisions raised the following question: **will pledges for 2020 be enough to meet the temperature target?**

110. UNEP published the first *Emissions Gap Report* ahead of COP 16 in late 2010. Many Parties to the Convention found this first edition useful and asked UNEP to update it annually, to inform negotiations on the level of ambition required from countries to meet the temperature target. The editions of the report provide an indication of: **what has been done in all these years; where emission trends seems to be taking us; where the full implementation of the pledges made after Copenhagen would take us; and where science modelling tells us we should be to reach the 2 °C limit.** He said the emissions gap is close to what was assessed in 2013, and that the gap has been almost constant for the past five years.

Figure 21
The emissions gap in 2020

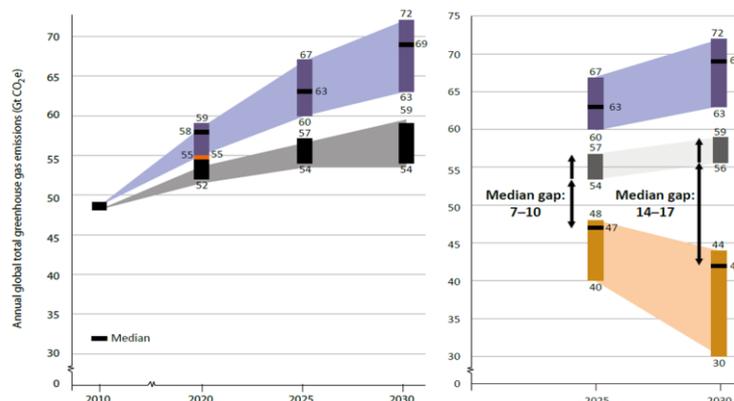


Source: Slide 2 of the presentation by Mr. John Christensen (United Nations Environment Programme), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_christensen.pdf. The figure shows that the emissions gap in 2020 remains at 8–10 Gt CO₂ eq per year as the difference between the Cancun pledges and emission pathways compatible with limiting warming below 2 °C above pre-industrial levels.
 Abbreviation: GtCO₂eq = Billion tonnes of CO₂ equivalent emissions

111. He explained that the top line indicates the ‘business as usual’ scenario at 59 Gt CO₂ eq, and the third line down illustrates emissions levels with the most stringent implementation of pledges, these are then compared to the median level of 44 Gt CO₂ eq for scenarios that meet the 2 degree target, which leaves a 8–10 Gt CO₂ eq gap in the year 2020 (figure 21). For this edition of the *Emissions Gap Report*, UNEP moved to a new set of models beyond 2020, looking at 2030 to inform the decision-making process. This is because the old models had a starting point for cost-efficient implementation in 2010, which did not happen. The new models therefore have a starting point of cost-efficient implementation in 2020, when the new climate agreement should apply. These

new models imply steeper reductions of GHGs after 2020, higher mitigation costs, negative emissions and significantly higher climate risks.

Figure 22
The emissions gap in 2025 and 2030

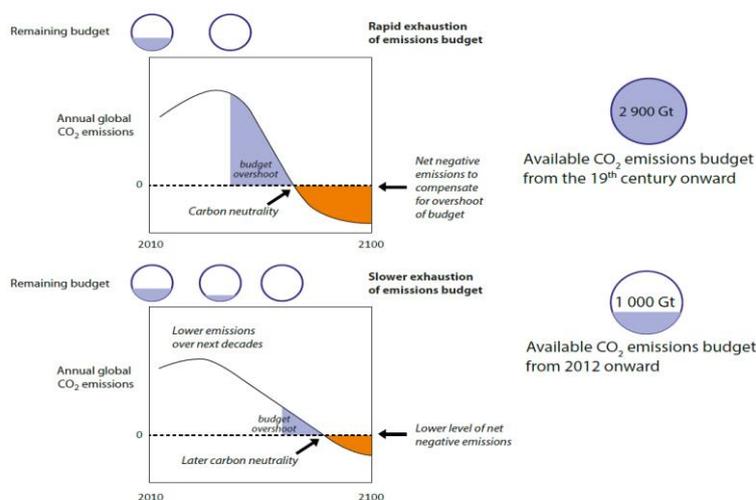


Source: Slide 4 of the presentation by Mr. John Christensen (United Nations Environment Programme), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_christensen.pdf. The figure shows that the emissions gap in 2025 is 7–10 Gt CO₂ eq, and in 2030, the gap is significantly bigger, at 14–17 Gt CO₂ eq. Abbreviation = GtCO₂eq: Billion tonnes of CO₂ equivalent.

112. Mr. Christensen indicated that since climate change negotiations are increasingly focusing on 2030, the 2014 edition of the *Emissions Gap Report* provides estimates of the gap in 2025 and 2030 (figure 22). To do so, UNEP calculated emission growth rates in the period 2020–2030 in four sectors: energy; non-CO₂ GHG emissions; CO₂ emissions from industry; and emissions from land-use change. He added that for the energy sector, UNEP used IEA data, and for the other three sectors UNEP used data from the IPCC scenario database. By combining these growth rates with the share of global emissions of each of the sectors above, UNEP extrapolated to 2030 the low- and high-end of the four pledge cases in 2020. By interpolation, UNEP obtained an estimate for 2025. **The emissions gap in 2025 is 7–10 Gt CO₂ eq, and in 2030 the gap is significantly bigger, at 14–17 Gt CO₂ eq.**

113. He pointed to the focus in this year’s edition on targets for 2030, and the emission budget for staying within the 2 °C limit, and referred to the discussions held during part 1 of SED 4-1 on the carbon budget, which corresponds to the total amount of carbon emissions that can be emitted while still staying within that limit.

Figure 23
The remaining carbon budget



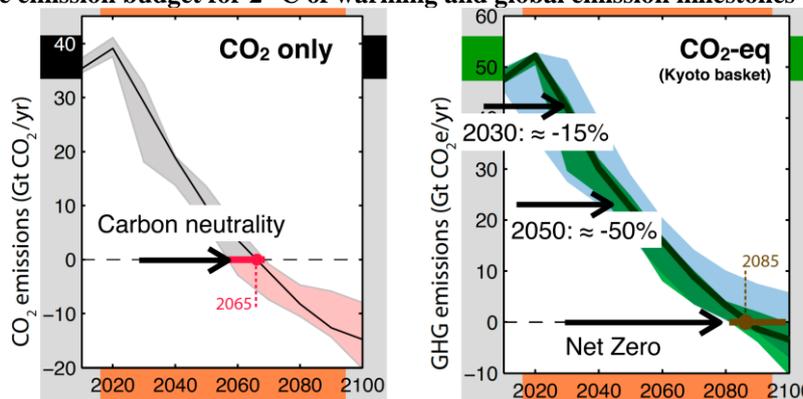
Source: Slide 5 of the presentation by Mr. John Christensen (United Nations Environmental Programme), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_christensen.pdf. The figure illustrates the differences between early (bottom) and delayed action (top) in terms of the pathway of global emissions for remaining under 2 °C of warming relative to pre-industrial levels. Abbreviation: Gt = a billion tonnes

114. He explained that at present, we have about 1,000 GtCO₂eq available in our budget, down from 2,900 at the beginning of the industrial revolution (figure 23). If we focus on **CO₂ only, emissions need to decrease to**

net zero between 2055 and 2070 to stay within the 2 °C limit (figure 24). Meanwhile, all GHGs emissions need to decrease to net zero between 2080 and 2100 to stay within the 2 °C limit. He stressed that the longer we wait on getting the curve bent, the steeper the curve, even with negative emissions towards the end of the century. He added that carbon neutrality and, in many cases, negative emissions will have to be reached, implying that carbon will have to be totally taken out of the system, through large deployment of biomass energy with CCS, or massive scale tree planting, stressing that the ensuing land, water and population requirements will be very challenging.

Figure 24

How to spend the emission budget for 2 °C of warming and global emission milestones



Source: Slide 5 of the presentation by Mr. John Christensen (United Nations Environment Programme), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_christensen.pdf>. The figure identifies the period 2055–2070 as the net zero CO₂ emissions window, and 2080–2100 as the net zero emissions window for total greenhouse gas emissions for emission pathways compatible with limiting warming below 2 °C above pre-industrial levels.
Abbreviation: Gt CO₂ eq = Billion tonnes of CO₂ equivalent emissions.

115. In concluding, Mr. Christensen underlined that a qualitative assessment of the mitigation potential of various key sectors and of country pledges shows that, on average, about 10–30 per cent of the mitigation potential identified is contained in the actual pledges, pointing to the large room for increasing ambition. On energy efficiency, he underscored that it involves various actors and a wide range of wins, and “hardly any loses”.

116. Mr. Stéphane Hallegatte (World Bank) gave a presentation on low-carbon resilient development, with a focus on pricing carbon. He underscored that the World Bank sees climate change as a development challenge that no ‘silver bullet’ can fix, stressing the need for policy packages. On mitigation, he noted the robust scientific findings in the AR5 on the relationship between cumulative CO₂ emissions and temperature. To stabilize climate change, **net CO₂ emissions need to be reduced to zero**. The question is therefore the speed at which this goal is achieved, since it will determine the temperature change.

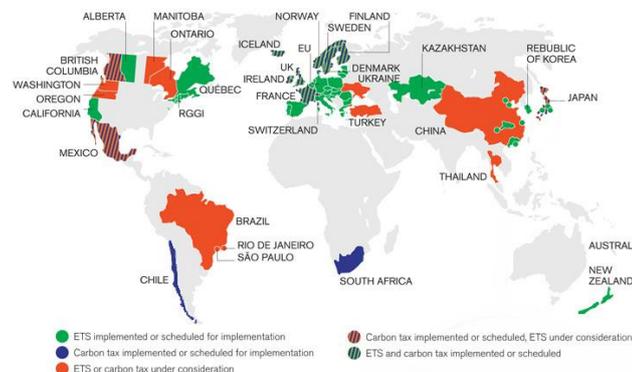
117. He identified four elements common to all models that provide the emission reductions required to bring emissions to zero at the end of the century, regardless of the temperature target, namely the need to: **improve energy efficiency**, with better buildings, cars, light, appliance, etc.; **carry out a fuel shift in most economic activities**, including transport, heating and industries; **decarbonize electricity generation**; and **implement land-use changes** in forestry, agriculture and urban development. He stressed that these four elements require immediate actions in different sectors.

118. Noting that “we know what needs to be done”, he described the support provided by the World Bank for countries to: reform fossil fuel subsidies and carbon pricing; improve energy efficiency; enhance renewable energy uptake and diversify their economy; double the rate of improvement of energy intensity by 2030, as called for by the SE4ALL initiative; carry out land-use planning, city planning and financing; and finance public transit.

119. **On fossil fuel subsidies and carbon pricing**, he referred to the United Nations Climate Summit held in September 2014, where 73 countries and over 1,000 investors and firms **called for carbon pricing** as a tool to ensure that climate change is mitigated in an efficient manner, underlining the importance of complementary social measures to ensure that the reform is not damaging poverty reduction. He also pointed to the Bank’s goal of stopping illegal deforestation by 2030 and making 100 per cent of the World Bank Group’s agriculture

projects climate-smart by 2018. **On carbon pricing**, Mr. Hallegatte mentioned the *State and Trends of Carbon Pricing 2014*, which indicates that it is gaining momentum, highlighting its **large co-benefits in terms of development and well-being**¹⁵ (see figure 25). He also referred to *Climate-smart Development*, which looks at the co-benefits that climate policy can bring, emphasizing that reduced air pollution and health-related deaths are some of the largest co-benefits of climate change mitigation.¹⁶

Figure 25
Carbon pricing is gaining momentum



Source: Slide 9 of the presentation by Mr. Stéphane Hallegatte (World Bank), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_hallegatte.pdf. The figure shows the world map highlighting countries where various schemes for carbon pricing have been implemented or are scheduled.
Abbreviation: ETS = emissions trading scheme

120. **On adaptation and resilience**, he cautioned that even if the target is 1.5 °C or 2 °C, it would be too risky to assume that it will be reached when planning for adaptation, pointing to the critical example of climate sensitivity uncertainty. The World Bank therefore plans adaptation with more pessimistic scenarios. Mr. Hallegatte explained that the series of three reports titled *Turn Down the Heat* investigates how impacts vary when warming increases from 2 °C to 4 °C above pre-industrial levels, and finds that “the difference is huge” (figure 26).¹⁷ For example, in a world 2 °C warmer, **water availability is projected to be reduced by 20 per cent, while this would go up to 50 per cent in a world 4 °C warmer**. The same **non-linearity exists for projected heat extremes, or the bleaching of coral reefs, with close to double impacts in a world 4 °C warmer compared with 2 °C warmer than in pre-industrial times, implying very different adaptation needs**. In the light of uncertainty about temperature change in the future, adaptation planning needs to take into account the possibility of global warming of 4 °C or higher.

121. **On climate change and poverty**, he stressed that the poor are often more exposed and more vulnerable to extreme weather events. He pointed to the example of the city of Mumbai in India, where the lowest quintile is disproportionately represented in the flood zone, and the richest quintile is almost absent. He added that when households are affected, as was the case in 2005, they can lose all their savings and approximately a year of income, representing significant obstacles to saving and accumulating the assets needed to escape poverty.

122. He stressed the dynamics of poverty, using the example of Andhra Pradesh in India, where the flows out of poverty are 14 per cent per year, but where 12 per cent of households fall back into poverty every year. The flows out of poverty are therefore small compared with annual flows in and out of poverty. He warned that: relatively minor impacts on these flows in and out of poverty can have a large impact on net poverty reduction; weather events are already a major cause for people to fall into poverty and constitute major obstacles for people

¹⁵ World Bank Group. 2014. *State and Trends of Carbon Pricing 2014*, May 2014. Available at http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0Carbo40Box385232B00OUO090.pdf.

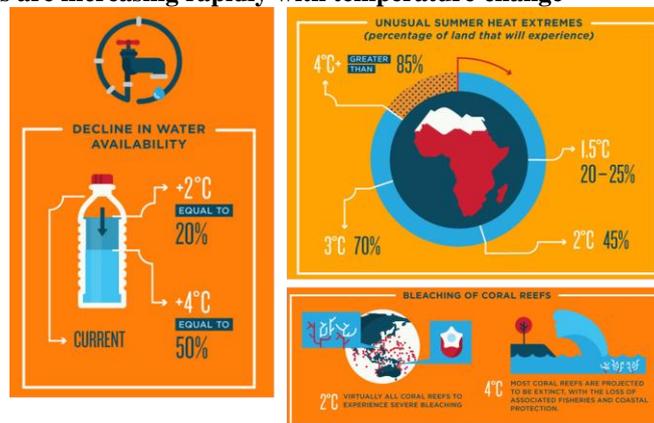
¹⁶ Climate Works Foundation and World Bank Group. 2014. *Climate-smart Development*. Available at <https://openknowledge.worldbank.org/bitstream/handle/10986/18815/889080WP0v10RE0Smart0Development0Ma.pdf?sequence=1>.

¹⁷ World Bank. *Turn Down the Heat*. Available at <http://www.worldbank.org/en/topic/climatechange/publication/turn-down-the-heat>.

to escape poverty; and in the absence of strong action, climate change will magnify these effects, potentially creating a significant drag on poverty reduction and a threat to sustained poverty eradication.

Figure 26

Climate change impacts are increasing rapidly with temperature change



Source: Slide 13 of the presentation by Mr. Stéphane Hallegatte (World Bank), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_hallegatte.pdf. The figure indicates the non-linear relationship between temperature increase and adaptation needs, and that adaptation needs for a 4 °C warmer world scenario and a 2 °C scenario are very different.

123. On the International Development Association (IDA), the World Bank’s fund for low-income countries, he highlighted commitments to better mainstream climate and resilience into development, and to screen all IDA projects for climate and disaster risks, pointing to ongoing work on developing and improving tools to do so.

124. In concluding, he underscored the importance of considering climate policies, related to both adaptation and mitigation, as development issues.

125. Ms. Christina Hood (IEA) gave a presentation on the challenges and opportunities related to energy and climate change, describing: the current state of the energy sector; modelling results and five key actions to achieve a low-carbon energy sector; and issues related to technology risk and risk management.

126. To describe the current state of the energy sector, she listed relevant IEA resources: energy and CO₂ statistics;¹⁸ free online database; smartphone apps; energy efficiency indicators; the *Energy Efficiency Indicators: Fundamentals on Statistics*¹⁹; energy technology, and research and development indicators; medium-term market reports; the *World Energy Outlook*²⁰ and *Energy Technology Perspectives*²¹ scenario analysis; and policy studies.

127. Besides emission levels, she said that another key aspect of the transition towards a low-carbon economy is the development of the needed technologies. In the *Tracking Clean Energy Progress Report 2014*,²² the IEA compares how quickly key clean energy technologies are being developed and deployed compared to interim 2025 targets in the *IEA 2014 Energy Technology Perspectives 2 °C scenario*, which lays out pathways to a sustainable energy system in 2050.

128. Ms. Hood underlined that this assessment indicates that technology development is off track for levels consistent with a 2 °C scenario, except for renewable power generation. She explained that **“we are not on track” not only in relation to turning the tide of coal, but across the entire energy system**. She warned against the costs of delaying action to transform our energy system. The **only exception – renewables - is not**

¹⁸ See IEA statistics web page, available at <http://www.iea.org/statistics/>; and CO₂ statistics. Available at <http://www.iea.org/statistics/topics/co2emissions/>.

¹⁹ IEA. 2014. *Energy Efficiency Indicators: Fundamentals on Statistics*. Available at <http://www.iea.org/publications/freepublications/publication/energy-efficiency-indicators-fundamentals-on-statistics---.html>.

²⁰ IEA. 2014. *World Energy Outlook 2014*. Available at <http://www.worldenergyoutlook.org/publications/weo-2014/>.

²¹ IEA. 2014. *Energy Technology Perspectives 2014*. Available at http://www.iea.org/bookshop/472-Energy_Technology_Perspectives_2014.

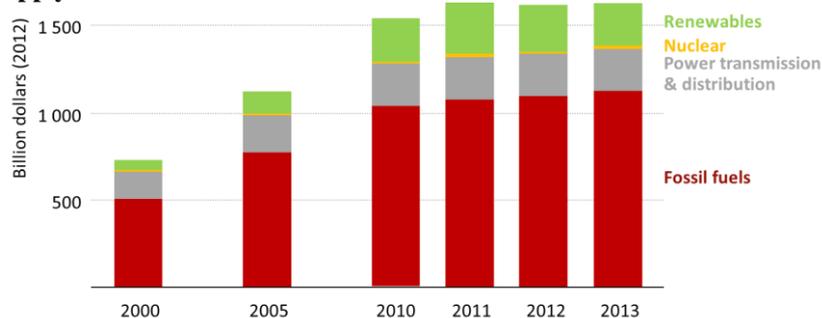
²² IEA. 2014. *Tracking Clean Energy Progress Report 2014*. Available at http://www.iea.org/publications/freepublications/publication/Tracking_clean_energy_progress_2014.pdf.

enough to meet long-term sustainable energy goals. She stressed that a broad range of technologies are needed across all production, generation and end-use sectors – especially in the electricity sector. Ms. Hood cautioned that without progress in the development, demonstration and deployment of these technologies, it will not be possible to meet long-term climate, security and economic goals for energy systems, calling on policy-makers to “change this picture”.

129. On investments, Ms. Hood underscored that investment in energy supply has doubled since 2000 and investment in renewables has scaled up considerably, but fossil fuels still dominate energy supply investments (figure 27).

Figure 27

Annual energy supply investment 2000–2013



Source: Slide 6 of the presentation by Ms. Christina Hood (International Energy Agency), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_hood.pdf>. The figure shows that fossil fuels still dominate annual energy supply investments.

130. On the ownership of worldwide power generation capacity and oil and gas reserves, she noted that a large proportion is held by state-owned companies. As a result, alongside investment by the private sector, the objectives, corporate culture and financing of state-owned companies will be critical to future energy investment flows.

131. On the key results of the IEA long-term models, she explained that from the *World Energy Outlook and Technology Perspectives*, the IEA extracted **six key measures** to achieve the 2 °C pathway (see figure 28).

132. **First**, action should start immediately, both to keep the emission pathway within reach and to limit the emission overshoot, but also to **implement some cost-effective short-term action** that can stop the growth in emissions by 2020 at no net economic cost, reducing emissions by 3.1 Gt, and carrying out 80 per cent of the savings required for a 2 °C pathway (figure 28). These measures include: implementing selected energy efficiency policies; limiting the use of inefficient coal power plants; reducing CH₄ releases from upstream oil and gas; and partially removing fossil-fuel subsidies.²³ She stressed that these measures are GDP-neutral in every region in the IEA model. She explained that renewable energy is not mentioned in the figure because it is already in the baseline scenario of the model.

133. **Second**, the **electricity sector should be decarbonized**. She compared a 6 °C scenario – if current policies remain in place – to the 2 °C scenario, where a dramatic change in the power sector takes place, with 94 per cent of electricity generated from low-carbon sources (renewables, nuclear, CCS) in 2050, and which will require focused attention from policy-makers.

134. **Third, investment patterns need to be reshaped**, especially for long-lived infrastructure. She compared the 450 ppm scenario to a new policies scenario, where efficiency spending is USD 6 trillion higher and the composition of supply investment changes, with the wide deployment of CCS and USD 300 billion of fossil fuel investment left stranded. In both scenarios, the total quantity of investment does not change much in energy supply, but there is a large shift from fossil fuels to low-carbon technologies. In addition, there is a scaling-up in investments of a factor of about four compared with current levels in energy efficiency and clean energy supply.

135. **Fourth, innovation in key technologies needs to be accelerated**, both in the short and in the long-term. In the short-term, renewables and energy efficiency are key in delivering emission savings. In the longer term,

²³ IEA. 2013. World Energy Outlook Special Report: Redrawing the Energy-Climate Map. Available at <<http://www.iea.org/publications/freepublications/publication/weo-special-report-2013-redrawing-the-energy-climate-map.html>>.

