

Key themes in the Working Group II contribution to the Intergovernmental Panel on Climate Change 5th assessment report

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Abstract Assessments conducted by the Intergovernmental Panel on Climate Change (IPCC) are significant undertakings that require input from experts and practitioners in multiple scientific disciplines, integrating local to international information across spatial and temporal scales. An IPCC report is a unique collaboration between the scientific community and policymakers, with governments (through their Focal Points) providing guidance and input to the scientists conducting an assessment at several stages during the process. This commentary reviews the IPCC mandate and process; summarizes key themes to be addressed in the Working Group II contribution to the 5th assessment report; discusses challenges for the WGII report when assessing qualitative literature, incorporating local knowledge, and identifying particularly vulnerable groups; and touches on the expertise and commitment of the WGII authors. Active engagement of the wider scientific community in IPCC assessments through publication and review will enhance their relevance to decision- and policy-makers.

Assessments of the potential impacts of and responses to climate change are complex undertakings, requiring input from experts and practitioners in multiple scientific disciplines, integrating local to international information across spatial and temporal scales. Assessments typically synthesize and describe the degree of scientific certainty in summary statements of recent trends and projected changes in climate and associated impacts, the extent to which strategies, policies, and measures could reduce projected risks, and their associated costs (including direct and indirect costs, and the costs of inaction). Where knowledge isn't sufficient, assessments indicate key research gaps that, if filled, could provide and enhance policy relevant findings. Equally important, an assessment should raise awareness of emerging issues, laying out the state of knowledge on questions about which decision- and policy-makers may not be aware. Decision- and policy-makers can use this synthesis of knowledge to develop strategies, policies, and measures to effectively and efficiently manage current and future risks to natural and social systems.

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Ford et al. (2011) express concerns about the comprehensiveness of coverage and approach in the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5), specifically the extent to which publications concerning the impacts on and perspectives of indigenous peoples will be included in the Working Group II (WGII; Impacts, Adaptation and Vulnerability) contribution to the AR5. Other publications also express concern about the breadth and depth of coverage of specific issues in the WGII report. For example, Van de Noort (2011) discusses the value of including more information from archeological research on the role of past human adaptations to climate change in the AR5. From different perspectives, these publications point out that understanding past relationships between the physical and human domains, especially at the local level, can provide crucial information on factors that increase or moderate vulnerability to a variety of stressors and on lessons for increasing resilience to current and projected climate change. They also point to challenges in incorporating some types of local information in international assessments.

Springing forward from Ford et al., this essay briefly reviews the IPCC mandate and process; outlines key themes to be addressed in the WGII report; discusses some challenges for the WGII report when assessing qualitative literature, incorporating local knowledge, and identifying particularly vulnerable groups; touches on the expertise and commitment of the authors of the WGII contribution to the AR5; and ends with a call to the scientific community to support the AR5 assessment through publication and expert review.

1 IPCC mandate and process

An IPCC report is a unique collaboration between the scientific community and policymakers, with governments (through their Focal Points) providing guidance and input to the scientists conducting an assessment at several stages during the process. IPCC reports are mandated to be comprehensive, objective, and balanced (IPCC 2011). A common misperception is that an IPCC assessment should only include peer-reviewed literature. In fact, authors are specifically mandated to include relevant peer-reviewed and non-peer-reviewed literature. Non-peer-reviewed literature is often the best source of information on business activities, research conducted in many developing countries, risk management and policy practice, stakeholder involvement, and other issues. Additional requirements are to describe different scientific, technical, and socioeconomic views on a subject, as well as for the assessment to be policy relevant and policy neutral. It is the role of the IPCC to inform national governments about the most up-to-date scientific thinking on an issue and, where appropriate, to highlight possible policy options to address current and projected risks, without promoting one set of options over another.

The IPCC Panel decides whether to prepare a report, including its scope, outline, and work plan, in consultation with the respective Working Groups (WG). Policymakers and other users of