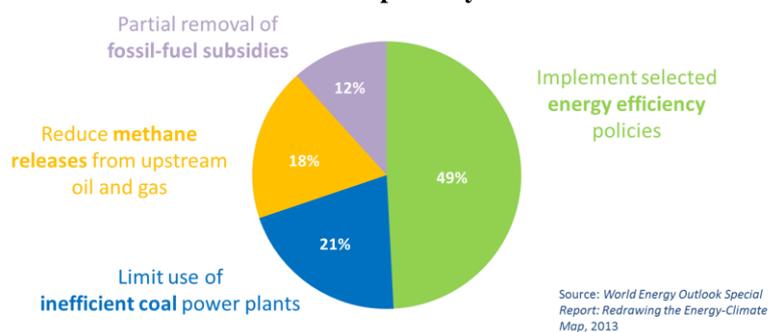
investments should be made now to ensure that technologies related to CCS and end-use fuel switching, including the electrification of transport, will be available when they are needed.

136. **Fifth, non-climate drivers of actions that reduce emissions should be harnessed.** She stated that in many cases, these non-climate drivers are the real reasons why governments take action. She called on the UNFCCC process to harness these other objectives, such as economic development, air quality improvement, energy security or road congestion alleviation, in order to maximize action on the ground.

137. **Sixth, the energy sector needs to become more resilient** to both extreme events and long-term gradual changes.

Figure 28

Cost-effective short-term action to achieve the 2 °C pathway



Source: Slide 9 of the presentation by Ms. Christina Hood (International Energy Agency), available at http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_hood.pdf. The figure shows that four measures can stop the growth in emissions by 2020 at no net economic cost.

138. Ms. Hood then addressed **managing technology risks**, underlining that technology delay will increase the costs and reduce the feasibility of low-carbon scenarios. To ensure that technologies needed for the transition to a low-carbon economy are available and at scale, she stressed the need for: international collaboration to share best-practice policy frameworks for research, development and demonstration (RD&D) support and evaluation; a portfolio approach to RD&D; the tracking and reporting of the global level of investment in technology development; a strong focus on energy efficiency; and economy-wide broad-based policies for implementation.

139. In concluding, she noted that **current policies and investment patterns are not consistent with a 2 °C scenario**, but that **moving to a 2 °C pathway is technically possible and affordable, but requires sustained efforts**. To achieve this pathway, she outlined key actions, namely: act to reduce emissions pre-2020; focus on the decarbonisation of the power sector; shift investment patterns; accelerate clean energy technology development; harness non-climate objectives; build resilience; and mitigate the risks of technology delay.

140. Ms. Kristie Ebi (WHO) gave a presentation on the health impacts of climate change. She stated that for the health community, there is no ‘safe limit’ for climate change and current climate risks are already unacceptable, underlining the importance of urgent adaptation and mitigation action. For WHO, the definition of ‘tolerated impacts’ is different to that used in the UNEP *Adaptation Gap Report*. There is a wide range of health outcomes that cause significant morbidity and mortality around the world today, many of which are sensitive to weather and climate. A small proportion of deaths from climate-sensitive health outcomes are currently due to climate change, indicating that **people are already suffering and dying from climate change**, which, from the perspective of the health sector, is intolerable.

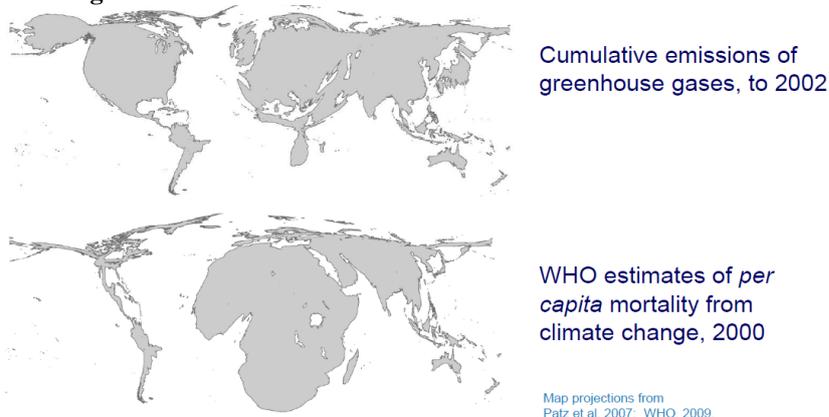
141. She presented two world maps representing the cumulative emissions of GHGs to 2002, and the WHO estimates of per capita mortality from climate change in 2000, highlighting the extremely uneven distribution of emissions and impacts (figure 29).

142. Ms. Ebi pointed to the example of the heat wave in the Russian Federation in 2010, which led to fires, heavy air pollution and about 11,000 excess deaths. It is estimated, with an 80 per cent level of confidence that the 2010 Moscow heat wave (and associated deaths) was due to climate change.

143. She then presented a graph from the human health chapter of the WGII contribution to the AR5, which illustrates the health impacts of climate change and the potential for adaptation (figure 30). The graph also shows the challenges that will have to be faced and what the residual risks could be. For each section of the pie, the orange indicates the risk levels with current levels of adaptation, while the yellow sections indicate the risks after high levels of adaptation. She underlined that this figure is based on the literature assessed in the AR5 and on expert judgment. Unfortunately, the efforts required to achieve high levels of adaptation are not consistent with current levels of funding for adaptation or technology transfer. In comparison with the current levels of risk,

1.5 °C of warming is projected to lead to very large increases in health risks, both in what can be avoided and what will remain. In a world 4 °C warmer, the risks are very high.

Figure 29
Impacts of climate change on human health

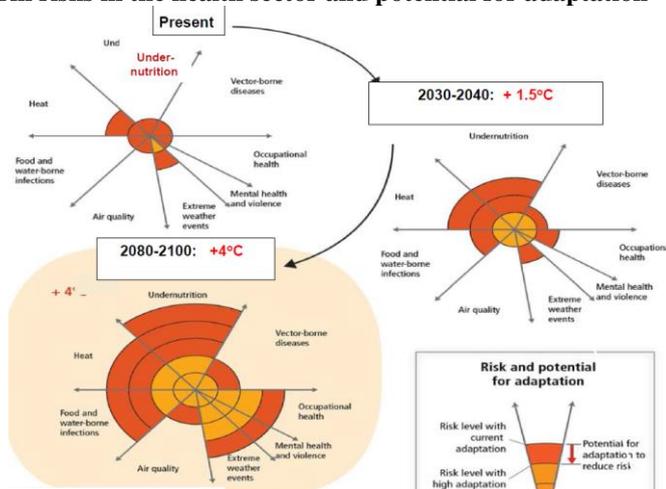


Source: Slide 3 of the presentation by Ms. Kristie Ebi (World Health Organization), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_ebi.pdf>. The figure shows the origin of cumulative emissions per continent and/or region by altering the relative size of the area (upper map, shrunken area means below average, enlarged area above average emissions) and similarly the estimates of per capita mortality (bottom map).

144. As another example, she referred to the ability of people to work in very high temperatures. She explained that full working capacity declines as temperature increases. According to the AR5, in Southeast Asia, in 2050, more than half of the afternoon work hours may be lost due to the need for rest breaks. According to a paper by Sherwood and Huber in the *Proceedings of the National Academy of Sciences*, a 10 °C of warming, large populated areas of the global would be in many respects uninhabitable.²⁴

145. Ms. Ebi then presented WHO estimates from fall 2014 of **mortality due to climate change: approximately 150,000 excess deaths per year at present, and approximately 250,000 in 2030**. She noted that these are only estimates of the four health outcomes for which there was sufficient information to run a model, not all possible health outcomes (figure 31).

Figure 30
Near-term and long-term risks in the health sector and potential for adaptation



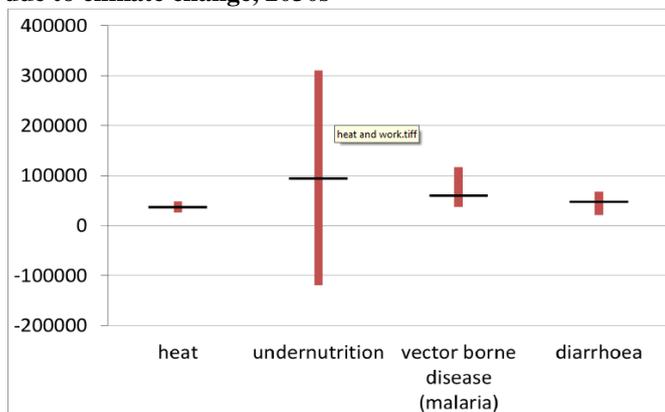
Source: Slide 5 of the presentation by Ms. Kristie Ebi (World Health Organization), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_ebi.pdf>. The figure shows various health risks for humans as posed by climate change at present, at 1.5 °C and at 4 °C of warming above pre-industrial levels, as well as the potential for adaptation (dark orange areas; light orange areas represent the remaining risks under high adaptation).

²⁴Proceedings of the National Academy of Sciences. 2010. Available at <<http://www.pnas.org/content/by/year/2010>>.

146. She listed other WHO reports that aim to help countries facing the risks of climate change to improve the resilience of the health sector: the *Atlas of Health and Climate*;²⁵ *Protecting Health from Climate Change – Vulnerability and Adaptation Assessment*;²⁶ and *WHO Guidance to Protect Health from Climate Change through Health Adaptation Planning*.²⁷ She stressed the importance of mainstreaming health concerns in other sectors, noting that choices made in other sectors should be health-resilient.

Figure 31

Estimates of mortality due to climate change, 2030s



Source: Slide 7 of the presentation by Ms. Kristie Ebi (World Health Organization), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_ebi.pdf>. The figure shows the estimates of excess mortality due to heat, under-nutrition, vector-borne disease, and diarrhoea, caused by climate change in the 2030s assuming the SRES A1B scenario and 50 per cent adaptation.

147. In concluding, she underlined that: there is no ‘safe limit’ for health, as climate variability and change are already impacting health significantly and inequitably; higher rates of warming are projected to further increase health risks; various thresholds exist at individual and community levels but are not linked to specific rates of global warming; much, but not all, of the current and future burden could be avoided through proactive and efficient adaptation; and mitigation is critical to reduce future health threats, as a precaution against uncertain risks and to gain large health co-benefits.

148. Mr. Alexandre Meybeck (FAO) gave a presentation on agriculture, food security and climate change. He described the triple challenge of: producing more food, in quantity, quality and diversity, everywhere for everyone; adapting to climate change; and contributing to climate change mitigation. He underscored that **the world’s population will increase by one third by 2050, thereby increasing food demands**, and stressed that in some areas, population will double or triple, and that often these are areas that are the most food insecure and vulnerable to climate change. Mr. Meybeck indicated that FAO estimates that **global agricultural production will have to increase by 60 per cent by 2050** to satisfy the increase in demand driven by population growth and diet changes.

149. With regards to adaptation, he stressed that there are **huge gaps in knowledge about the impacts of climate change on a lot of crops and on agro ecosystems**, such as pollinators. These gaps in knowledge exist for all the interrelations in the soil or on the farm that enable farmers to produce food. **There is no safe limit to the increase in emissions because of the uncertainties about the impact of climate change on these complex ecosystems**. Another area where there are significant gaps in knowledge is crop and animal diseases, which are impacted by climate change. In short, we do not have enough information about the impacts of climate change on biophysical ecosystems. This information gap is even more significant in relation to food systems, which combine biophysical and socioeconomic systems.

150. What is certain is that with climate change, there will be a decrease of production in certain areas, changes in the geography of production, and an increased variability of production. All of these will have an

²⁵ World Health Organization. 2012. *Atlas of Health and Climate*. Available at <<http://www.who.int/globalchange/publications/atlas/en/>>.

²⁶ World Health Organization. 2011. *Protecting Health from Climate Change – Vulnerability and Adaptation Assessment*. Available at <http://www.who.int/globalchange/publications/Final_Climate_Change.pdf>.

²⁷ World Health Organization. 2013. *WHO Guidance to Protect Health from Climate Change through Health Adaptation Planning*. Available at <http://apps.who.int/iris/bitstream/10665/137383/1/9789241508001_eng.pdf?ua=1>.

impact on all the dimensions of food security and nutrition, with stronger impacts on the most vulnerable countries and the most vulnerable people, including small holders. There is less knowledge on the impacts of nutrition, because most of the research has been carried out on staple crops.

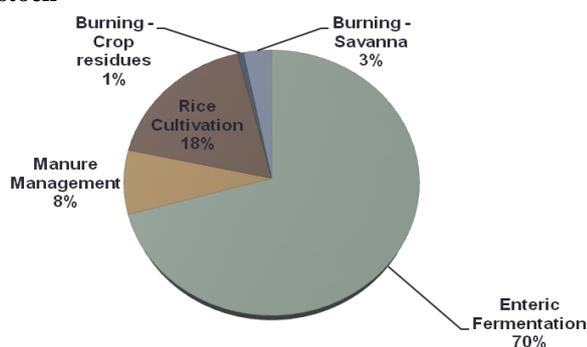
151. With regards to mitigation, agriculture can **reduce emissions per kilogram of output** – or decouple production and emission growth, and enhance agricultural soil carbons sinks.

152. He explained that FAO combines the three objectives of producing more food, adapting to climate change and contributing to climate change mitigation, through **climate-smart agriculture** (CSA), which focuses on more resource-efficient and resilient ecosystems. Resilience needs to be viewed at different scales from both a socioeconomic and an environmental and ecosystem perspective.

153. He said a large part of the mitigation potential of agriculture is in land use, which implies decreasing deforestation, sustainably increasing the production on degraded lands and decreasing emissions from livestock. On livestock, he underlined that **agriculture accounts for 50 per cent of global CH₄ emissions, and within agriculture 78 per cent of CH₄ emissions are from livestock** (figure 32).

Figure 32

Methane emissions from livestock



Source: Slide 16 of the presentation by Mr. Alexandre Meybeck (Food and Agriculture Organization of the United Nations), available at <http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/141203_sed4_meybeck.pdf>. The figure shows that 78 per cent of methane emissions are from livestock.

154. **CH₄ emissions are also energy losses**, so reducing methane emissions results from improved natural resources use efficiency. He stated that a wide range of technical interventions can improve natural resource use efficiency and productivity while reducing emissions, including: using grazing in place of feed, improvements in the management of the herd, better genetics, better feeding programmes and better veterinary services. There are **non-climate drivers** of action and these are those we need to mobilize if we want to incentivize farmers to take action.

155. This focus on livestock shows opportunities for high impact: livestock represents 78 per cent of agricultural and 40 per cent of global CH₄ emissions; livestock production is expected to grow; the reduction in emissions from livestock comes at low cost and with a wide range of co-benefits (climate, productivity, profitability, food security, nutrition, human health, green energy, etc.); and technologies are available and provide cost-effective reduction opportunities, especially for low productive systems, using relatively common practices, although a number of barriers need to be overcome.

156. He used the example of a project in Zambia to illustrate that the margin for reducing emissions in the agricultural sector without threatening food production and food security is limited. In concluding, he emphasized that the key is to increase natural resource efficiency while being able to resist the impact of climate change. Globally, the more efficient a breed, the more sensitive it is to any variations, especially to heat waves.

2. General discussions

157. The ensuing discussion was guided by the following questions:

(a) We heard from the IPCC that increasing magnitudes of warming will increase severe, widespread and irreversible impacts of climate change. In the light of this, what are the risks assessed by your organization on human health, food production and other ecosystem services at a 1.5–2.0 °C level of global mean warming compared with pre-industrial levels, and how does your organization contribute to reducing and managing these risks?

(b) What is the gap between current mitigation and adaptation efforts and those required to achieve the long-term global goal as characterized by a 1.5–2.0 °C level of warming relative to pre-industrial levels? How can this gap be bridged?

(c) What policy options has your organization identified for the decarbonization of the energy system called for by pathways consistent with limiting warming below 1.5 °C or 2 °C compared with pre-industrial levels? What are the economic and technological risks associated with this decarbonization?

(d) How effective have the steps taken by your organization been in terms of supporting national activities aimed at minimizing the impacts of climate change? What barriers have your organization encountered and how has it succeeded in overcoming them?

(e) Which policies and measures has your organization identified as effective to bridge the emissions and adaptation gap, and how can these policies and measures be emulated?

158. Noting that the *Adaptation Gap Report* presented the adaptation costs for scenario RCP2.6, which projects the lowest median global warming of all the RCP scenarios (approximately 1.6 °C by 2100), one Party asked about the **adaptation cost implications of an additional 0.5 °C of warming**. She also asked for more information on the estimate that adaptation costs would be 3–4 or 4–5 higher than previous World Bank estimates, and on the **distribution of these costs**, especially in relation to SIDS and LDCs. An expert explained that UNEP used scenario RCP2.6 for the 2 °C limit, so actually the lower cost estimate corresponds to 1.5 °C than 2 °C of warming, but the cost ranges for the two temperature limits overlap significantly in the early decades.

159. On the **differences in the cost estimates**, one expert explained that this stems from the fact that the *Adaptation Gap Report* not only examined global studies, but also sectoral and national studies, and that the latter contain huge variations in the climate scenarios applied, the methods used and assumptions made, and the temporal, spatial and sectoral scope of coverage. In addition, national studies have more realistic assumptions on barriers to implementation of adaptation, which tend to raise the costs significantly. Another expert added that higher estimates of adaptation costs are due to the fact that the coverage of previous estimates was limited in terms of sectors, whereas in the *Adaptation Gap Report*, the authors assessed more sectors and more countries; the World Bank estimates were based on a 2 °C pathway, whereas a 4 °C pathway raises significantly the costs of adaptation, and the national-level studies examined do not always distinguish between the 2 °C and 4 °C scenarios; and in previous assessments, the gains and losses from adaptation were aggregated, potentially lowering the costs of adaptation, but in the *Adaptation Gap Report* this was corrected to be more precise, as often gains and costs are often not comparable between sectors. Yet another expert underscored that some of the vulnerability is linked to the lack of infrastructure, and that the World Bank estimates that infrastructure lacks USD 1–1.5 trillion per year.

160. On the **regional distribution of adaptation costs**, an expert emphasized that when there is an existing development and adaptation deficit, future adaptation costs are projected to be much higher, as is the case in SIDS and LDCs, although no specific estimates for SIDS or LDCs are currently available.

161. One Party asked for confirmation that the *Emissions Gap Report* assesses relevant literature on scenarios that return warming to below 1.5 °C above pre-industrial levels by 2100, and that there are technologically and economically feasible scenarios available in the literature that achieve this limit. She asked if **the same methodology as was used in the scenario analysis of the Emissions Gap Report to provide emission benchmarks for 2025 and 2030 could be applied to these 1.5 °C scenarios**. An expert clarified that for the *Emissions Gap Report*, UNEP focused on 2 °C of warming as the main area for analysis, but that there has also been work on the 1.5 °C scenario. Another expert confirmed that, for the 2014 edition of the *Emissions Gap Report*, UNEP used the AR5 scenarios database for their quantitative assessment, and that these scenarios are deemed technologically and economically feasible. He added that, in the literature, there are studies available that produce the same kind of scenarios but limit temperature increase to 1.5 °C above pre-industrial levels by 2100. The latter scenarios were not contributed to the AR5 database. An assessment of these scenarios was taken into account in the 2014 *Emissions Gap Report* and previous editions, but not in the same way as for 2 °C scenarios. He said that **in principle, the same methodology could be applied to the smaller set of 1.5 °C scenarios**, with some caveats: these scenarios all include a **temperature overshoot**; they achieve the target with **approximately 50 per cent probability**; and the scientific basis will be weaker because of the limited amount of 1.5 °C scenarios. In response to this question, an expert provided emission benchmarks for 1.5 °C scenarios based on the *Emissions Gap Methodology* to the SED co-chairs.

162. In response to a question by one Party about **which technologies are the most promising** for achieving negative emissions, an expert indicated that these are predominantly the **sustainable production of bioenergy, CCS and increased forest cover**. He underlined that UNEP did not assess these options, but noted the need to assess the feasibility of the assumption that these technologies will be available at scale when needed. Another expert explained that WGIII explored the consequences of the unavailability or the limited availability of these technologies. He stressed that **CO₂ removal technologies are essential in achieving negative emissions**, which serve two purposes: they are necessary because of historic emissions; and more importantly, in the second half of the century, they will **compensate for those non-CO₂ gas emissions that cannot be reduced to zero**. WGIII

explored a comprehensive range of technologies and the consequences of the unavailability of CO₂ removal technologies, which would mean that emissions should be more significantly reduced in the short-term in order to achieve a relatively cost-effective pathway. Another expert explained that the IEA scenarios would fall within the lower end of those included in the *Emissions Gap Report*, with rapid reductions in the short-term, because IEA experts are uncomfortable with assuming massive reductions with negative emissions later in the century. However, she noted that IEA scenarios cover the period up to 2040 or 2050, by when CRD technologies will not have been introduced yet, but the design of the scenario makes assumptions about what will happen beyond these dates. On prospects for the CDR technology, she said it is a question of combining bioenergy and CCS, noting that at present, very slow progress has been made with CCS itself, let alone coupling it with bioenergy. She therefore underscored the **need for significant progress on CCS**.

163. A Party asked about the meaning of the term ‘**societally desirable adaptation**’ in the *Adaptation Gap Report*, since adaptation is often not a choice. An expert explained that the term is based on the WGII report, which describes how to move from a level of adaptation that is technically and economically feasible, to what will actually happen on the ground. She noted that some communities or groups may choose to tolerate a higher level of climate change impacts because of different preferences regarding the adaptation target.

164. A Party asked if the figure of 90 per cent of adaptation funding going to developing countries mentioned by one of the presenters includes national and regional funds, as well as private sectors funds, at the national level. An expert clarified that the figure comes from a study of the Climate Policy Initiative, and includes developed and developing countries’ funding for adaptation, including that from national and regional development banks.²⁸

165. A Party asked about the **cumulative impacts of the pledges made at the September 2014 United Nations Climate Summit** in relation to mitigation and adaptation. An expert stated that the United Nations office in charge of the summit is trying to set up a tracking system of the many pledges made, while noting the challenges of doing so because the pledges are often not concrete commitments and are not comparable, and their additionality is difficult to assess. Another expert added that the summit should be seen within a process that aims to build momentum on the road to Paris, and that assessing individual steps separately may not give an accurate picture, as follow up action may be taken in the future.

166. A Party asked a question concerning WHO figures that indicate that with 1.5 °C warming, the **number of children at risk of stunting will increase by more than 6 million by 2030** even with high economic growth. In response, an expert confirmed that this can be considered conservative since it does not take into account climate-related disasters and their potential impacts on food production and prices, implying that the projected increase in stunting is conservative.²⁹ The expert further clarified that the WHO looked at each health outcome at a time so the total aggregate impacts were not estimated.

167. A Party asked about the long-term **physical limits of the potential for negative emissions**. He queried whether relying heavily on negative emissions during this century could lead the sinks to be “entirely filled up”, thereby prejudicing future generations after 2100. An expert said he did not know the answer but that he would look it up and provide the required information by the next day. Another expert explained that to determine the physical limits to negative emissions, one needs to take into account the fact that the oceans will lose part of the previously absorbed CO₂. Experts provided further information indicating that, to date, there are only rough estimates of the total global storage capacity. Estimates indicate that the capacity is significantly larger than storage needs in low GHG level stabilization scenarios up to 2100. Geological reservoirs could store several thousand GtC, the oceans a few thousand GtC in the long term, and the land may have the potential to store the equivalent to historical land-use loss of 180 ± 80 GtC (see also WGI Table 6.15, page 549 for physical potentials of removing CO₂ from the atmosphere).

168. Noting that by the end of 2100, non-CO₂ gases will have a larger share of global emissions, a large portion of which will come from agriculture to meet the demands of a growing population, a Party asked whether strategies exist to **combine the need for agriculture to adapt to climate change and to reduce its emissions**. An expert clarified that all scenarios that predict a lower global level of emissions feature a larger share of agricultural emissions and an important share of non-CO₂ emissions, which is why to achieve zero net emissions, negative emissions have to be factored in, because “we do not know how to produce food without emitting”.

²⁸ Climate Policy Initiative. 2014. *Global Landscape of Climate Finance*. Available at <<http://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2014>>.

²⁹ World Health Organization. 2014. Quantitative Risk Assessment of the Effects of Climate Change on Selected Causes of Death, 2030s and 2050s. Available at <http://apps.who.int/iris/bitstream/10665/134014/1/9789241507691_eng.pdf>.

FAO aims to achieve the three objectives of producing more food, adapting to climate change and contributing to climate change mitigation through CSA.

169. A Party asked for an indication of **which of the results presented** during part 2 of SED 4-1 **come from the AR5, and which do not**. An expert indicated that the WHO estimates were published after the IPCC cut-off dates and were therefore not part of the assessment, although the IPCC authors were aware of the work being done.

170. A Party asked **how the adaptation gap is going to be addressed**, adding that adaptation is a pressing need for developing countries. An expert said the AR5 clearly indicates that while adaptation and mitigation act at different timescales we need to work on adaptation, mitigation and development at the same time. Another expert stated that to ensure that the adaptation gap is filled, we should first ensure that it is as small as possible, and that will be achieved through progress in mitigation. He emphasized the need to “act now on adaptation”, underlining the need for communities to “learn by doing”. Another expert added that one of the aims of the *Adaptation Gap Report* is to generate discussions on this issue. She stated that “there is no question there is such a gap”, expressing the hope held by UNEP that the report can generate a more strategic global thinking on adaptation and follow up with more specific analysis.

171. A Party made a comment on the limited carbon budget, calling on those countries that have “the capacity to do more, to do more”, stressing that **the lesser the budget is, the greater the need to focus on the principle of common but differentiated responsibility**. An expert said the mitigation analysis in the *Emissions Gap Report* is done at the global level and does not interfere with the application of the Convention’s principles. He added that the report also points to opportunities across sectors and to co-benefits that will drive action at various levels.

172. A Party asked if the World Bank’s findings on **commoditizing carbon** are cost-effective in developing countries, which often have single commodity economies, and/or do not have mature markets. In relation to setting the price of carbon, he also asked whether the World Bank would seek to interfere with the market price or impose restrictions, stressing the freedom of the markets. An expert emphasized that the World Bank refers to “pricing carbon” as a generic phrase, aware of the fact that each country will pick the instrument that is best suited to the national circumstances, either a tax or a market. He referred to the Partnership on Market Readiness, which is a grant-based global partnership of developed and developing countries that provides funding and technical assistance for the collective innovation and piloting of market-based instruments for GHG emission reduction. He said the partnership also provides a platform for technical discussions of such instruments to spur innovation and support implementation. He added that in countries with weak institutions and low income, carbon taxes are much simpler than market-based instruments. He emphasized that all the instruments aim to raise revenues, which can be used to alleviate the shock of fossil fuel subsidy reforms, as has been the case in Ghana and Indonesia.

173. Commenting on a presentation that indicated that **poverty is decreasing**, one Party questioned the veracity of this finding. An expert confirmed that extreme poverty has been reduced in the past 20 years. The international poverty line is set at USD 1.25 per day in purchasing power parity; 42 per cent of the world’s population was below that line 20 years ago. Today, this has been reduced to 17 per cent. He pointed to some caveats to this finding, including that poverty cannot be described solely through purchasing power as it is more complex, and that significant regional differences in poverty levels exist.

174. On energy and climate change, one Party commented that **investment in fossil fuels is still dominant** because it is a sustainable supply of energy and does not require subsidies on the production side. On **carbon intensity**, the same Party asked how to classify the carbon intensity of various energy sources, such as coal and gas. An expert welcomed the focus on carbon intensity, noting that it helps illustrate “what you need to do to make the transition” to a low-carbon economy rather than the goal itself. She added that one should look at the end uses of energy rather than examine the carbon intensity of various fuels. The power sector is projected to decarbonize rapidly because there are many choices for power generation. In the IEA models, the average emission intensity of the power sector goes below that of natural gas generation in the mid-2020’s and continues downwards, led by new investments in low- or zero-carbon power generation. Changes in carbon intensity in the transport sector are much slower.

175. Noting that many developed **economies are driven by taxes on fossil fuels** that provide a major source of revenue, a Party asked how reduced demand for fossil fuels may affect these economies. An expert stated that the Organisation for Economic Co-operation and Development (OECD) is currently carrying out some research on how other policy areas than energy and climate will be affected by this transition and whether they support the transition, including tax and trade policies. The expert stated that a paper on this matter should be released in 2015.

176. A Party noting that scenario RCP8.5 projects an increase in temperature of 4–5 °C, asked for **clarification about the reference to a 6 °C scenario and its basis**. An expert explained that the reference to 6 °C is a long-term stabilization level rather than a 2100 level.

177. A Party asked about strategies to address **energy poverty**. An expert pointed to an IEA analysis that found that providing universal access to basic electricity for the 1.3 billion people who do not have it would imply an increase of less than one per cent in global emissions.³⁰ She stressed that meeting these basic energy needs should therefore “not be an excuse” for very large emission increases. Another expert pointed to a World Bank report on the co-benefits of climate policies, which indicates that the energy poor use biomass with very bad health consequences, batteries or costly generators.³¹ He added that providing clean sources of energy to these people therefore has significant development gains and should be one of the priorities of the energy sector.

178. A Party asked WHO to clarify its reference to “**uninhabitable places**”, stressing that his country was very uninhabitable. An expert stated that some countries had done a “great job” of making themselves very comfortable, reiterating the point made by another expert earlier on the need to address mitigation, adaptation and development simultaneously. She called on other countries to learn from those countries living with very high temperatures, stressing the need to facilitate lessons learned across countries, taking into consideration various development contexts.

179. A Party asked FAO about the **potential savings that could be generated by changing lifestyles and reducing food consumption and food waste**. The same Party asked about the impacts of ethanol production on food security and its carbon footprint. An expert underlined that the carbon footprint of bioenergy varies greatly depending on the biomass used, the country where it is produced or the technology used. He stated that it is difficult to generalize, but that the carbon footprint of bioenergy generally is decreasing. There could be value in developing technologies now that will have a reduced footprint in the future. On the impact of bioenergy production on food security, he said this is a very complex question and referred to the report of the High-Level Panel of Experts on Food Security and Nutrition, which was prepared at the request of the Committee for World Food Security.³² The report indicates that the impacts of bioenergy on food security are very diverse and depend on the area of production of biofuels, but also on the timescale used. He underlined that in some countries, bioenergy production can have an impact on food prices, but it is also a driver of development and can lift people out of poverty and reduce energy poverty. He added that modern forms of biomass can be healthier and more efficient for a lot of uses, including in agricultural production. Noting that food demand is projected to increase by 60 per cent while the population is projected to increase by 30 per cent, he emphasized the need to limit demand through changes in diets and lifestyles. He stressed that it is more difficult to act on consumption than on production patterns.

180. A Party asked for confirmation that the AR5 indicates that **mitigation** action would come with important economic and social **co-benefits** and increases in energy security. Noting that immediate mitigation action is required in 1.5 °C scenarios, he asked if this would imply that the co-benefits of mitigation action would materialize earlier in these scenarios than in 2 °C scenarios. An expert said the co-benefits of mitigation action are clear, but **challenges exist in terms of measuring and defining them**. On the differences in the materialization of co-benefits in 1.5 °C and 2 °C scenarios, he said he was not aware of any study that examined this question.

181. A Party referred to the IEA presentation outlining emission reduction measures at zero GDP cost, in particular calling for the **removal of inefficient fossil fuel subsidies** which could reduce post 2020 emissions by about 12 per cent, adding that this can often bring a GDP benefit. He pointed to recent developments on this issue within the Group of Twenty (G20) and the Asia-Pacific Economic Cooperation (APEC) forum and in the post-2015 development agenda negotiations. An expert welcomed the developments mentioned, noting that they are success examples that provide an incentive for other countries to also remove fossil fuels subsidies. He explained that originally, such subsidies were generally put in place to help the poor access energy and help industry develop and create jobs. These two objectives can be achieved much more efficiently through other

³⁰ IEA. 2011. Energy for All: Financing Access for the Poor. Available at <http://www.worldenergyoutlook.org/media/weowebiste/energydevelopment/weo2011_energy_for_all.pdf>.

³¹ World Bank. 2014. Climate-smart Development: Adding Up the Benefits of Actions that Help Build Prosperity, End Poverty and Combat Climate Change. Available at <<http://documents.worldbank.org/curated/en/2014/06/19703432/climate-smart-development-adding-up-benefits-actions-help-build-prosperity-end-poverty-combat-climate-change-vol-1-2-main-report>>.

³² Available at <<http://www.fao.org/cfs/cfs-hlpe/reports/en/>>.

measures, for example with cash transfers for the poor, infrastructure development, or decreases in taxes on industry. Carbon pricing would make little sense in a place with massive fossil fuel subsidies, where the first step should be subsidy reform. In all cases, there is a focus on the poor and ensuring that they benefit from the reform. Another expert added that fossil fuel subsidy reform is a cost-effective measure for many countries, emphasizing that often the reform will be triggered by non-climate benefits.

182. A Party noted that the **emission-intensity is agreed inside the agricultural sector** and is well understood outside that sector. He asked about relevant FAO work on the use of emissions per unit of food and goal setting.

183. A Party asked **how important the Paris agreement is to get a switch in energy investment towards the decarbonization needed to get the world on a 2 °C pathway**, in particular to materialize the 80 per cent cost-neutral investments that were mentioned. An expert said the IEA sees the Paris agreement as very important, especially in the shift in investments in long-lived infrastructure, where investors need a long-term signal that such investments will be ‘smart’. In relation to cost-neutral measures that can drive emission reductions before 2020, she stated that the Paris agreement can also play some role in providing an incentive for all actors to take early action if they know that stringent targets will be set in the near future, but action should happen with or without an agreement.

184. A Party asked about the importance of the **decarbonization of the electricity sector for limiting warming to 2 °C above pre-industrial levels**. Noting that in IPCC scenarios limiting global warming below 2 °C, this decarbonization happens around 2050, he also asked when the carbon intensity of this sector approaches zero in the IEA models. An expert stated that the IEA model indicates that electricity needs to be largely decarbonized by 2050, so under the same timeframe as that indicated by the IPCC in the AR5, adding that this will underpin the decarbonization of other sectors.

185. A Party referred to the **difficulty of defining adaptation funding**, asking if disaster relief would be considered adaptation funding, and what types of public and private funding could be considered as adaptation funding. He also asked for clarifications regarding the limitations and uncertainties related to the cost estimates of adaptation. An expert indicated that **disaster relief is not considered as adaptation funding** in the UNEP *Adaptation Gap Report*, which only includes funding for adaptation that is qualified as ‘significant’ or ‘principal’, as defined by the OECD database. He added that **funding for disaster risk management is increasingly being included** in estimates of adaptation finance flows. He recognized that there are high uncertainties in the cost estimates of adaptation because of the little data available to assess the effect of the measures. Although we are at the early stage of costing adaptation, a lot of progress has been made to lower these uncertainties. He also specified that private sector finance was not included in the estimates in the UNEP report because of the **inability to track private sector activities in adaptation**. Another expert emphasized that there are great **differences among sectors in relation to where the funding is going**. For example, only three per cent of the Least Developed Country Fund resources are going to the health sector. Another expert explained that the WGII report does not contain an adaptation gap dollar figure because many investments can be legitimately linked to adaptation or to another objective. To recognize this diversity of objectives, the IPCC decided that it was best not to identify a particular number.

186. A Party asked about the **reliance on nuclear power to achieve 2 °C scenarios and negative emissions**. An expert indicated that the WGIII assessed the impacts of the changes in the technology portfolios on the mitigation costs in figure 17.15 of the WGIII report. It found that a **moderate phase out of nuclear power can easily be substituted by renewables** because it is a flat optimum. However, there are multiple pathways to achieving low stabilization limits in a cost-effective way, for example through high energy efficiency and renewable energy, or through high shares of nuclear and CCS. He underscored that CCS is an exception, as it is particularly important in combination with bioenergy. He added that CCS technology has two functions: it prolongs the life of fossil fuels; and more importantly, it plays a role in producing negative emissions that counter historical emissions and emissions in other sectors that cannot be reduced to zero. Another expert explained that in the IEA 2 °C scenario, nuclear energy plays an important but supportive role, as it is part of the low-cost package.

187. A Party asked about the **release of large GHG reservoirs associated with hydropower generation**. An expert pointed to the *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*,³³

³³ IPCC. 2011. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Available at <<http://srren.ipcc-wg3.de/report>>.

which indicates that the emissions released from the reservoirs depend on what was on the land that was flooded by the reservoir, but that they would be quite small compared with the emission reductions achieved through hydropower.

188. Noting that to guide the next review the IPCC may conduct a paper on agriculture, climate change and food security, a Party asked **what aspects of the AR5 would be a valuable input to such a paper**, and what the **primary research gaps** are in this space.

189. A Party said that adaptation and mitigation should be put in the broader context of finance and technology argued that **it is optimistic to state that achieving the 2 °C pathway is technically and economically feasible**, emphasizing that economic and technological resources are distributed unevenly at the regional and national levels, and asked if this was considered in the analysis. An expert explained that the World Bank looks at the difference between the economic costs and the financing needs, stressing that some of the measures that have net benefits in economic terms may require a lot of up-front investment and less operational costs. He said that if the constraints are financial, these measures may be very difficult to put in place. As a result, financing instruments will play a key role in the transition to a low-carbon economy, especially in a world where we are still lacking USD 1.0–1.5 trillion per year in investments. He indicated that the World Bank is working to provide solutions to this investment gap, most probably through a package of measures. He added that carbon pricing could provide some of the financing that is needed to achieve the climate goal. Another expert underlined that the analysis carried out for the *Emissions Gap Report* is carried out at the global scale, however, all the editions of the report have included a chapter on what can be done, using examples at the country level. Yet another expert added that the WGIII chapter on regional costs and feasibility indicates that it is not just an issue of technical feasibility, but also a question of regional distribution of costs. He pointed to remarkable differences across the regions, stating that it all pertains to the distributional aspect of the whole problem and how to organize transfers and financial support.

190. A Party asked if an **analysis of the barriers to adaptation technology transfer** had been carried out, and if experts could provide some recommendations on how to overcome these barriers. An expert pointed to the World Bank's *Green Growth Report*,³⁴ which stresses that transfer is not the only issue, emphasizing the important need for technology to be adapted to the local context in order to be effective. He also stated that trade barriers can sometimes constitute a significant obstacle to technology transfer. Another expert said there is expert judgment that goes into the IEA scenarios on how quickly different technologies would be taken up in different regions. She added that just because a measure could be taken at zero GDP cost, it does not mean that it would be easily implemented, stressing that some capacity and finance issues would need to be overcome. Yet another expert clarified that the *Adaptation Gap Report* refers to a barrier analysis of technology transfer. She indicated that the technology chapter primarily builds on lessons learned from the technology needs assessment project funded by the Global Environment Facility (GEF), which UNEP helped implement. The main barriers identified are: financial barriers; regulatory and legal frameworks; technical barriers to the development and transfer of technology; and institutional and organizational barriers.

191. A Party asked if there was **anything else that should be done in the UNFCCC process, aside from negotiating the Paris agreement, to speed up the transformational change** required to drive down emissions. An expert encouraged the UNFCCC to **look at the issue in a more holistic way, and not only focus on emission reductions targets every few years but also on the energy sector transformation that is required** to ensure that the needed infrastructure is in place. Another expert called for an **increased focus on adaptation and development**, underlining the tendency to focus on one element of the problem at a time and stressing the need to “look at the full picture”.

192. A Party asked about the **impacts of air-borne desert dust particles**, which are considered the primary cause of premature death in the Middle East, and are projected to increase with climate change and the resulting increased desertification. He also asked if any analysis has been carried out on the possible feedback of desert dust particles on climate change. An expert indicated that WHO is well aware of the health impacts of desert dust particles, but that there is relatively little literature on the issue. She noted, however, that more research is currently underway for various regions, and that the literature is becoming large enough to be assessed. Another expert pointed to the IPCC Special Report on *Managing the Risks of Extreme Events and Disasters to Advance*

³⁴World Bank. 2012. Inclusive Green Growth: The Pathway to Sustainable Development. Available at <http://siteresources.worldbank.org/EXTSDNET/Resources/Inclusive_Green_Growth_May_2012.pdf>.

Climate Change Adaptation,³⁵ which touched on the health impacts of desert dust particles, but was unable to distinguish a separate climate change cause for these impacts. He also mentioned that WGI examined the impacts of dust as a climate forcer, but did not carry out a separate analysis of desert dust. He said these are opportunities for future research and assessment.

193. A Party questioned the fact that **floods are disproportionately affecting the poor in Mumbai**, as presented by the World Bank. He explained that most of the impacts of floods in Mumbai are due to the inadequacy of the services provided, such as sanitation, as well as heavy rain coinciding with high tides. He added that with improved services, another Indian city has had some success in reducing the impacts of flooding. An expert recognized that, in both developed and developing countries, the land markets are pushing people out onto land that are exposed to flooding. He pointed to the success of disaster risk management when a hurricane hit India in 2013, demonstrating that cheap solutions, taking into account the local context, can save thousands of lives.

194. A Party asked if an assessment of the national and local governments' efforts to minimize vector-borne and water-borne impacts after extreme events has been carried out.

D. Part 3: Information from United Nations and international organizations, and from processes under the Convention

1. Presentations by experts

195. Mr. Juan Hoffmaister, Adaptation Committee Co-Chair, presented on enhanced adaptation action in the context of the 2 °C limit to global warming. He listed the three workstreams of the Adaptation Committee's 2013–2015 workplan, namely: **technical support and guidance to Parties on adaptation action; technical support and guidance to Parties on MOI; and awareness-raising, outreach and sharing of information**. While noting that the Adaptation Committee's 2013–2015 workplan does not include a specific focus on the long-term global goal, he stated that the Cancun adaptation framework is flexible enough to respond to the issues emerging in the light of this goal, and that a new flexible workplan is being developed for 2016 and beyond.

196. He explained that the aim of NAPs was to reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience, and facilitate the integration of climate change adaptation into new and existing policies, programmes and activities, and development planning processes and strategies, within all sectors and levels.

197. Mr. Hoffmaister then described some experiences with NAPs, including: when preparing their national communications, most countries have already conducted an analysis of observed changes in the climate system, applied climate scenarios for projections and conducted vulnerability assessments; many LDCs can build on results from the assessments they have undertaken for their National Adaptation Programmes of Action; and Parties have reported challenges in using the latest IPCC scenarios to formulate and implement NAPs, as well as concerns regarding their applicability to specific and/or local contexts such as mountainous regions.

198. He mentioned **lessons learned in the formulation and implementation of NAPs** and national development planning, stressing the importance of an appropriate national mandate and high-level coordination mechanisms for adaptation. Among the many programmes and activities that countries have been, and are supporting, that already contribute to the objectives of the NAP process, he pointed to sector budgets, and projects aimed at alleviating poverty through enhancing the resilience of communities at the national and local levels to climate change risks and impacts. He underlined that some bilateral organizations are receiving very few requests from countries for support for the NAPs process, in contrast to the high number of requests for support under the NAP global support programme.

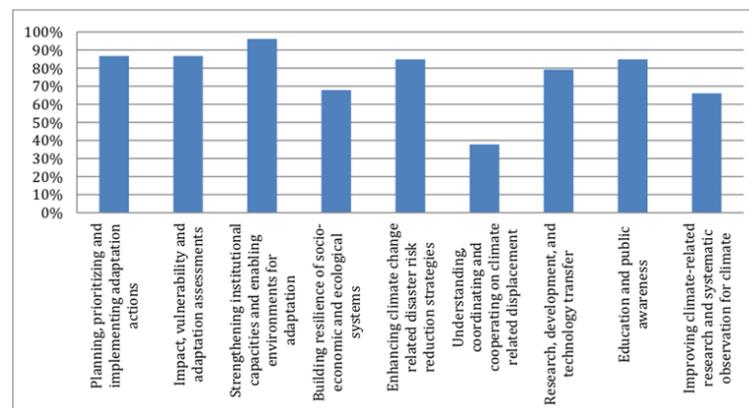
199. In addition, he reported that: organizations and agencies need to consider their organizational mandates, set-ups and resources in the light of the long-term nature of the NAP process; for many Parties, there is a lack of clarity on procedures for applying for funding from the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF) for the NAPs process; and since both funds are based on voluntary contributions, some Parties suffer from inadequate and unpredictable financing that hinders further scaling up and mainstreaming adaptation into national development planning.

³⁵ IPCC. 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Available at <<http://www.ipcc-wg2.gov/SREX/>>.

200. On the **monitoring and evaluation of adaptation**, he stressed that: appropriate monitoring and evaluation frameworks are needed, relevant to needs and tailored to country circumstances; due to the context-specific nature of adaptation, a common set of global indicators is not useful; national-level assessments can play a different role in measuring adaptive capacity from subnational or project-based assessments, for example, to measure the degree of coordination and integration of adaptation in national priorities; a positive learning environment is important; and planning and allocation of resources, both technical and financial, are key for effective monitoring and evaluation systems.

Figure 33

Mapping and analysis of support from United Nations agencies and regional institutions on adaptation (2013/2014)



Source: Slide 8 of the presentation by Mr. Juan Hoffmaister (Co-Chair of the Adaptation Committee (AC)), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_ac_co-chairs_sed4-2_feb8.pdf>. The figure indicates areas of support provided by organizations and United Nations agencies that share information with the Adaptation Committee (for details, see Report AC/2014/7, Information paper *Strengthening the understanding of the roles of regional institutions and UN agencies in supporting enhanced adaptation actions in developing countries*).

201. In closing, he presented a graph illustrating findings from mapping and analysis of support from United Nations agencies and regional institutions on adaptation, which indicates that all organizations and United Nations agencies that share information with the Adaptation Committee are providing support to strengthen institutional capacity, but that other issues, such as those associated with climate-related displacements, are not receiving support across the whole system (figure 33).

202. Mr. Paul Leadley, Coordinator of *Global Biodiversity Outlook- 4*,³⁶ delivered a presentation on connecting biodiversity with climate change mitigation and adaptation, which was prepared in collaboration with Mr. David Cooper, Director of Science, Assessment and Monitoring, CBD, and Mr. Phillip Williamson, Lead Author of *An Updated Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity*.³⁷ The main messages of his presentation were that: many organisms and ecosystems are already impacted by recent climate changes and additional change will exacerbate impacts; thresholds are often difficult to identify; **biodiversity can play an important role in increasing climate change resilience**; and **pathways to remain within 1.5 °C or 2 °C of warming above pre-industrial levels will require careful management to conserve biodiversity and ecosystems**, as well as to optimize their contribution to climate mitigation and adaptation.

203. He explained that ocean acidification is a direct response to rising atmospheric CO₂, involving more dissolved CO₂, bicarbonate ions (HCO₃⁻) and hydrogen ions (H⁺) (i.e. lowered pH) but less carbonate ions (CO₃²⁻). He said marine organisms can react to any of these changes, and different organisms react in different ways. He pointed to the interactions with: other climate-related stressors (e.g. warming, hypoxia); indirect pH effects (e.g. increased metal toxicity); food and nutrient availability; and biotic factors (e.g. food web changes, competition). While noting the pole-ward migration of marine species due to temperature changes, he underlined that ocean acidification reduces species' ranges.

³⁶Secretariat of the Convention on Biological Diversity. 2014. Global Biodiversity Outlook. Available at <<http://www.cbd.int/gbo4/>>.

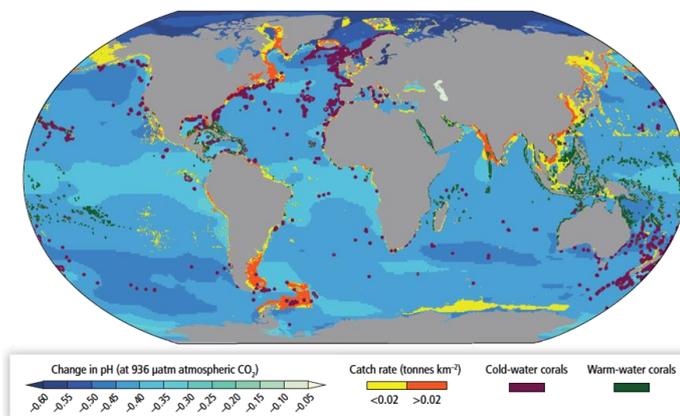
³⁷Secretariat of the Convention on Biological Diversity. 2014. An Updated Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity. Available at <<http://www.cbd.int/doc/publications/cbd-ts-75-en.pdf>>.

204. On the **difference between CO₂ levels associated with 1.5 and 2 °C warming**, he stated that ocean acidification already causes impacts on marine species, and that any additional increase of atmospheric CO₂ and other stressors will progressively increase the ocean acidification risk to biodiversity (figure 5 above).

205. On the **natural capacity of marine organisms to adapt**, he noted that Palaeolithic-evidence shows natural ocean acidification events, albeit at much slower rates than today, which caused the extinction of many benthic species. Some experiments show that there is capacity to adaptation to lower pH, but it is very limited. Natural experiments around CO₂ vents in shallow seas show that there is a dramatic loss of biodiversity. He added that even if some species can adapt, ecosystem changes will occur, and there will also be corrosion of unprotected carbonate structures (e.g. cold-water corals) in unsaturated waters. Mr. Leadley stated that the impact of ocean acidification on warm-water corals is also of concern, since the lower pH affects their ability to calcify and hence population recovery from bleaching. He underlined that reef loss affects many other species and increases the impacts of sea-level rise. Warm-water coral reefs are already under stress, with more than 50 per cent currently in poor health, while cold-water corals are at risk from the increasing area of seafloor experiencing aragonite saturation of less than 1.0. He said that protecting coral reefs requires combining global action (i.e. CO₂ emission mitigation for climate and ocean acidification) and local action (i.e. the protection of herbivorous fish and pollution controls) (figure 34).

Figure 34

Species vulnerable to ocean acidification – of high socioeconomic or ecological importance



Source: Slide 9 of the presentation by Mr. Paul Leadley (Convention on Biological Diversity), available at http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_cbd_sed4-2_feb8.pdf. The figure indicates known locations of cold- and warm-water corals, depicted on a global map showing the projected distribution of ocean acidification under RCP8.5 (pH change from 1986–2005 to 2081–2100)

206. Mr. Leadley then focused on **forests**, noting that they are being negatively impacted by climate change sooner than had been anticipated, and that impacts vary substantially across tree species and regions (AR5, WGII chapter 4). He stressed that: reinforcing species and genetic diversity of trees can enhance the adaptive capacity of forests to climate change; reducing deforestation can contribute both to climate change mitigation and biodiversity protection; using diverse tree species mixes or natural regrowth for restoration can contribute to climate change mitigation and biodiversity protection; planting forests could make important contributions to future bioenergy, but if they replace primary forest they have negative impacts on biodiversity and medium-term climate balance.

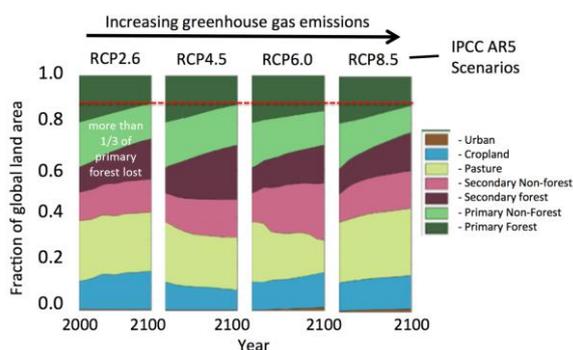
207. He underscored that since the **conversion of tropical forests to plantations** has very large, long-term, negative impacts on biodiversity and soil carbon stocks, leaving tropical forests intact is ‘a win-win’, hence the importance of REDD plus.³⁸ He then explained that the *Global Biodiversity Outlook* indicates poor progress on halting deforestation of primary forests globally, with the exception of a 70 per cent reduction in deforestation in Brazil. He added that progress can be made but depends on, inter alia: good governance; publically available monitoring of deforestation; public awareness; the expansion of protected areas and demarcation of indigenous lands; incentive measures; and willingness to move forward.

³⁸In Decision 1/CP.16, paragraph 70, the Conference of the Parties encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities: reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks (REDD).

208. On **reforestation**, Mr. Leadley underscored that, if appropriately done, active and passive forest restoration can have large positive benefits for climate mitigation, biodiversity and ecosystem services. He explained that while massive reforestation efforts are made globally, some are carried out with monoculture and exotic species, and hence have poor biodiversity benefits. While recognizing the complexity of optimizing co-benefits for biodiversity, climate mitigation and other ecosystems services for restoration projects, he stressed that new decision support tools can help evaluate trade-offs.

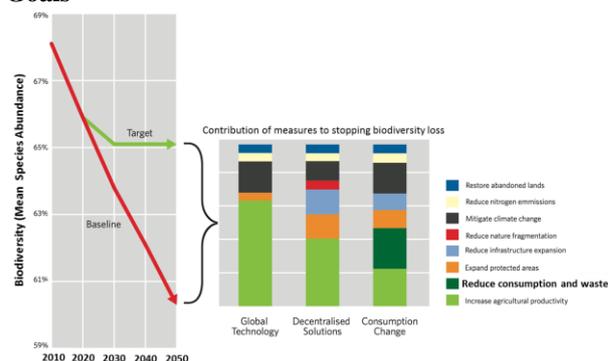
209. Mr. Leadley then examined the **primary land-use scenarios** associated with the four of the RCP scenarios, highlighting that in **RCP2.6, more than a third of primary forests was lost**, and that none of the other RCP scenarios had a positive impact on primary forests (figure 35). He stated that the other scenarios are “not very good for primary forest either” due to the negative effects of climate change on primary forest.

Figure 35
Primary land-use scenarios associated with the four representative concentration pathways scenarios



Source: Slide 13 of the presentation by Mr. Paul Leadley (Convention on Biological Diversity), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_cbd_sed4-2_feb8.pdf>. The figure shows changes in the global land use during the course of this century expressed as fractions of total land area for various RCPs. The red horizontal line indicates the remarkably similar loss of primary forests in all four scenarios by 2100.
Abbreviation: RCP = representative concentrations pathways.
IPCC AR5 = Fifth Assessment report of Intergovernmental Panel on Climate Change

Figure 36
Achieving the Convention on Biological Diversity 2050 Vision and ties with Sustainable Development Goals



Source: Slide 14 of the presentation by Mr. Paul Leadley (Convention on Biological Diversity), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_cbd_sed4-2_feb8.pdf>. The figure shows current trends in biodiversity loss (left panel, red line) and the CBD conservation target (green curve). The right panel shows three alternative scenarios of policy measures (global technology, decentralized solutions, and consumption change), each achieving the same conservation target while also reaching climate as well as sustainable development goals. The importance of reducing consumption and waste was underscored.

210. He therefore called on the IPCC, the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) and the UNFCCC to work together to meet climate and biodiversity targets and other sustainable development goals, in particular to: stop biodiversity loss by 2050; meet the Millennium Development Goals, with a focus on eliminating hunger; and keep global warming below 2 °C above pre-industrial levels. He presented three such possible alternative scenarios that will meet all the goals together, based on the IMAGE model, for achieving the 2050 Vision, emphasising the importance of reducing consumption and waste (figure 36).

211. Mr. Sergio Zelaya, Special Advisor on Global Issues, UNCCD, gave a presentation titled “Desertification and land degradation and their impact on natural ecosystems and food security, a UNCCD response to the 2 °C target”.

212. He presented some global facts on land, including that: global arable land represents 1/32 of the planet surface; **52 per cent of agricultural land is affected by degradation; land sector emissions amount to 6.2 Gt CO₂ eq per year; 1.8 billion of the world’s population in 2025 will be living with absolute water scarcity and two-thirds (or 5.3 billion) could live under water stress conditions; land degradation over the next 25 years may reduce global food production by up to 12 per cent**, and lead to an increase of as much as 30 per cent in world food prices; the world’s drylands represent 40 per cent of total land mass, a third of the population, and 44 per cent of the food production system; 925 million people are hungry, including 80 per cent of small-holder farmers and the landless poor in rural areas; 40 per cent of interstate conflicts are associated with land and natural resources; and some 135 million people may be displaced by 2045 as a result of desertification.

213. After providing some definition of basic terms related to land and land degradation, he focused on the interaction between land and climate, underlining that **small changes in that interaction can cause larger global changes**. Pointing to AR5 findings, he explained that: dry areas are expected to increase in many parts of the world, increasing the current extent of semi-arid areas and the risks to the proper functioning of ecosystems;

as the productivity and availability of land resources falls, so does adaptive capacity and resilience; and the unsustainable use of natural resources for food and energy causes land degradation locally, increases carbon emissions, reduces biodiversity and diminishes rainfall at multiple scales.

214. He pointed to common approaches to climate change mitigation and adaptation for addressing land degradation in drylands today and in non-dryland areas at risk. Noting that a large proportion of land ecosystems used for provisioning services is ‘degraded’, mostly due to the modes of use, he called for **non-degraded productive land, land under restoration in drylands and land at risk of becoming drier to be addressed** by exploring, identifying and further improving sustainable land management (SLM) methods and practices.

215. Mr. Zelaya explained that UNCCD adopts a holistic approach to land management and land degradation by aiming at **land degradation neutrality**. He outlined some benefits of land degradation neutrality, namely: its low cost, with an estimated average cost for land restoration of EUR 130 per ha or 0.45 Gt CO₂ eq while the economic rates of return of conservation, rehabilitation and SLM could reach 12–40 per cent; its multiple benefits, such as improved livelihoods in terms of food and water security, productivity increase and employment options; and its contribution to a low-carbon world, since the restoration of 12 million ha/a year could sequester 6.75 Gt CO₂ eq/year.

216. He underlined that land degradation neutrality is an ecosystem approach but that it is not a global target as it is still under negotiation, and each country can determine its level of ambition. Mr. Zelaya pointed to UNCCD COP decisions on the bottom-up target approach, noting their coherence with the UNFCCC process.

217. In closing, he outlined five opportunities for UNCCD to support Parties by: (i) providing support to the formulation of their INDCs in relation to key information on land use; (ii) integrating and combining sources of data for INDCs to assess the mitigation potential of existing plans and policies for land rehabilitation using IPCC default stock change and emission factors; (iii) setting up national land use mitigation targets and identifying their potential and co-benefits; (iv) focusing action on achieving land degradation neutrality as a starting point when reporting on INDCs implementation; and (v) providing land-based indicators common for reporting on climate change adaptation and mitigation, and on progress on land degradation neutrality and SLM.

218. Mr. Amena Yauvoli, SBI Chair, gave a presentation on supporting adaptation and mitigation action through capacity-building and education. He described the Durban Forum on capacity-building, which was established in 2011 by decision 2/CP.17, and whose mandate was expanded with decision 10/CMP.8 to cover issues relating to capacity-building under the Kyoto Protocol. The forum, which is organized by the SBI, has held three annual in-session meetings so far, with the next scheduled to take place during SBI 42, in June 2015.

219. The **Durban Forum aims to**: enhance the monitoring and review of the effectiveness of capacity-building; exchange experiences, good practices and lessons learned; provide an overview of capacity-building elements in the work of bodies established under the Convention and its Kyoto Protocol; and provide inputs to the review of the framework for capacity-building in developing countries. He underlined that the participatory mechanisms of the Durban Forum are very broad based, and the agenda is usually driven by Parties through submissions on possible topics.

220. At previous meetings, Durban Forum participants have **discussed** ways to further enhance the monitoring and review of the effectiveness of capacity-building, the creation of an enabling environment, and capacity-building for adaptation and mitigation and gender mainstreaming. Mr. Yauvoli indicated that discussions held at each meeting of the Durban Forum are summarized in a report, which is forwarded for consideration to SBI.

221. He reported that **Durban Forum meetings are confirming that** there is a variety of activities to build capacity to mitigate and adapt to climate change that are embedded in mitigation and adaptation projects, and that bodies established under the Convention and its Kyoto Protocol are engaged in capacity-building activities, mostly at the regional level.

222. Among the **lessons learned** from the 2014 meeting of the Durban Forum, he highlighted the need to: build capacity to generate a higher level of social awareness of climate change and its impacts; actively coordinate stakeholders involved and identify the ‘right’ stakeholders and institutions to be trained to ensure that capacity-building efforts are effective; and enhance South–South and peer-to-peer cooperation to enable a strong cross-fertilization of ideas.

223. Mr. Yauvoli then described the **Dialogue on Article 6 of the Convention**, which was established in 2012 by decision 15/CP.18 under SBI. He explained that the Dialogue had held two annual in-session meetings so far, in 2013 and 2014, with the next scheduled to take place during SBI 42, in June 2015. The Dialogue on Article 6 of the Convention aims to provide a regular forum for Parties and other stakeholders to share their experiences, ideas, good practices and lessons learned regarding the implementation of Article 6 of the Convention. He noted that **participation in the Dialogue is broad-based**, and that the six elements of Article 6 of the Convention (education, training, public awareness, public participation, public access to information and international

cooperation) are clustered into two focal areas that alternate on the Dialogue’s agenda on an annual basis: the first area being education and training and international cooperation on these matters; the second, public access to information, public participation and public awareness, and international cooperation on these matters. He explained that discussions held at each meeting of the Dialogue are summarized in a report, which is forwarded for consideration to the SBI.

224. Among **messages emerging from the Dialogues**, he highlighted that: education and public awareness are fundamental for encouraging people to tackle climate change by changing their attitudes and behaviours towards climate-friendly lifestyles; climate change issues should be communicated in a manner that is understandable for all groups of society, attributable to daily life and does not create panic, but emphasizes opportunities; and the implementation of all elements of Article 6 of the Convention will contribute significantly to achieving the ultimate objective of the Convention and to implementing effectively adaptation and mitigation actions.

225. In concluding, Mr. Yauvoli underscored that **capacity needs to be built and education fostered in order to assess the adequacy of the 2 °C goal and the overall progress towards that goal**. He also said the Durban Forum and the Dialogue on Article 6 of the Convention can contribute to: promoting discussions among experts and practitioners; identifying lessons learned; replicating good practices and fostering action for emission pathways consistent with a 2 °C limit; and gathering information to support the review of the adequacy of the long-term global goal.

226. Mr. Jukka Uosukainen, Director, CTCN, gave a presentation on the development and transfer of technologies in the context of the 2 °C limit to global warming. He explained that, together with the Technology Executive Committee (TEC), the CTCN forms the UNFCCC Technology Mechanism, and is among the pre-2020 UNFCCC processes focusing on enhanced implementation. He added that while the TEC is the policy arm of the Technology Mechanism, the CTCN is the implementation arm, and aims to enhance action on the development and transfer of technology for action on climate change.

227. The CTCN mandate is to stimulate “technology cooperation and enhance the development and transfer of technologies to developing country Parties at their request”. The CTCN offers the following three services: (i) providing technical assistance to developing countries; (ii) sharing knowledge and training; (iii) fostering collaboration on climate technologies, including linking climate technology projects with financing opportunity. The CTCN is hosted by UNEP, in collaboration with the United Nations Industrial Development Organization (UNIDO), and supported by 11 partner institutions with expertise in climate technologies.

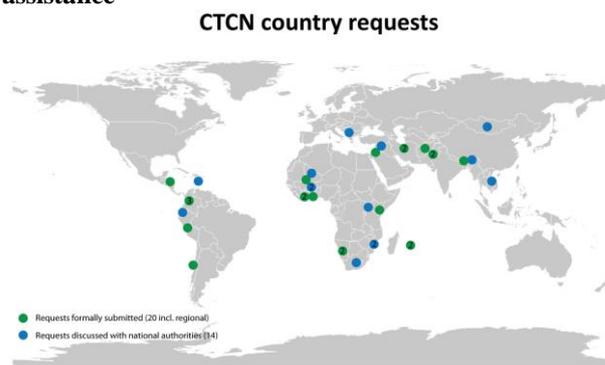
228. Mr. Uosukainen indicated that as of 19 January 2015, 105 countries had selected their National Designated Entities (NDEs), stressing that the CTCN cannot render its services without an NDE and encouraging those countries who have not yet designated one to do so (figure 37).

Figure 37
Countries with designated national CTCN entities



Source: Slide 5 of the presentation by Mr. Jukka Uosukainen (Climate Technology Centre and Network), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/5_ctcn_sed4-2_feb8.pdf>. The figure shows a map of countries that have designated their national entities to the Climate Technology Centre and Network (80 developing countries).

Figure 38
Countries’ requests to the CTCN for technical assistance



Source: Slide 8 of the presentation by Mr. Jukka Uosukainen (Climate Technology Centre and Network), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/5_ctcn_sed4-2_feb8.pdf>. The figure illustrates countries requests for technical assistance from the Climate Technology Centre and Network.

229. He described the **technical assistance** provided by the CTCN, stressing that it is: provided to developing countries upon their request; free of charge, with a value up to USD 250,000; both state of the art and locally-relevant expertise; provided to academics, the public, nongovernmental organizations or private entities; and for a broad range of adaptation and mitigation technologies.

230. Mr. Uosukainen stated that through its network, the CTCN mobilizes policy and technical expertise from academia, civil society, finance and private sectors to deliver technology solutions, capacity-building and implementation advice to developing countries. He indicated that the CTCN had received 20 requests for technical assistance, some of which were already in the implementation phase, and that 14 additional requests are under discussion with national authorities (figure 38). He underlined the role of NDEs in coordinating the demands of their countries and explained that the assistance provided comes, at the moment, from the expertise of the 11 institutions that make up the consortium, but that the CTCN is looking to increase the number of its network members.

231. Mr. Uosukainen emphasized that the technical assistance provided by the CTCN is particularly quick, with expert teams set up in a couple of months and requests implemented within a year. He indicated that 72 requests (approximately 100 at the moment of writing this report) are anticipated in 2015, noting the need to maintain the balance between adaptation and mitigation requests, as well as among regions. He cited the examples of assistance provided to Colombia in relation to energy efficiency and renewable energy strategies, and to Iran on the design and manufacturing of photovoltaic solar cells. He underscored that the CTCN aims to link with all relevant activities under the UNFCCC process, such as the NAP and the technology needs assessment processes, in order to ensure coherence and coordination.

232. In closing, he underscored that: the TNA process and the work of the CTCN should be linked; the NDEs will play a key role, especially in bringing together all the relevant stakeholders; and technology support systems currently represent only a percentile of climate funding within the remit of the Convention, but it is fast growing.

2. General discussions

233. The ensuing discussion was guided by the following questions on theme 1 and theme 2 of the 2013–2015 review:

(a) Where has promising progress been achieved and what barriers to adaptation of which ecosystems, which agricultural systems, and which developing regions have been identified?

(b) What progress has been made in building capacity and educating on climate change? What are the main barriers to these efforts? What could be done to overcome these?

(c) What success stories exist in relation to national and regional actions that have enhanced the effectiveness of technology policies?

(d) What progress has been made on funding for climate action? What barriers and opportunities exist for the scaling-up of climate finance flows?

(e) Can ecosystems adapt naturally with respect to the transformation pathways compatible with a long-term global goal of 2 °C or 1.5 °C respectively? Which ecosystems are the most at risk? Which the least? What is the role of biodiversity for adaptation in general and which specific opportunities exist, such as ecosystem based adaptation?

(f) What role can capacity-building and education play in achieving the long-term global goal?

(g) Which transformation pathways compatible with 1.5 °C or 2 °C warming compared with pre-industrial levels are projected to threaten food production or offer the most opportunities?

(h) What barriers or opportunities to CSA and adaptation in the fisheries sector are projected to exist for emission pathways consistent with 1.5 °C and 2 °C warming compared to pre-industrial levels?

(i) What are the key opportunities for and barriers to adaptation that are projected to exist for emission pathways consistent with 1.5 °C and 2 °C warming compared with pre-industrial levels?

(j) What level of climate finance will be required to achieve the long-term global goal? What are the key factors that need to be in place to ensure that such a level is reached?

234. A Party asked about the **impact of land degradation on natural ecosystems and food security and linkages with the INDCs**. He noted that USD 1.7 billion will be required to achieve land degradation neutrality, and that INDCs are expected to clearly define the MOI in accordance with the Convention. He asked for clarification of the **role of INDCs in achieving land degradation neutrality**. Another Party asked about the **connections among actions aimed at protecting soils and halting land degradation, climate mitigation benefits and the price of carbon** and commented that the price of carbon would be higher in a world that is 1.5 °C warmer and that the higher price would thus have the co-benefits of halting land degradation. An expert explained that the target of 2 million ha of land restored proposed by UNCCD corresponds to the amount of land degraded annually. He added that the price of carbon used is based on the 2 °C scenario. He added that UNCCD is able to quickly assist those countries that wish to include the land component in their INDCs, pointing to

challenges related to property rights and land tenure, and stressing that UNCCD would only use IPCC guidelines and methodologies for assessing the mitigation benefits. A Party further asked if, considering the USD 1.7 billion assessed by UNCCC, a link can be made with the financial mechanism under the Convention. He then asked if, at the next meeting of the SED, a GCF expert could provide information on the amount of finance available to support efforts to achieve land degradation neutrality. Mr. Zou Ji underlined that the Geneva meeting of the SED was its last.

235. A Party asked **how the CTCN plans to collaborate with the Durban Forum**, and if there are any capacity-building projects under the CTCN. An expert explained that he considers most of the CTCN activities to be capacity-building, underlining the importance of coordinating its work with the Durban Forum. He added that if requests for the services provided by the CTCN are not clearly defined then the CTCN works with the country in reformulating them, which is also a capacity-building process. He also pointed to an “incubator programme” for LDCs to help them define and identify their technology problems, which has already been used by approximately 10 LDCs. The expert also pointed to the organization by the CTCN of webinars that provide training on specific climate-related technologies.

236. A Party asked about the **impact of monoculture on biodiversity and genetic diversity**, noting that it may have climate mitigation benefits. An expert explained that, in many situations, genetic diversity provides many favourable outcomes and is useful in both tree plantation and restoration projects. He cautioned that “it is not always win-win”, and that some species restoration projects will not provide the fastest carbon storage nor the best resilience, hence the importance of support tools to evaluate the trade-offs between climate and biodiversity benefits.

237. A Party asked for **statistics regarding the amount of technology requests related to mitigation and those related to adaptation**, as well as information on the criteria used to prioritize requests. An expert replied that the 30 requests received so far by the CTCN are quite evenly distributed across regions and sectors. He said the CTCN has two sets of criteria for selecting requests. The first is an eligibility criterion, indicating that the request should support national climate efforts and support indigenous capacities in the country. The second criterion relates to prioritization in case the CTCN cannot serve all the requests received. In such cases, the CTCN is to ensure the balance between requests related to mitigation and those related to adaptation, as well as to serve LDCs and other vulnerable countries as a priority. He added that the CTCN currently has enough funds to serve all the requests received, but depends on bilateral funding from developed countries.

238. A Party noted that the presentation by the CBD had shown a clear difference in **impacts on ocean acidification and on coral reefs between 2 °C and 1.5 °C** of warming above pre-industrial levels. If there is a temperature overshoot, he asked how long, if at all, it will take for biodiversity to be restored. An expert indicated that if there is a temperature overshoot, which would be accompanied by a CO₂ overshoot, then the global water chemistry would take a very long time to recover, as shown by the Palaeo evidence (e.g. 10,000 years).

239. A Party asked for clarification on the CBD presentation regarding the modelling and **what is meant by reducing climate change, and whether it implies addressing global temperature increase or also other elements**. An expert explained that climate scenarios take into account emissions of CO₂, N₂O and CH₄ associated with all the different sectors, as well as other CBD targets, such as reducing deforestation, halting biodiversity loss, advancing human development, or ensuring sufficient food for everyone on Earth.

240. A Party pointed out that the workplan of the **Adaptation Committee does not have a specific focus on the long-term global goal**, and suggested that SED discussions be concentrated on the commitments under the Convention. While expressing his disappointment regarding the absence of a presentation on finance during SED 4, he asked if there are **initiatives under the Adaptation Committee on the consideration of commitments under the Convention relating to MOI**. An expert said that despite the absence of a specific reference to the long-term global goal in the workplan of the Adaptation Committee, which was adopted through a Party-driven process, it would be “difficult to argue” that NAPs are not contributing to the achievement of the long-term global goal. He stressed that it is up to **Parties to determine at the national level the level of risk they want to address**. On finance, he referred to ongoing work on adaptation finance carried out in collaboration with the Standing Committee on Finance, which examines national institutional arrangements, the NAP process and the challenges faced by countries in relation to access to finance and the integration of adaptation into national development plans.

241. A Party welcomed the use of the example of Brazil’s efforts to reduce deforestation in the CBD presentation, but **underscored that tree mortality is increasing globally**, to some extent due to climate change, stressing that without global efforts to mitigate climate change, forests will continue to be threatened. An expert agreed, noting evidence showing that trees and forests are sensitive to temperature increases. He said that it is clear that the carbon stored in these protected areas is vulnerable to temperature increases, warning that with temperatures above 2 °C of warming, there could be very serious forest die backs in the Amazon.

242. A Party asked **which adaptation actions are the most urgent** to preserve coral reefs and food supply and protect biodiversity in the context of climate change and desertification, and **what kind of financial support is required** to promote adaptation and mitigate climate change impacts. An expert underlined that besides ocean acidification, coral reefs are also affected by coral bleaching and increased sea level, which are all impacts of climate change. He also pointed to local pressures on coral reefs, such as land-based pollution, overfishing, dangerous or disruptive fishing practices, and suboptimal coastal developments. He explained that countries can address these non-climate pressures through, inter alia, **reduced pollution and improved marine and coastal planning** in the short and medium term. He underlined that these measures will not bear fruit if they are not carried out in concert with global efforts to mitigate climate change. He also stressed the “enormous” benefits of protecting coral reefs, pointing to protection from erosion with a 97 per cent reduction in wave effects and support to local fisheries and tourism. An expert indicated that where marine protected areas have been designated for coral reefs, some improvement has been seen in fish biomass and food web structure, but restoration has taken 10–15 years.

243. A Party asked for confirmation that **stringent mitigation pathways have considerable co-benefits for biodiversity** conservation or are essential to prevent biodiversity and ecosystem loss. She also noted that the **expected primary forest loss** in the RCP scenarios, which is very similar in all of them, does not take into account the climate change impacts on forests. She asked if these detrimental effects had been taken into account, the impacts of forest loss would be higher in RCP scenarios that do not keep temperature increase to low levels. An expert agreed that the greater the change in climate, the greater the threats to biodiversity. While recognizing that actions taken to address climate change action have clear biodiversity co-benefits, he warned that such action can also impact on biodiversity conservation. He called for attention to be paid to land-use change and emissions from the industry and energy sectors, as well as to the carbon stored in ecosystems beyond forests, including in the agricultural sector. He stressed the need for **building an incentive framework** that includes considerations of emissions from land-use change. He explained that in the **RCP2.6 scenario, the impacts from climate change on biodiversity are much reduced, but it implies significant land-use changes, which will be problematic for biodiversity**. He added that in order to reduce biodiversity loss, land-use change must be brought under control. He said that the scenarios presented indicate that it is **possible to achieve both the climate and biodiversity objectives** while ensuring food security, but this will not be an easy task and it will require adopting a very holistic approach. Another expert, noting some studies on geoengineering options that could locally raise the pH of oceans, stated that these options pose their own risks to biodiversity.

244. Another Party asked if **biodiversity loss projected for warming levels above 1.5 °C can be a damage multiplier of climate change impacts**, pointing to the coastal protection that coral reefs provide and that would be lost if they disappear (link through ecosystem services such as pollination, water purification and support for ecosystem based adaptation). An expert agreed that species extinction is a threat multiplier, underlining that the risk of extinction does rise from 1.5 °C to 2 °C of warming, but the details of how this will happen are not well known. While noting that evidence exists of the adverse effects of increased levels of warming on systems such as coral reefs or trees, he pointed to differences in impacts among regions and species. While recognizing that the details of the impacts of increased warming are not well known, he said that there is a high level of certainty regarding the fact that the risk to ecosystems and the services they perform rises with increased levels of warming.

245. A Party noted a paradox between the presentation by Mr. Leadley, who had said that the difference between 2 °C and 1.5 °C is really a matter of an increase in risk, while the SBSTA Chair had stated that what constitutes a tolerable risk may differ across regions, nations and sectors.

246. A Party noted that the Adaptation Committee reported that many bilateral organizations are receiving very few requests, indicating that the **utility of resources has been sub-optimal**. He asked how this opportunity could be better capitalized on. An expert explained that the fact that some bilateral institutions are not receiving many requests is not a challenge of optimal use, but **rather a challenge of institutional capacity**. He pointed to capacity constraints of some developing countries to make use of the existing opportunities. He indicated that in the future, bilateral agencies may support the global support programme if the countries feel more comfortable channelling their requests to the latter.

247. A Party asked how the **link between the CTCN and the NAP, TNA and nationally appropriate mitigation action (NAMA)** processes could be made more efficient, and requested more information on the LDC readiness programme within CTCN. An expert explained that to link the work of the CTCN to other processes, the CTCN will need to collaborate on the regional workshops planned for the TNA process, since the audience is the same, namely the NDEs. On the LDC capacity-building programme or ‘incubator’, he mentioned the caution of the CTCN to avoid overlapping with the capacity-building activities of other bodies. Noting that the Adaptation Fund is already carrying out some capacity-building and preparedness activities, he said the CTCN is looking at working in synergy with the Fund on this issue.

248. A Party asked about **non-climatic stressors** and possible success stories in addressing them that need to be taken into account when examining vulnerable ecosystems. An expert replied that while much research needs to be done on land ecosystems, evidence shows that land degradation is caused by human activities, but climate change exacerbates this trend, both in drylands and in non-dryland areas that are at risk. He called for addressing today's drylands and not those that are at risk. He pointed to the proposal from the UNCCD to restore 12 million ha of degraded land annually, stressing the need for it to be part of the solution to addressing climate change. He added that INDCs are a viable option for including such a land component and suggested that the GCF consider how this could be supported. Another expert said that non-climatic factors that are important include **invasive species**, which are the cause of the greater number of extinctions, especially on islands. He pointed to the example of New Zealand, which successfully restricts the introduction of invasive species and controls them once they have been introduced. He also mentioned the case of pollution in Europe, where there are relatively high nitrogen deposition rates, and where substantial progress has been made by countries in setting ecologically significant nitrogen level limits. A third added that non-climate stressors, such as pollution or sedimentation, pose risks to corals, but it will take a long time and more studies to be able to differentiate their impacts from those of climate change. He noted however, that studies show that when there is intense temperature elevation, irrespective of water quality, mass coral bleaching may occur. He stated that it can be concluded with **reasonable certainty that thermal stress is the key driver**.

249. A Party welcomed the discussions on the links between climate change impacts on biodiversity and desertification and non-climate drivers and asked **how well we understand the importance of different drivers, and what action to address climate change has co-benefits for biodiversity conservation or to combat desertification**. He also asked if the impacts of ocean acidification could be tied to the level of CO₂ in the atmosphere. An expert explained that acting on non-climate stressors is frequently a 'no regret' solution, and that measures aimed at, for example, **reducing nitrogen pollution or pressure on overfished resources**, will increase the resilience of ecosystems to climate change. He noted the limited understanding of all the interactions among these stressors, as often models only take into account a small number of interactions. He pointed to some regional tipping points mentioned in the *Global Biodiversity Outlook*, warning that "synergistic interactions could lead to many bad surprises". Another expert indicated that there is no consensus within the scientific community on any 'safe level' of ocean acidification and related CO₂ concentration in the atmosphere, but some literature places this safe limit for corals at 350 ppm, a threshold that has already been passed. A third expert explained that a study he co-authored was not included in the assessment carried out by WGI as it was published after the IPCC cut-off dates.³⁹ He said that the temperature target does not cover all the aspects touched upon in Article 2 of the Convention, calling for **ocean acidification to be considered in a separate manner**. While recognizing that limiting temperature limits ocean acidification to some extent, and that more information is needed on the regional impacts of ocean acidification, he underlined that a separate target on ocean acidification may set a much lower amount of CO₂ concentration increases in the atmosphere. Yet another expert explained that scientific knowledge on the climate and non-climate drivers of desertification and land degradation is insufficient and underlined that land ecosystems are not sufficiently included in climate solutions.

250. A Party noted that over 50 per cent of land degradation stress in Africa is climate-related, and asked **how to assess the risk of land degradation arising from both climate and non-climate stressors** in the light of the ultimate objective of the UNFCCC. An expert referred to the very large portion of the population, in particular in Africa, which is affected by land degradation, pointing to AR5 findings projecting that drylands will become drier and that a larger portion of terrestrial area will become drylands.

251. In response to a question by a Party on the **scale of funding required to address land degradation and desertification**, noting that the UNCCD presentation indicated that drylands are vulnerable and that 40 per cent of total land mass is dryland, the expert questioned whether the MOI available will be adequate to address the current level of drylands, or that projected at 1.5 °C or 2 °C of warming.

252. Noting that LDCs have various priorities related to development and poverty eradication issues, a Party asked if the recommendation to **mainstream adaptation in development planning**, which has a cost implication, is appropriate for LDCs. An expert indicated that whether countries decide to mainstream adaptation or carry out stand-alone projects depends on the types of hazards and exposure they are facing. He added that in the case of LDCs, the consideration of reducing vulnerability comes as a complement to the second objective of NAPs, namely the integration of adaptation to climate change into other policies.

³⁹Steinacher M, Joos F, Stocker TF. 2013. Allowable carbon emissions lowered by multiple climate targets, *Nature*. 499:197-201.

253. A Party asked if the CTCN had received any **request relating to adaptation technology in Africa**. An expert indicated that the CTCN had received three following requests from African countries: from Mali on resilient rural communities; from Cote d'Ivoire on climate information systems for both adaptation and mitigation; and from Namibia on transformation of water harvesting systems. He added that the CTCN encourages the replication of its response activities in neighbouring countries.

254. A Party underscored the **importance of the intersections of the three Rio Conventions**, suggesting that while developing their NAPs, Parties should involve the resources under these three Conventions. She also pointed to the challenges faced by experts carrying out vulnerability or impact assessments in using the new climate scenarios produced by the IPCC and called for discussion on how to simplify the use of the IPCC scenarios for performing national impact, vulnerability and adaptation studies. An expert stated that the collaboration of the three Rio Conventions could materialize in the context of ecosystem-based adaptation in the next workplan of the Adaptation Committee, which is under development.

255. Noting that his country is in the process of declaring their entire exclusive economic zone as a marine protected area and a sanctuary to contribute to halting biodiversity loss, a Party asked the experts to elaborate on **the role of biodiversity in rendering key ecosystem services**, the possible impacts of losing such ecosystems, as projected above 1.5 °C of warming, and their importance for the livelihoods of traditional and indigenous communities. An expert underscored the critical importance of other ecosystems aside from corals in supporting fisheries, such as mangroves or sea grasses. He added that often the smaller the country, the more its population's livelihoods are dependent on these ecosystems. He indicated that 30 million people are directly dependent on systems supported by coral reefs.

256. A Party asked about the **adequacy of the technology management system under the UNFCCC**, in particular about who owns and requests the technologies, as well as about the role of market-based mechanisms in encouraging the transfer of technology. An expert explained that market-based mechanisms have shown they can mobilize technologies, pointing to the example of the CDM, which has mobilized technologies in a wide range of countries. He cautioned that this mobilization is linked to the level of incentives, which is currently not very high, and therefore does not provide the level of trust or long-term certainty needed by private actors to invest in the technologies. Another expert explained that the CTCN aims to provide technology-neutral advice to countries, who can then follow up with requests for more detailed advice on a particular provider or technology. He explained that further to a request from Parties, the CTCN is examining whether to establish a library of technologies and their providers. He cautioned that this may entail "a huge amount of work" because of the constantly changing landscape of climate technologies. He added, however, that one could look at technologies mentioned in Parties' national communications and share that information through other countries with an automated system.

E. Part 4: Regional and emerging information

1. Presentations by experts on regional information on the observed impacts of climate change

257. The ensuing discussion was guided by the following questions on theme 2 (subparagraphs (a–d) below) and theme 1 (subparagraphs (e–k) below) of the review:

- (a) What are the most recent findings in relation to observed regional impacts?
- (b) Are there regions in which some ecosystems cannot adapt naturally? Is their adaptation assisted or might it help to assist them, and by which means? What are the consequences for agriculture and development?
- (c) What challenges does global warming pose to agricultural practices, policies and measures, from a regional perspective?
- (d) What challenges does global warming pose to sustainable development from a regional perspective?
- (e) How has progress towards the long-term global goal varied across regions?
- (f) How do opportunities and barriers to adaptation and mitigation vary across regions?
- (g) Which risks vary the most across regions? How do these risks vary at various levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre- industrial levels?
- (h) How do risks for vulnerable ecosystems vary across regions at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?
- (i) How do regional food security risks vary at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(j) How do observed impacts including those of sea level rise and extreme events vary across regions and at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

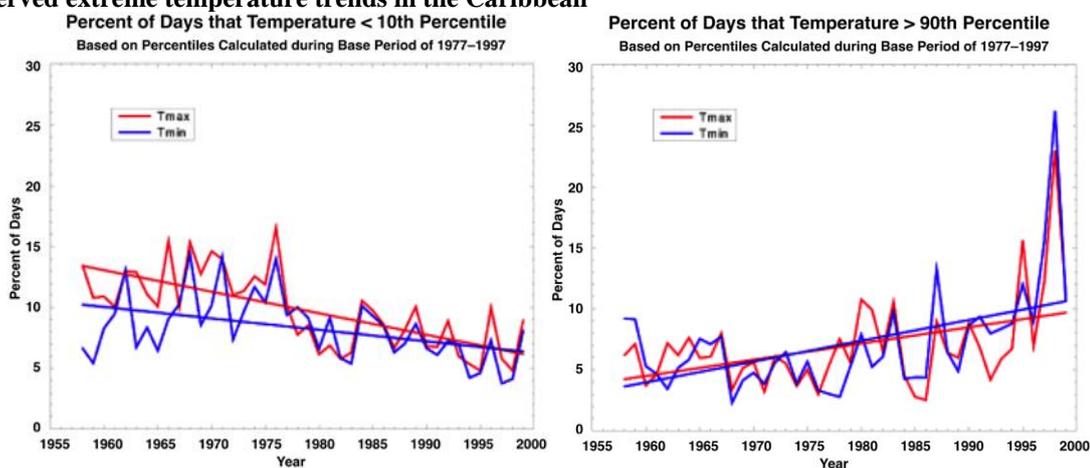
(k) From a regional perspective, what is the future of ecosystems, agriculture and sustainable development in the context of climate variability, climate change and uncertainty about future climate conditions?

258. Mr. Leonard Nurse, Chairman of the Board of Governors, Caribbean Community Climate Change Centre (CCCC), presented a Caribbean perspective on observed impacts of climate change. In terms of temperature changes, he stated that the observed changes in the Caribbean reflect global trends. Over the period 1950–2000, there have been more warm days and nights, and fewer cold days and nights, a trend that is increasing (figure 39).

259. On **observed rainfall**, the mean annual rainfall on average between 1900 and 2000 has shown a constant decline by around 0.18 mm per year. In the southern Caribbean, over the period 1900–1980, there has been a contraction in the ‘traditional’ wet season, which typically lasts from June to October. There have been longer dry spells and increasing drought incidences since 1900, and there has been an increase in the number of heavy rainfall events in last 75 years. He pointed to the example of Saint Lucia, which suffered its worst drought in 40 years in 2009–2010, and was then hit by Hurricane Tomas in 2010, which produced 25 inches of rainfall in 24 hours in some areas.

Figure 39

Observed extreme temperature trends in the Caribbean



Source: Slide 2 of the presentation by Mr. Leonard Nurse (Caribbean Community Climate Change Centre), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_ccccc_sed4-2_feb9_1.pdf>. The figure shows for Caribbean since 1950 a growing trend in the number of warmest days and nights and a decreasing trend in the number of coldest days and nights.

260. As indicated in the AR5 chapter on islands, he reported that the **rate of sea level rise around islands** is generally higher than the global average: in the tropical Western Pacific, the rate of sea level rise is almost four times the global average; in the Indian Ocean, the rate of rise is as much as twice the global average; in the Caribbean, the rate of rise is generally higher than global average, at approximately 1.8 mm per year; and in the case of Guyana, where there is land subsidence, the observed mean rate of rise is approximately 2.4 mm per year (figure 40).

261. He underlined that the impact of climate change on **freshwater resources** is “a tremendous concern to our region”, pointing to declining mean annual rainfall, more frequent and longer dry spells, higher evaporation rates, salinity intrusion, and increasing present and future demand.

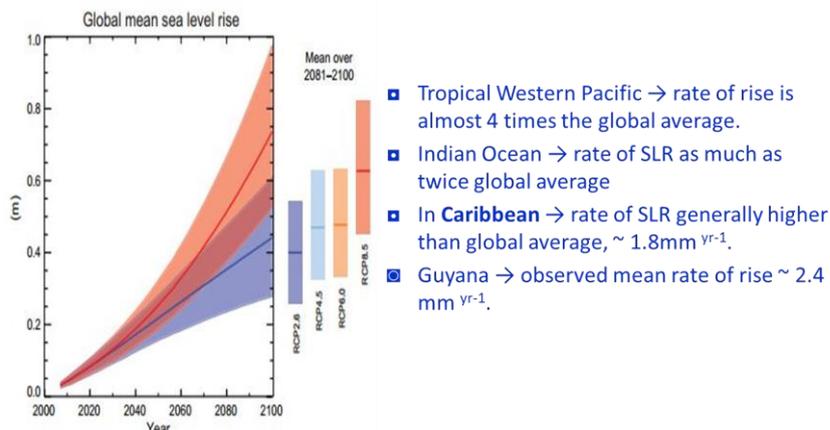
262. On **coral reefs**, he underscored that these high-value ecosystems are at high risk, that the casual link between **ocean warming and coral bleaching** is well established and that an increase in water temperature of less than one degree is enough for bleaching to take place. Mr. Nurse added that many studies show that Caribbean reefs will continue to be severely degraded in the coming decades, based on the response of corals to thermal stress, and that there is no field evidence that corals can evolve and adapt to unabated thermal stress, certainly not on decadal timescales. While recognizing that other, non-climate stressors are important, he said the thermal stress is “the key signal”.

263. He reported on findings emerging from an EU-funded study that were released in December 2014, titled “FORCE – Future of Reefs in a Changing Environment”, which compiled information on **aragonite saturation** levels. He explained that aragonite is a mineral form of calcium carbonate (CaCO₃) found in corals and some other marine organisms, and that the lower aragonite saturation state of water is beginning to affect the

development of the skeletons of corals. According to the AR5 projections, as the oceans continue to acidify, the impacts of climate change on reefs are anticipated to become more evident and significant.

Figure 40

Observed sea level rise in Small Island Developing States regions in the twentieth century



Source: Slide 4 of the presentation by Mr. Leonard Nurse (Caribbean Community Climate Change Centre), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_ccccc_sed4-2_feb9_1.pdf>. The figure indicates that the rate of sea level rise in islands is generally higher than the global average.

Abbreviations: RCP = representative concentration pathways; SLR = sea level rise.

264. On **human health**, Mr. Nurse reported: a higher incidence of some vector-borne diseases since 1970, such as dengue fever, noting that some of the transmission factors are also climate sensitive; increased morbidity and mortality from hydro-meteorological events since 1950, particularly floods and storms; increased freshwater scarcity since 1960, with ensuing challenges for sanitation and hygiene; and a higher incidence of ciguatera fish poisoning in last four decades related to higher sea surface temperatures that provide favourable conditions for ciguatoxins.

265. On **tourism**, he highlighted direct and indirect effects from climate change: an increased risk to critical infrastructure such as air and seaports and accommodation; the amplification by sea level rise of ocean swell and storm surge elevations that lead to flooding, accelerated coastal erosion and land loss; and the loss of climate-sensitive attractions, in particular corals. He stressed that scuba diving “is not a trivial industry” and that revenues from scuba diving alone are significant in various Caribbean countries. For example, Bonaire earns over USD 50 million per year from recreational diver fees, and Belize earned USD 150–196 million from coral reef and mangrove-related recreation in 2007.

266. He presented some **downscaled projections for the region**, stressing that they are trending in the same direction as the observations, including: a projected 1–4 °C warming relative to 1960–1990 mean temperature by the end of the century; a projected 25–30 per cent decrease in rainfall before the end of the century; and a drying trend between -25 and -30 per cent by the end of the century, which far exceeds natural variability (figure 41).

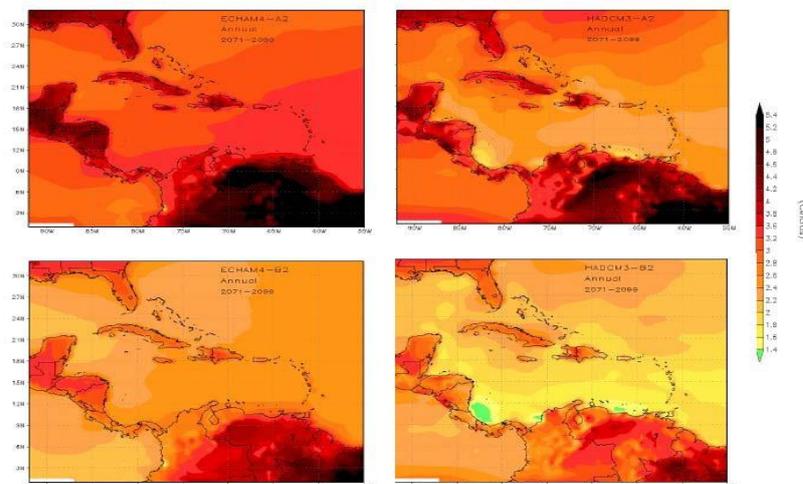
267. Mr. Nurse then described the **Caribbean contribution to the achievement of the long-term global goal**. The Heads of State of the Caribbean Community and Common Market (CARICOM) mandated the CCCC to develop a “Regional Framework for Achieving Development Resilient to Climate Change”, which was approved in July 2009, and an “Implementation Plan”. He said the Framework and Plan focus on key strategic elements, including economic trends and challenges, social sector trends and challenges, technology trends and challenges and energy for sustainable development. Mr. Nurse then focused on the energy pillar of the Framework. He reported that the Caribbean Community Energy Policy was adopted in 2013 and aims to transform the energy sector to provide clean energy. In January 2015, the Caribbean Energy Security Summit was co-hosted by the United States Department of State, the Council of the Americas and the Atlantic Council. The event brought together 26 countries, including all CARICOM States, who committed to “clean sustainable energy for all”, and saw a pledge of cooperation from the United States Overseas Private Investment Corporation that proposed a clean energy programme in the Caribbean, including USD 43 million for a 34 MW wind energy project in Jamaica.

268. He also mentioned SIDS DOCK, an initiative developed by CCCC and the South Pacific Regional Environment Programme (SPREP), which aims to: increase energy efficiency by 25 per cent compared with 2005 levels; generate a minimum of 50 per cent of electric power from renewable sources by 2033; and achieve a 20–30 per cent decrease in the use of conventional transportation fuel in SIDS by 2033. The partnership was established by a memorandum of understanding among the Alliance of Small Island States (AOSIS), the United

Nations Development Programme, the World Bank and the Government of Denmark, and launched in December 2010 in Cancun, Mexico, with a USD 14.5 million grant from the Government of Denmark.

Figure 41

Projected 1–4 °C warming by the end of the century (relative to 1960–1990 mean)



Source: Slide 11 of the presentation by Mr. Leonard Nurse (Caribbean Community Climate Change Centre), available at http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/1_ccccc_sed4-2_feb9__1.pdf Juan Hoffmaister >. The figure shows the projections for mean temperature in the Caribbean for an A2 scenario (upper panels) and B2 scenario (bottom panels) using ECHAM4 (left-hand side panels) and HADCM3 (right-hand side panels).

269. He stated that these programmes are bearing fruit, citing the successful example of the Wigton Wind Farm in Jamaica. He also mentioned: the deployment of renewable energy and energy efficiency in the public sector in Jamaica; the Sustainable Energy for the Eastern Caribbean project in Antigua and Barbuda, Grenada, and Saint Vincent and the Grenadines; and a sustainable energy programme in Guyana.

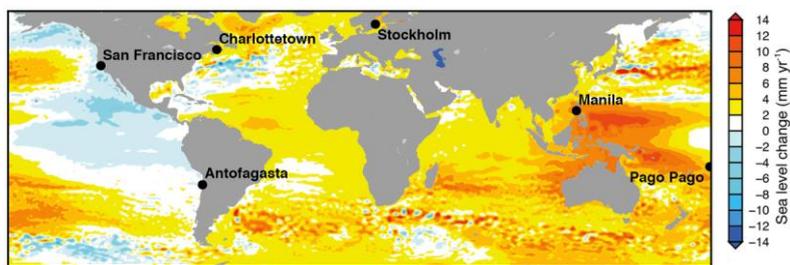
270. In concluding, Mr. Nurse emphasized that: climate change will continue to exacerbate existing challenges, as well as trigger new ones; **Caribbean countries believe that there is adequate, credible evidence to justify the pursuit of a long-term goal that limits global warming to 2 °C relative to pre-industrial levels**; delays in ‘aggressive’ mitigation will frustrate achievement of the long-term global goal and impose further limits on adaptation; and the Caribbean region has demonstrated a clear commitment to achievement of the long-term global goal.

271. Ms. Diane McFadzien, Climate Change Advisor, SPREP, presented views from the Pacific. She underlined that in the Pacific region, the islands are very spread out and some have small populations, elements that have a direct relation with the people’s adaptive capacity. She described some observed impacts of climate change in the Pacific region, underlining that capacity to document or research these impacts is limited in the region. She said observed impacts are in line with the findings of the AR5.

272. On **temperature rise**, she noted: a persistent regional warming trend since 1961 (0.18 °C annual), with the warmest years on record in the last two decades; an increase of more than three-fold in the frequency of warm days and nights; an increase in rare extremes from 20 days a year to 45–80 days a year; and an increase in sea surface temperatures across the Pacific. On **sea level rise**, she indicated that the observed rate of sea level rise in the western Pacific is three times above the global average for 1993–2012. While recognizing that this may mainly be attributed to natural variability, she stated that it shows the high regional vulnerability to sea level rise, and underlined that projections of future regional sea-level rise are above global levels (figure 42).

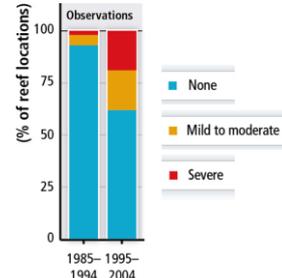
273. On observed impacts on coral reefs, she mentioned: an increase in coral bleaching re-occurrence and severity; a rapid decline in the abundance of reef building corals of 1–2 per cent per year for 1968–2004; and loss of ecosystems services and impacts on the GDP of countries in the region (see figure 43). Ms. McFadzien added that **saltwater intrusion and inundation** is also a concern, especially for atolls, with observed occurrences of salinization of limited freshwater resources, increased risks to agricultural production and food security, and negative health effects. On **health**, she pointed to: increased incidences of vector-borne disease, including malaria and dengue, especially endemic dengue in Samoa, Tonga and Kiribati; health impacts of changes to water availability, including cholera outbreaks after extreme events; and increased outbreaks of ciguatera fish poisoning linked to temperature increases.

Figure 42
Observed sea level rise from 1993–2012



Source: Slide 4 of the presentation by Ms. Diane McFadzien (South Pacific Regional Environment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_sprep_sed4-2_feb9.pdf>. The figure shows a map of rates of change in sea surface height (geocentric sea level) for the period 1993–2012 from satellite altimetry (see Intergovernmental Panel on Climate Change Fifth Assessment Report, Working Group I, Frequently Asked Questions 13.1, figure 1).

Figure 43
Observed impacts on Pacific coral reefs



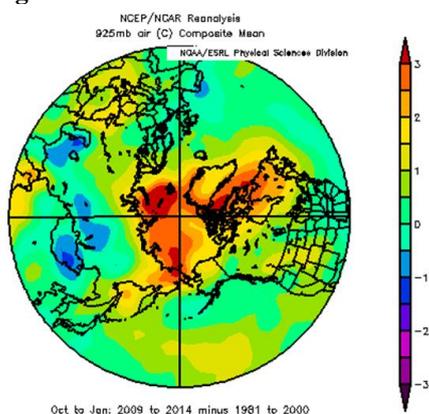
Source: Slide 5 of the presentation by Ms. Diane McFadzien (South Pacific Regional Environment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/2_sprep_sed4-2_feb9.pdf>. The figure shows the increase in impact on coral reefs in the Pacific from the period 1985–1994 to the period 1995–2004.

274. She underscored the **vulnerability to climatic extremes** of Pacific small islands, which rank high in relative exposure to tropical cyclones. She added that economic losses from tropical cyclones translate to losses in GDP of 15–25 per cent, hampering economic development. She outlined adaptation actions in the region, including: the strengthening of metrological services; capacity-building programmes, including the development of vulnerability and adaptation assessments, cost benefit analysis and ecosystem-based adaptation tools; the Pacific Adaptation to Climate Change project; and joint National Action Plans. She indicated that despite the very low level of emissions of countries in the region, various mitigation programmes are in place.

275. In concluding, she stressed that: the **Pacific has a substantial economic dependency on climate-sensitive sectors**, such as ecosystem services and tourism, with limited opportunities for economic diversification; **adaptation potential is limited for many of the observed impacts of climate change**; and **implementation of adaptation options**, if available, **comes at very high costs** in relation to countries' national budgets.

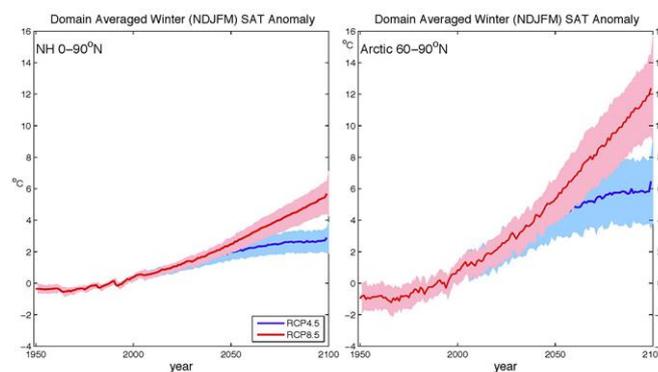
276. Mr. Lars-Otto Reiersen, Executive Secretary, Arctic Monitoring and Assessment Programme (AMAP) Secretariat, presented an Arctic perspective. He explained that the work of AMAP touches upon, inter alia: the status of the climate, climate feedbacks, the Greenland ice sheet, ocean acidification; sea ice snow cover, freshwater resources, permafrost and short lived climate forcers.

Figure 44
Arctic temperature amplification: 2-3 times changes in mid-latitudes



Source: Slide 4 of the presentation by Mr. Lars-Otto Reiersen (Arctic Monitoring and Assessment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_amap_sed4-2-feb9.pdf>. The figure shows that in the Arctic the temperature increase is two to three times greater than that observed at mid-latitudes.

Figure 45
Arctic temperature changes in mid-latitudes



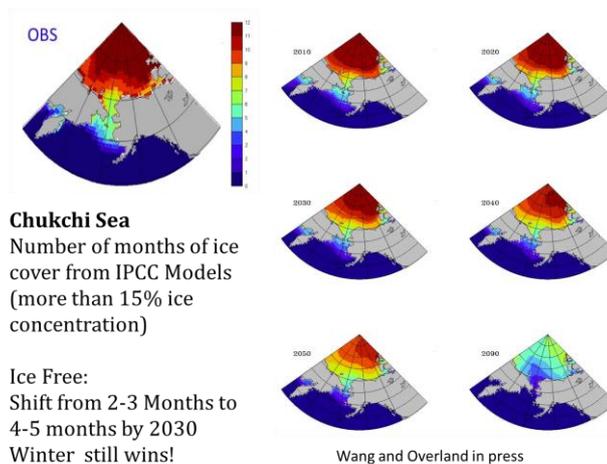
Source: Slide 5 of the presentation by Mr. Lars-Otto Reiersen (Arctic Monitoring and Assessment Programme), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_amap_sed4-2-feb9.pdf>. The figure shows that in the Arctic the projected temperature increase for RCP4.5 and 8.5 is at least twice that projected for mid-latitudes.
Abbreviation: RCP = representative concentrations pathways.
SAT = surface air temperature

277. On **temperature**, he explained that temperature amplification in the Arctic is three to four times greater than changes in mid-latitudes because of the **albedo effect**, i.e. the land and the ocean are absorbing more heat because of the melting of the snow and ice (figure 44). He presented new modelling graphs of the Arctic temperature based on scenario RCP4.5, which projects a 6 °C average temperature rise by 2100, and scenario RCP8.5, which projects a 12 °C rise by 2100 (figure 45).

278. He underlined the importance of the volume of the sea ice, emphasizing that the ice has become younger and thinner since the end of the 1980s, with much of the older, thicker ice in the north of Alaska now melting away during the summer. He pointed to adverse impacts of the disappearance and thinning of the sea ice on polar bears, which are congregating in the north of Canada.

279. Mr. Reiersen then focused on **Pacific-Arctic Ocean heat storage**, pointing to an anomaly of 6–7 °C warmer waters in the straight between Alaska and Siberia. He underscored the importance of sea temperature, explaining that most of the **sea ice is melting from below**, owing to the increased sea water temperature. He presented IPCC models for the Chukchi Sea, showing a shift in ice-free months from 2–3 months per year to 4–5 months per year by 2030, and the projected total disappearance of sea ice by 2100 (figure 46).

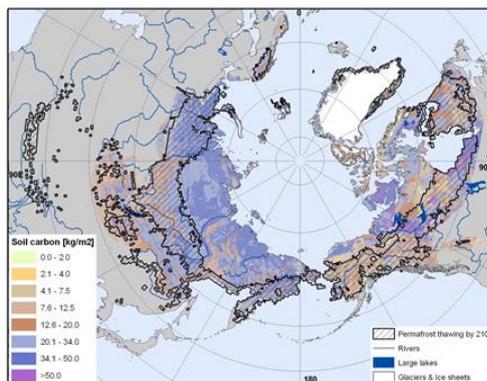
Figure 46
Sea ice cover in the Chukchi Sea



Source: Slide 8 of the presentation by Mr. Lars-Otto Reiersen (Arctic Monitoring and Assessment Programme), available at http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_amap_sed4-2-feb9.pdf. The figure shows the projected decrease in sea ice cover in the Chukchi Sea, over the period 2010–2090.
Abbreviation: IPCC = Intergovernmental Panel on Climate Change

280. He noted that the normal **Polar Vortex pattern of West to East flowing winds that traps cold air in the Arctic was broken down in December 2009** and in following years, allowing cold air to spill southwards, which partly explains recent extreme weather events in northern America and Europe.

Figure 47
Reduction of permafrost by 2100



Source: Slide 13 of the presentation by Mr. Lars-Otto Reiersen (Arctic Monitoring and Assessment Programme), available at http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/3_amap_sed4-2-feb9.pdf. The figure shows the projected areas permafrost thawing by 2100 and the amounts of carbon currently trapped in those soils.

281. On **snow cover**, he reported decreases of snow cover of up to 40 per cent in 2012 compared with 1971–2000 levels. Looking ahead, he showed projections of decreases in snow water equivalent, as well as in annual

snow cover duration. On the **thawing of the permafrost**, he pointed to an estimated loss by 2100 of an average of 100 Gt of carbon from these areas (figure 47).

282. On the **run-off of water from Greenland**, he compared an Arctic climate assessment in 2011, which projected the water run-off from Greenland at 2 hundred Gt of water – the equivalent of the volume of approximately 1 m of water above the land mass of Australia – to the latest figures that double this amount, to approximately the equivalent of 2 m of water above the land mass of Australia, with a significant contribution to sea level rise. On **ocean acidification**, he pointed to the assessment published by AMAP in 2013, which indicated that: Arctic marine waters are experiencing widespread and rapid ocean acidification; the primary driver of ocean acidification is uptake of CO₂ emitted to the atmosphere by human activities; the Arctic Ocean is especially vulnerable to ocean acidification; and acidification is not uniform across the Arctic Ocean.

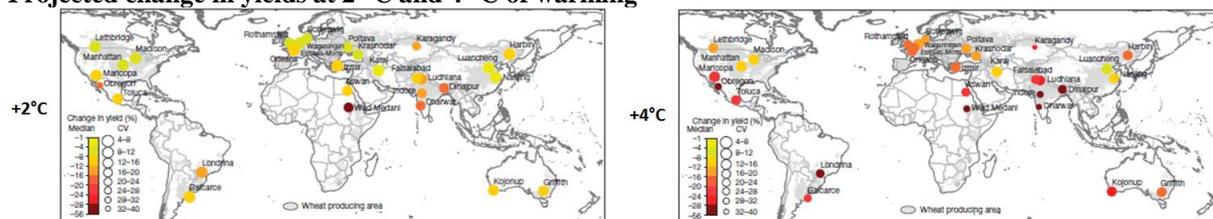
283. Noting that the Arctic is now opening up to mining, shipping and oil and gas activities, he said it faces new and emerging challenges, such as invasive species and health impacts affecting the people of the Arctic. He also pointed to the impacts of climate change and loss of sea ice on walrus and polar bears.

284. Ms. Sonja Vermeulen, Head of Research, CGIAR Research Program on Climate Change, Agriculture and Food Security, presented on agriculture and food security in a changing climate. She explained that she would present some **key papers published after the IPCC cut-off dates**, which confirm the findings of the contribution of WGII to the AR5, in particular its chapter on agriculture and food systems.

285. She stated that **recent results**, for example from the Agricultural Model Intercomparison and Improvement Project (AgMIP)⁴⁰ **reconfirm AR5 findings on observed impacts** on crops, pasture and marine fisheries at global and regional levels. These findings indicated that from 1980 until 2008, negative climate impacts were observed on the yields of three of the four major crops (wheat, soy, maize), with consistent negative impacts across most regions for maize and wheat. She also recalled that the AR5 shows that by 2050, about 10 per cent of **projections** across all regions and all RCP scenarios expect a positive impact on crop yields, and 25 per cent of those studies project negative impacts, sometimes substantial. These **negative impacts are particularly concentrated in tropical areas**. She further underlined that research has focused on crops and mean impacts, with less research carried out on capacities and adaptation strategies, and on yield impacts of climate variability and extremes.

286. She then presented results from AgMIP, which aggregates 30 different models, with very high agreement among the agricultural models, relatively high agreement among downscaled climate models and fairly large differences among economic models that extrapolate impacts on food prices. She pointed to a paper emerging from AgMIP indicating that **wheat shows a six per cent yield loss for each degree of temperature rise**, equivalent to a quarter of the current global trade (figure 48).

Figure 48
Projected change in yields at 2 °C and 4 °C of warming



Source: Slide 4 of the presentation by Ms. Sonja Vermeulen (CGIAR), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/4_cgjar_sed4-2_feb9.pdf>. The figure shows projected changes in yields for 2 °C of warming (left panel) and 4 °C of warming (right panel) above pre-industrial levels. Wheat shows a 6 per cent yield loss for each degree Celsius rise, equivalent to 42 Mt or a quarter of global trade.

287. On **cash crops**, Ms. Vermeulen said they also face major impacts and shifts in growing areas, pointing to the example of regional changes in suitable growing areas for Arabica coffee in 2050, based on scenario RCP6.0. While recognizing that the 2013–2015 review is concerned with the difference between 1.5 °C and 2 °C of warming above pre-industrial levels, she stressed that **little agricultural research uses scenario RCP2.6**, and instead the higher RCP scenarios are used, particularly scenario RCP6.0 and scenario RCP8.5. In Indonesia, 84 per cent of current coffee-growing areas will no longer be at an economically viable level of production by 2050.

⁴⁰ AgMIP is an international collaborative effort to assess the state of global agricultural modelling and to understand climate impacts on the agricultural sector.

While noting that other areas will open up, she pointed to arising adaptation issues, such as the low number of transport routes, unavailability of processing facilities, slow development of markets, etc. In Central America, she stressed that the need for coffee plantations to move up in altitude threatens areas that are protected for biodiversity and water management reasons.

288. Ms. Vermeulen then referred to a paper by Lobell and Tabaldi (2014) that finds that since **demand for food** will increase in the next 20 years, even small yield changes in that period are of major concern. She stressed that the likelihood of a 10 per cent yield loss in the next 20 years is: for wheat, less than 1 in 200 without climate change, and 1 in 20 with climate change; and for maize, less than 1 in 200 without climate change, and 1 in 10 with climate change. She drew attention to a recent paper that warns that **future food production is highly vulnerable to both climate change and air pollution**, with implications for global food security. The paper finds that **ozone** is playing an increasing role in wheat and rice production, and a lesser role in maize production.

289. On the impact of climate change on **livestock and marine fisheries**, she noted that less research is carried out in this field, and that yield outcomes for livestock depend on complex factors, particularly the availability of feed. She indicated that regional projections of rangeland and pasture yields are expected to be released during 2015. On marine fisheries, she indicated that with 2 °C of warming above current climatic conditions, yield losses are likely in Southeast Asia, Sri Lanka, Angola and Namibia, and yield gains are likely in Iceland and the southern coast of West Africa. She noted that the regions with high economic dependence on fisheries are likely to see a yield loss.

290. On **capacities to respond**, she referred to a study on empirical evidence from Brazil, Mexico and the United States of America that shows that both generic and specific capacities matter in determining food security outcomes. She stressed that both generic capacities, such as poverty levels in society and access to services, and specific capacities, such as climatic information to farmers or early warning systems, need to work in tandem. Underlining the importance of **water and water management capacities**, she cited the example of Afghanistan, where the impacts of extreme events on wheat yields can be decreased with irrigation, but will depend on the ability to maintain irrigation facilities.

291. Ms. Vermeulen mentioned that in Mexico, some breeds of heat-tolerant wheat have been able to overcome some of the heat impacts, but cautioned against the limits to these breeding interventions. She noted that “the real way in which farmers experience climate change” is in terms of **years of failure and increased risk to production**. She cited the example of Mozambique, where the fishermen have to go further off shore because of the declining fishing stocks, and are impacted by the storms that increase the risk of loss of life at sea, and that cause damages to their fishing gear, their houses and subsistence gardens. She called for substantially more work to be carried out on these risks and the impact of extreme events on farmers’ livelihoods and their ability to ‘bounce back’ after major shocks.

292. She also referred to insufficient knowledge on the impacts of climate change on pests and disease, welcoming a call from the SBSTA to make submissions on that issue in March 2015.

2. General discussions

293. The ensuing discussion was guided by the following questions on theme 2 (subparagraphs (a–f) below) and theme 1 (subparagraphs (g–k) below) of the review:

- (a) What are the most recent findings in relation to observed regional impacts?
- (b) Are there regions in which some ecosystems cannot adapt naturally? Is their adaptation assisted or might it help to assist them, and by which means? What are the consequences for agriculture and development?
- (c) What challenges does global warming pose to agricultural practices, policies and measures, from a regional perspective?
- (d) What challenges does global warming pose to sustainable development from a regional perspective?
- (e) How has progress towards the long-term global goal varied across regions?
- (f) How do opportunities and barriers to adaptation and mitigation vary across regions?
- (g) Which risks vary the most across regions? How do these risks vary at various levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?
- (h) How do risks for vulnerable ecosystems vary across regions at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(i) How do regional food security risks vary at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(j) How do observed impacts including those of sea level rise and extreme events vary across regions and at different levels of warming, notably with a warming of 1.5 °C and 2 °C relative to pre-industrial levels?

(k) What is the future of ecosystems, agriculture and sustainable development from a regional perspective, in the context of climate variability, climate change and uncertainty about future climate conditions?

294. A Party lamented the absence of a presentation on Africa, which has unique challenges. He stressed the importance of water security and suggested addressing **the mitigation co-benefits of adaptation action**, such as water desalination and mangroves. Stressing the uniqueness of the IPCC review process, he noted the gaps in regional information and expressed reservations with using emerging scientific information that is not as robust. He suggested deciding how to treat emerging data before hearing it, and further noted that the IPCC produces special reports, which deal with urgent matters and emerging information.

295. A Party asked how the indirect impacts of climate change on livelihoods can be assessed, in particular in LDCs and SIDS. An expert explained that **globally, very little food is traded**, particularly staple crops, with only 16 per cent of cereals being traded globally. She therefore underscored the importance of local food systems, stressing the need for national and subnational projections. On vulnerabilities in these communities, she said there are some well-established techniques for their assessment, pointing to work done by the International Livestock Research Institute (ILRI), which carries out assessments to identify hotspots of vulnerability to climate change. She further **stressed the importance of building small holders' own capacities**.

296. Further to a request for clarification by a Party on the annual rainfall figures presented for the Caribbean, an expert stated that the decline in annual rainfall in the Caribbean varies greatly spatially from 25 to 100 inches depending on closeness to the coast, aerography and other factors. He explained that the figures presented are average declines reported by the reporting stations, mainly at airports and farming stations.

297. A Party asked what the available **options for economic diversification in SIDS** are, given the impacts of climate change on various economic sectors, in particular agriculture, tourism and fishing. An expert explained that for **tourism, the options for economic diversification are limited**, noting that tourism in the Pacific is driven by foreign ownership and that diversification will most likely imply moving to more appealing locations. She added that the local population will be most hit, with employment losses, in particular as coral reefs and ecosystems that attract tourism are becoming eroded. She pointed to some examples of attempts to develop cultural tourism in order to move away from coral-dependent activities.

298. A Party asked about the **links between adaptation and mitigation in the regions discussed**. An expert explained that mitigation actions in the Caribbean have been implemented as part of a larger package of adaptation and mitigation efforts aimed at achieving sustainable development. He outlined some co-benefits of mitigation action, including **savings of foreign exchange, lower energy rates provided to consumers, health benefits and increased energy access**. He also pointed to some co-benefits of solar dryers used by farmers, noting that their use is being scaled up. Another expert pointed to the example of the **alternate wetting and drying irrigation technique in rice cultures** carried out in China, India, Japan, Philippines and Viet Nam, which leads to adaptation and food security gains via reduced input costs for farmers, as well as mitigation benefits because of the avoided CH₄ emissions of about 48 per cent.

299. A Party asked which adaptation strategies would be appropriate in the Himalayas and if there are plans to address the information gaps identified in the AR5. An expert drew attention to similarities between the Alpine areas and the Arctic, in particular the melting of glaciers. He said some of the work carried out in the **Arctic on adaptation options** could be applied in the Himalayas. He added that very little data is available on adaptation needs in the Arctic and looked forward to cooperation with other regions facing similar challenges. Another expert indicated that research findings published after the **IPCC cut-off dates** confirm the AR5 findings, in particular in relation to the **retreat of glaciers, ocean heat uptake** with regional impacts and **statistics on extreme events**.

300. A Party asked if a **regional adaptation plan exists in the Caribbean region**, and if a financial assessment of the **adaptation and mitigation needs of the region** has been carried out. An expert explained that the Regional Framework for Achieving Development Resilient to Climate Change adopted by the Caribbean Heads of State includes an **adaptation** component. On financial needs, he referred to work in the region on projections, primarily on sea level rise. Some of the modelling for a 1 m **sea level rise** for the Bahamas, Belize, Guyana and Suriname combined is projected to amount to annual **GDP losses of USD 1.2 billion**; the loss of at least 16 multimillion dollar tourism resorts; USD 4 billion in infrastructure costs, with significant transportation losses at airports; and USD 5 billion for relocation loss. Another expert referred to table 16.3 in chapter 16 of the contribution of WGII to the AR5, which identifies **adaptation opportunities, constraints and limits**, and to section 16.6, which addresses mitigation and adaptation interactions.

301. A Party asked about the **economic quantification of the projected losses in the agricultural sector**. An expert said that an increasing number of studies have quantified losses incurred as a consequence of climate change, for example the projection of a loss of 42 million tons of wheat or a quarter of global trade for each degree of warming. She also pointed to a historical study on climate change impacts on wheat, maize, rice and soy between 1980 and 2008, which estimates the yield losses due to climate change, for example a 3.8 per cent global average loss, which is equivalent to 23 million tonnes or the total production of Mexico, and a 5.5 per cent yield loss for wheat, which is equivalent to the total production of France. The study also examines the impacts on food prices (e.g. 6.4 per cent increase in food commodity prices considering that carbon fertilizing of the crop has taken place or an 18.9 per cent increase without carbon fertilization). Another expert indicated that **increased yields are projected in the Arctic**, as some vegetables that could not be grown before will be produced, but stressed that this is a “**very minor positive effect**” of warming temperatures.

302. A Party asked what the **costs of the mitigation actions outlined in the presentation on the Caribbean** are, what the **costs of adaptation in all the vulnerable regions presented** are, and whether technologies are available to address mitigation and adaptation needs. An expert said that although there are some national-level studies related to costs of adaptation and mitigation, they are not comprehensive and tend to focus on particular sectors. In a study by the United Nations Economic Commission for Latin America and the Caribbean on the economics of climate change, the figures are highly variable from country to country and a gross figure is not available at this time.

303. A Party pointed to a **gap in information from Latin America**, while recognizing that representatives from that region had failed to suggest institutions that could have delivered a presentation at the meeting. He suggested that the SED 4 report mention that according to the AR5, **observed temperature over the last 20 years has increased by an average of 0.5 °C per decade, and that the rate of warming in Central America is twice the global mean**. He also referred to a recent report of the Inter-American Development Bank (IDB) titled “Climate Change at the IDB: Building Resilience and Reducing Emissions”, which indicates that GHG emissions of the 26 countries of the region decreased after 2005, largely because emissions from land-use change and forestry fell by 44 per cent between 1990 and 2011, mainly as a consequence of reduced deforestation in the Brazilian Amazon. The report also finds that Latin America and the Caribbean’s electricity mix is cleaner than those in other world regions.

304. Noting that the presentations confirmed the findings of the IPCC and the need for the global goal, a Party asked if changes in **urban, spatial and development planning** had been observed in vulnerable areas to address vulnerability and exposure to climate change risks. An expert underlined that issues related to **exposure** are critical, pointing to a number of initiatives in the Caribbean that aim to reduce exposure, such as the Caribbean Uniform Building Code (CUBiC) that contains provisions to reduce exposure to impacts from hurricanes and flooding. He also referred to training of country planning officers in climate change vulnerability analyses. The expert underscored the importance of governance in making adaptation more effective, citing a chapter dedicated to this issue in the Regional Framework for Achieving Development Resilient to Climate Change. He stated that insurance and reinsurance are “hugely important” in the Caribbean to lessen the risks posed by climate change. Noting the high costs of these measures, he added that they are part of a suite of adaptation approaches. Another expert described some changes in **infrastructure planning** due to climate change impacts in the Arctic, including the erosion of soft coastal areas due to loss of sea ice protecting the coast from waves, **driving populations in Alaska to migrate inland**, and thawing of permafrost affecting roads and buildings. He stated that a lesson learned from the events that will affect the North is that the average temperatures “are maybe not the most interesting”, the **important indicators are the extremes**.

305. While recognizing that having a presentation of all the regions was not feasible, a Party suggested that the 2013–2015 review be informed by the volume on regional information of the contribution of WGII to the AR5. An expert described the strategy adopted by **WGI to address the regional aspects of climate change**. He said that for the first time, WGI took a process point of view to better understand the future impact on affected regions of climate process modes, such as El Niño or the Pacific oscillation, along with long-term trends. He indicated that the chapter also includes an atlas of 37 regional projections, available in digital form, which provides data for three time horizons and all four RCP scenarios, on temperature and precipitation anomalies. He specified that the atlas covers in detail the African and Mediterranean regions and provides data relevant to droughts and water shortages. The expert also mentioned the Coordinated Regional Climate Downscaling Experiment (CORDEX) that covers 14 regions, with regional scale models, providing ‘fine-grain’ information and the emerging Coupled Model Intercomparison Project Phase 6 (CMIP6) effort. He underlined that in the near future, the WGII community will have increased access to a lot of new physically based information relevant to regional impacts and risk studies. Another expert added that the contribution of WGII to the AR5 includes a full volume on regions, with nine regional chapters, including one on oceans. He pointed to chapter 21 of that volume, which is an introduction that explains the caveats on the regional aspects. He added that the information presented: is mainly from WGII, with an introduction outlining WGI information; addresses non-

climatic stressors, such as land-use changes and socio-economic conditions; and includes some aspects coming from WGIII.

306. Mr. Clifford Polycarp (GCF) explained that the GCF is “now shifting gears to move to full scale operations”. He said that in 2014, the Fund focused on mobilizing resources and reached a target of USD 10 billion. In order to **start committing resources**, he stressed the need for: each country to designate a **national focal point** responsible for all GCF operations and engagement in that country – approximately 50 countries still have to designate one; **institutions to be accredited to the GCF**, according to its standards, which are differentiated according to a ‘fit for purpose’ accreditation criteria, with the first batch of accreditation expected at the Fund’s Board meeting in March 2015; and **proposals for projects and programmes from the accredited institutions**, which should be in line with the country’s priorities, support at least one of the Fund’s eight strategic results, and meet the Fund’s six funding and investment criteria. He added that the Fund’s eight strategic results cover all sectors, and that overtime, the GCF will need to: maintain a 50-50 balance between adaptation and mitigation; maintain a regional balance; and allocate 50 per cent of its adaptation funding to SIDS, LDCs and African countries.

307. He indicated that over the coming months, the GCF will develop more detailed guidelines on these requirements and processes. For several countries, capacities will need to be built or strengthened to enable them to access the Fund’s resources and use them effectively. Mr. Polycarp explained that the Fund can already start to provide **readiness support to strengthen the designated national authorities**. He reported that the Fund is in ‘active dialogue’ with approximately 50 countries on their possible proposals, with about a dozen concrete proposals being developed.

308. In concluding, he underscored the importance for designated national authorities to be in place in all developing countries, a diverse range of public and private entities to be accredited, and a handful of projects to be approved by the GCF Board before the end of 2015.

309. A Party asked if a global warming of **2 °C or 1.5 °C** above pre-industrial levels would imply the passing of some **thresholds in the Arctic**. An expert explained that 2 °C warming on the global level would imply a temperature **change of twice that amount in the Arctic**. He underscored the importance of **the speed of change**, which affects the ability of animals to adapt, in particular those linked to the ice. He added that new species are already appearing in the Arctic region at current levels of warming. In the oceans, new species are coming in, such as mackerel and will “fight” with traditional species of the Arctic.

310. A Party asked if research had been carried out on: the impacts of climate change on **crops like sorghum, beans** and others that contribute significantly to the GDP of African countries; the impact of parasites on these crops and the impact on livestock; and the associated adaptation costs. An expert indicated that substantial impact studies on major crops such as sorghum, beans, yams and cassava, have been carried out in Africa. She added that research on livestock in general, as well as on pests and disease, is a weak area.

311. A Party pointed to the **limits to adaptation**, in particular in relation to the risks posed by **sea level rise and climate extremes to ocean ecosystems**, and asked how these risks amplify with the ongoing warming, and how they threaten the ecosystem goods and services provided. An expert stated that the services provided by marine ecosystems can be either marketed or non-marketed. He cited the example of coral reefs that provide sand for beaches and absorb, reflect and dissipate wave energy from high energy events. If they are lost, countries would have to replace them by coastal engineering protection measures that are extremely costly. These costs could be a barrier for many island States. He also mentioned the services provided by mangroves, including habitat for fish and filtering of land-based contaminants. He explained that putting a dollar value on fisheries is much easier than other ecosystem services that are equally critical, and that only indicative values are available. The expert also referred to the cultural importance of ocean and coastal areas, noting that in some Pacific islands some coastal cemeteries have been lost.

312. A Party noted that while the higher emissions RCP scenarios are used in agricultural studies, they make projections to 2050. Given that the warming level for all these scenarios is similar in the near-term he asked if these results can help illustrate the differences between 1.5 °C and 2 °C of warming. An expert agreed that in broad terms, in the higher emission scenarios, the global temperature can be expected to be approximately 2 °C warmer in 2050. She also drew attention to the fact that the AR5 refers to a temperature increase of 2 °C as a tipping point in terms of impacts on agriculture, particular in temperate regions.

313. A Party asked for more information on the solutions to address the increasing pressures on freshwater supplies, in particular the challenges associated with precipitation changes and salt water intrusion. He asked if they had explored some solutions, such as desalination and the challenge it poses. He also asked if the CTCN is working in Africa or the Near East on this issue. An expert explained that a wide range of solutions to address freshwater scarcity had been implemented in the Pacific region, stressing that no “one size fits all”. She referred to work on demand-side management, such as measures to address leakages, and supply side management. She

also outlined challenges related to the development of rainwater harvesting, such as land tenure issues or the inadequacy of traditional roofs to collect water. She stated that desalination is “the least popular option” because of its high costs. Another expert added that although desalination has been seen as a panacea for coping with freshwater stress in small islands, some of the challenges associated with this solution include: management of the risks associated with the disposal of the brine; its negative impacts on marine ecosystems where there is poor disposal of the brine, for example too close to the shore; and its high energy intensity. However, he also mentioned a successful desalination project of the CCCCC in Saint Vincent and the Grenadines powered by photovoltaic energy, which produces a surplus of energy.

314. A Party asked if lessons could be learned from a study of 2014 on the unique situation of the corals living in the bays around Palau’s Rock Islands, where coral reefs thrive despite acidic oceans. An expert said that it may be too early or too difficult to extrapolate from the findings of that “perplexing study” across other reefs, adding that the reefs in question have adapted to the increasing acidity of the water over a very long timeframe. In contrast, existing reefs will have to adapt over decades, to a much higher rate of acidification. He also said that it is not clear if those coral will survive in water at lower acidity. Another expert underlined that the variability of conditions affects the comparability of situations. He said that the reefs in the study may be able to survive in water with high acidity because of the absence of other pressures, or that the acidity of the waters may only be slowing the rate of their growth, which would impact their recovery between bleaching events. In the absence of bleaching those corals were not tested on how rapidly they could grow. He stressed that this local study requires further investigation.

315. A Party asked for more details on the **existing mitigation possibilities in the agricultural sector**, and if any **initiative exists to promote and share good practices in this field**. An expert explained that direct emissions from the **agricultural sector account for approximately 12–14 per cent of global emissions**, with livestock management, rice management and agricultural soils as major subsectors. She also stressed the role of agriculture as a driver of deforestation. She identified hotspots for mitigation opportunities, including **managing water levels in rice cultures**, which comes with economic benefits, or **changing feeding regimes and managing herd sizes in ruminants**. She underlined that the greatest mitigation potential is in relation to the **carbon stored in the soil**, but that technically, it is difficult to raise the level of carbon in the soil. On good practices, she explained that CGIAR is working on **climate-smart villages** where farmers and researchers test packages of interventions, such as water management techniques, weather-based insurance and the provision of weather services to farmers.

316. A Party asked which are the **GCF’s priority areas in mitigation** to ensure that its resources will be channelled to those activities that have the highest impact, and how does its approach differ from that of the GEF. In particular, she asked to what extent the decarbonization of the energy and industrial sectors is reflected in the GCF priorities. An expert explained that the GCF results framework includes four areas on mitigation: energy, transportation, forest and land use, and buildings and cities. While stressing that the GCF will have to support emission reduction activities in all four areas, he stated that considering the significance of the energy sector, many demands are expected from it.

317. A Party asked how much of the USD 10 billion pledged to the GCF has been deposited. He also referred to the difficulties faced by some national financial entities in disclosing fiduciary information, which may be requested in order to be accredited with the GCF. He then asked about how the GCF was planning on mobilizing adaptation funding, and how the 50 per cent of resources to be allocated to adaptation was going to be carried out, either through a ceiling over the whole portfolio of the GCF or on a regional basis. An expert explained that the process of realizing the pledges into agreements is underway, and that the GCF aims to have 50 per cent of the pledged amount deposited by the end of April 2015. On **fiduciary requirements** for entities seeking accreditation with the GCF, he said the Fund uses an online application system, assuring that all the confidential information disclosed will be treated as such. On the **adaptation window**, he indicated that there is no decision from the COP or the GCF Board on this issue, and that the adaptation projects and programmes could come from any source. On the **distribution of projects**, he said the current targets are at the portfolio level, and that the Fund is to ensure regional balance among projects, but does not have any specific numerical target.

318. A Party asked about the status of the request by COP 20 to the GCF Board to accelerate the operationalization of the adaptation and mitigation windows, and to ensure adequate resources for capacity-building and technology development and transfer, as well as the status of the development of a monitoring and accountability framework for the GCF. An expert explained that underlying the Fund’s results framework is a performance measurement framework that will be accompanied by indicators, including the number of people affected by the project. He added that work on the development of the performance measurement framework started in 2014 and is still ongoing.

F. Part 4: Emerging information

1. Presentation by experts

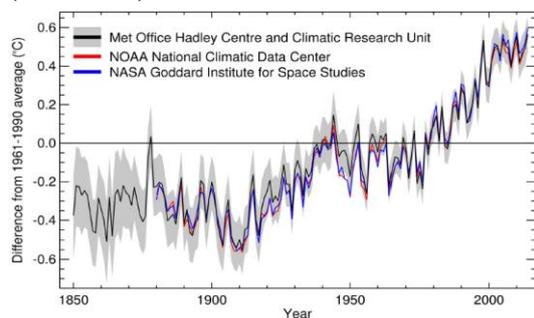
319. Mr. Rajendra Pachauri, IPCC Chair, was unable to deliver his presentation as scheduled. A copy of his Power Point presentation is available on the 2013–2015 review page on the UNFCCC website.⁴¹

320. Mr. Deon Terblanche, Research Director, WMO, delivered a presentation on behalf of Mr. Jerry Lengoasa, WMO Deputy Secretary-General, on the current state of the climate and updated information published after the IPCC cut-off dates for literature to be considered for the AR5. His presentation addressed the latest evidence on the observed state of the global climate, knowledge of GHGs in the atmosphere and how to address knowledge gaps.

321. He described a graph showing the **global average temperature anomaly** for the period 1850–2014, stressing that, according to the calculation method used, 2014 was the warmest year on record. He underlined that not only was 2014 the warmest on record, but in addition, it was not an El Niño year (figure 50).

Figure 49

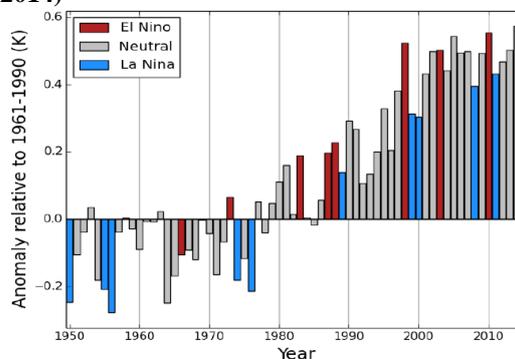
Global average temperature anomaly (1850–2014)



Source: Slide 3 of the presentation by Mr. Deon Terblanche (World Meteorological Organization), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/6_wmo_sed4-2_feb9.pdf>. The figure shows the increase in global average temperature since 1850, and that the 2000–2010 decade was the warmest on record.

Figure 50

Global average temperature anomaly (1950–2014)



Source: Slide 5 of the presentation by Mr. Deon Terblanche (World Meteorological Organization), available at <http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/6_wmo_sed4-2_feb9.pdf>. The figure shows that 2014 ranks as the warmest year on record, in particular in the absence of El Niño.

322. **On the oceans**, he indicated that averaged global sea surface temperature for the period January–December 2014 was estimated at 0.48 °C above the 1961–1990 long-term average, a record high value. The 2014 average of the ocean heat content estimated for the 700 m and 2000 m layers was higher than for any earlier year on record.

323. From the work of the World Climate Research Programme (WCRP), of which WMO is a co-sponsor, he cited an article that presents evidence suggesting that as the **Arctic continues to warm faster than elsewhere** in response to rising GHG concentrations, the frequency of extreme weather events, such as cold spells, stormy periods, heat waves and droughts, caused by persistent jet-stream patterns will increase. He underlined that what happens in the Arctic has implications “way beyond the Arctic” with impacts at mid-latitudes and beyond.

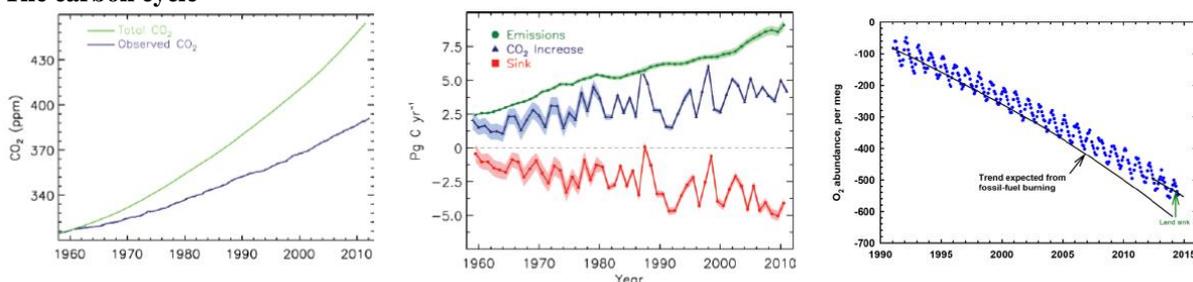
324. **On GHG concentrations in the atmosphere**, he referred to the WMO Global Atmosphere Watch (GAW) programme, which aims to provide high-quality observations of the chemical composition of the atmosphere and improve the understanding of the increasing influence of human activity on the global atmosphere. He stated that: atmospheric CO₂ continues to increase every year, a trend largely driven by fossil fuel emissions; atmospheric CO₂ levels were above 400 ppm at the Mauna Loa observatory for three months beginning in April 2014 for the first time; and the growth rate of CO₂ concentrations varies greatly from year to year with the global growth rate between 2012 and 2013 the largest since the current global record started in the 1980s. The growth rate has been increasing on a decadal basis, as inter-annual variability is largely driven by the sinks of the Earth system (ocean and biosphere).

⁴¹ See: <<http://unfccc.int/7521.php>>.

325. On the **complexity of the carbon cycle**, he presented three graphs showing the expected increase in atmospheric CO₂ based on the total emissions compared with the observed values in the atmosphere (figure 51, left-hand side panel); anthropogenic emissions, sinks with strong inter-annual variability, and the resultant increase in atmospheric CO₂ (figure 51, middle panel); and observed slow decrease in oxygen abundance in the atmosphere due to the burning of fossil fuels, which can be used to discriminate between ocean and terrestrial biosphere sinks (figure 51, right-hand side panel). He explained that improving observations will enable better quantification of the sources and sinks, stressing that knowledge of terrestrial and ocean sinks is essential for better understanding the anthropogenic contribution.

326. On **ocean acidification**, he also reported an upward trend in ocean acidity at a few sites, despite the lack of a global representative figure. He underscored the need to standardize the measurements in the atmosphere and the oceans with the aim of achieving common calibration standards.

Figure 51
The carbon cycle



Source: Slide 10 of the presentation by Mr. Deon Terblanche (World Meteorological Organization), available at http://unfccc.int/files/science/workstreams/the_2013-2015_review/application/pdf/6_wmo_sed4-2_feb9.pdf. The figure shows: the expected increase in atmospheric CO₂ based on the total emissions compared with the observed values in the atmosphere (left-hand side panel); anthropogenic emissions, sinks and the resultant increase in atmospheric CO₂ (middle panel); and the observed changes in oxygen abundance in the atmosphere due to the burning of fossil fuels (right-hand side panel).

327. He stated that society is attempting to advance efforts to reduce CO₂ emissions and will likely do so even more in the future; mitigation efforts will vary by country, region and emission sector, and be diverse in their approach; **the complexity of the carbon cycle is such that tracking the adequacy of aggregate measures to achieve the long-term global goal will require considerable monitoring system enhancements**; and emission reduction approaches require independent, scientific monitoring to support verification and policy decisions. He then outlined gaps in the current integrated observing system, including: insufficient density of observations over land, the sea and in the free atmosphere; insufficient measurements of isotopes and co-emitted gases for source attribution; incompatible observations on different scales and in different media (e.g. atmospheric observations versus partial pressure CO₂ observations); and insufficient complexity and performance of transport models on global, regional and local scales. He stressed the need for a comprehensive GHG information system that would include atmospheric, oceanic and land measurements. This would imply that WMO/GAW and the Global Climate Observing System, which oversee most of the long-term atmospheric measurements, and other organizations, which oversee the oceanic and land measurements, work together to that end.

328. In concluding, he underscored the need for: the **development of the observing system in all domains**; investment in observation in the atmospheric domain due to its role in mixing, transport and radiative forcing in order to obtain maximum benefits in the short term; the development of the modelling tools to deliver products on the temporal and spatial scales relevant to decision-making; collaboration between the 'spheres', i.e. atmosphere, oceans and biosphere; and inter-agency coordination.

2. General discussion

329. A Party underscored that global measurements of CO₂ in the atmosphere not only indicate an upward trend, but also an **increasingly upward trend**. He stated that "if one message comes out of the review process, it has to be that **we are not on track to deliver 2 °C**". An expert explained that about half of the total GHG emissions have been absorbed by the oceans and the terrestrial biosphere, but pointed to the great inter-annual variability of the sinks, as well as the great amount of uncertainty in terms of how the oceans and terrestrial biosphere will react in future and the risk that this entails.

330. A Party asked for views on findings published after the IPCC cut-off dates on the **instability of the east Antarctica ice sheet**, and that its irreversible retreat may be triggered at low levels of warming, leading to higher projections in sea level rise. An expert indicated that WGI placed a large emphasis on looking at new comprehensive assessments of sea level rise, as reflected in the scoping exercise that proposed dedicating a chapter of the WGI report to this issue. He said that the chapter on sea level rise enabled the group to collect the

expertise in the scientific community in a comprehensive manner. He stressed that sea level rise estimates and projections widely varied in the scientific literature assessed, with various model types used to project sea level rise, some fully based on physical processes, others being semi-empirical models. The author team was able to provide projections for the end of the twenty-first century for the first time including all relevant components: the thermal expansion of the water due to warming; the melting of the large ice sheets, Greenland and Antarctica; as well as the melting of glaciers and storage use changes. Recognizing that science has progressed since the IPCC cut-off dates, he said the new results published would not lead to a full revision of the IPCC assessment, but rather add interesting details that strengthen the possibilities outlined. He added that if instabilities are triggered in ice sheets, this could lead to a sea level rise of up to 7 m by 2300 over a millennium if the Greenland ice sheet is sent on a pathway of total melt down. He also stressed that the AR4 thresholds were revised downwards in the AR5, and that the IPCC gave low confidence to the possibility of a large amount of the Greenland ice sheet melting at 1 °C of warming above pre-industrial levels. He underscored that the new emerging science is limited to observation, highlighting the importance of understanding ocean warming and its interaction with the ice sheets. He concluded that the possibility of potentially higher sea level rise and the new scientific findings will have to be assessed in the next IPCC cycle. Another expert added that satellite observations are becoming increasingly important in the field of sea level rise, calling on satellite agencies to invest in the capabilities to monitor ice sheets and sea levels. A third expert indicated that AMAP is in the process of updating the latest assessments from 2011, which will be presented in March 2017, supporting the need to improve the network for observations in the Arctic, as well as the models which enhance our understanding of feedbacks.

331. A Party **cautioned against using non-IPCC information**. Mr. Fischlin underlined that Parties may ignore information that has not been assessed rigorously enough, but said that they may also take it into account in a risk-management context. Another Party underlined the importance of looking at the long-term trend, noting that while the IPCC is “the gold standard”, the review process should be open to other sources that can help increase our understanding of climate change.

332. A Party asked about the **uncertainties related to the findings that 2014 was the warmest on record**. An expert explained that in the past decade, we have had a number a very warm years (2014 was the warmest but was very close to 2010 and 2005). He stressed the importance of the general trend and comparing on a decadal basis, which clearly indicates an upward trend. Mr. Fischlin asked if the new findings on 2014 change the trends published by WGI in its *Summary for Policymakers*. An expert indicated that the observations for 2014 had not been assessed by the IPCC yet, underlining the distinction among observation, information and assessment. He said that establishing the value of global temperature change is difficult, stressing that large areas of the globe are unobserved, and where information has to be interpolated. While recognizing that there is uncertainty, he stated that there is high probability that 2014 was indeed the warmest year on record. He underscored the importance of trends over individual years, emphasizing that the WGI approach is decadal averages, and that “we are looking at a series of years that are, altogether, the hottest over the past 60 years”. He added that the fact that El Niño had no part in the warming, and that nonetheless 2014 was the warmest on record, is important to note.

333. A Party asked about the **relationship between temperature and CO₂ concentrations**, which produces a linear relationship. Noting that there are thresholds that, if passed, will cause severe irreversible impacts, he asked if the review’s focus on the linear relationship makes us disregard some other key severe risks and threats. An expert said there is no simple linear relationship between actual or current CO₂ concentration in the atmosphere and the current global mean temperature. This near-linear relationship does exist between cumulative CO₂ emissions and projected temperature rise in the twenty-first century. He pointed to figure 10 of the *Summary for Policymakers* of the AR5 SYR, which brings together the unique assessment of risks in five categories, associated with information from WGIII on required emission reductions.

G. Closing

334. Mr. Zou Ji outlined some reflections on the work carried out by the SED and its role within the science-policy interface. He reminded participants that the SED had held five meetings since its inception, in conjunction with meetings of the subsidiary bodies. He outlined a few common aspects of all SED meetings, and commented on the dialogue that had taken place over the four sessions of the SED. He stressed that all meetings of the SED shared some common aspects, both procedural and of substance, which he said illustrate the transparent, participatory and balanced way the meetings were organized and carried out, as well as the robustness of the science presented.

335. First of all, all meetings of the SED were open to all Parties and observers. Second, their organization was always based on submissions by Parties, and the SED co-facilitators published an information note ahead of each

meeting to ensure the transparency of the organization of the meetings. Third, SED meetings were organized as a fact-finding exchange of views between experts and Parties. He indicated that a total of 60 presentations were made by 73 experts. The experts presented findings from the AR5, relevant reports and work of United Nations organizations and others, as well as bodies under the Convention, highlighting their relevance to the 2013–2015 review. While noting that a majority of IPCC experts were invited to present at SED meetings (33 of the 73 presentations were made by IPCC experts), he expressed his belief that this reflected the fact that the AR5 is “the most robust and authoritative assessment of climate science to date”, and that decision 1/CP.16 specifically mandated that the review be informed by IPCC sources.

336. Mr. Zou Ji added that a significant number of non-IPCC experts were also invited, and that the geographical, cultural and gender balance among invited experts was always respected. He stressed that non-IPCC experts presented, in a balanced manner, information sources from United Nations agencies and other international organizations, as well as observed regional impacts of climate change.

337. He then addressed the format and substance of the discussions. Mr. Zou Ji underlined that the presentations made at SED meetings were always followed by a moderated discussion that addressed guiding questions and questions from all participants. Furthermore, at all SED meetings, the amount of time allocated to discussions was significant, always exceeding that allocated to the presentations themselves. The meetings were all well attended, bringing together many government delegates and experts from all regions, as well as civil society representatives. He stressed that delegates engaged in a remarkably constructive, productive and rich manner in all discussions with experts, often asking follow-up questions that deepened the debate. He also underscored that at SED 3 and 4, experts presenting in one part also attended other parts of the session, allowing for linkages to be made among presentations, and the interrelation between adaptation and mitigation to be well addressed. He therefore stated that the SED discussions were “very rich and substantive, balanced, and carried out in a transparent way”.

338. Mr. Zou Ji remarked that all SED meetings addressed the two themes of the review in a balanced manner, in terms of the time allocated to them, as well as the format and content of the presentations and discussions. He noted that summary reports on SED 1, 2 and 3, and all presentations and audio and video recordings of the meetings are available on the 2013–2015 review web page.

339. In terms of content, Mr. Zou Ji said the SED had considered a wide range of sources, covering adaptation, mitigation, finance, technology and capacity-building issues. These sources included the contributions of all three working groups of the IPCC to the AR5 and the SYR, and the work of various processes and bodies under the Convention, namely the Adaptation Committee, the Standing Committee on Finance, the CTCN, the TEC, the GCF and the SBI. The SED also heard from United Nations and other organizations, namely the GEF, UNEP, FAO, IEA, the World Bank and WHO. Experts from various regional organizations and regional centres also presented at SED 4.

340. In concluding, Mr. Zou Ji stated that these common traits of the SED sessions illustrate the robustness, transparency, integrity and reliability of the work of the SED. He emphasized that these aspects of the SED meetings have placed it in a position to fulfil its main mandate, namely to ensure the scientific integrity of the 2013–2015 review. He thanked Parties, the secretariat and his co-facilitator for their support and engagement in the work of the SED.

341. Mr. Fischlin made some reflections on the work of the SED and its role within the science–policy interface. He outlined a number of ways in which the SED had brought closer together the policy and scientific communities. He recalled that as mandated by the Parties, the SED had taken into account “the best available scientific knowledge, including the assessment reports of the IPCC”. He indicated that this mandate had been fulfilled, since at SED 2, 3 and 4-1, the SED supported Parties in internalizing the key findings contained in the contributions of the three Working Groups of the IPCC to the AR5 and the SYR.

342. He added that at SED 1, 2 and 4, the SED supported Parties in internalizing key findings contained in landmark reports emerging from the recent work of United Nations organizations and other organizations. While underlining that all these findings were relevant to both themes of the 2013–2015 review, he stated that the SED thus facilitated their consideration in a broad and comprehensive policymaking context.

343. Mr. Fischlin then referred to Article 2 of the Convention, in particular the objective to achieve the stabilization of GHG concentrations in the atmosphere “at a level that would prevent dangerous anthropogenic interference with the climate system”. While noting that what constitutes a ‘danger’ is subjective, he stressed that it is our common fear of the threat of climate change that “brought us all together under the Convention”, by agreeing on avoiding that danger. On the other hand, he added, Article 2 “divides us”, since people may differ on what constitutes danger, and global climate change is impacting us all in different ways. He explained that Article 2 calls for sound information upon which to act after having decided whether the risk is too high, in other words too dangerous, or whether it is an ‘acceptable’ risk.

344. Mr. Fischlin underlined that the above is what the SED achieved. He stressed that at SED 3, IPCC experts indicated that assessing the adequacy of the upper limit for global warming in the light of Article 2 of the Convention involves both risk assessments and value judgments. He added that risk assessment is what science can provide, sound information on possible dangers. Yet, values also need to be taken into account, which leads to choosing from policy options. Therefore, he said, we need the scientific information, which enables us to make the policy choices. He underscored that in the AR5, the IPCC assessed risks across contexts and through time in a most comprehensive manner, hereby providing an analytical framework that can now be used as a foundation for a collective agreement on how much global warming we choose to accept or tolerate while considering all implications. He expressed confidence that through the SED much of this framework had been mobilized, enabling us now to make these policy choices.

345. In concluding, he expressed the hope that the SED had “empowered” Parties “by informing and supporting policy formulation, not only within the 2013–2015, but also on the road to Paris, taking into account the various values and recognizing that what constitutes an intolerable risk may well differ across sectors, regions and countries”. He thanked experts, the secretariat, Mr. Zou Ji and the Parties for the many “excitingly fruitful discussions” that had been held within the SED.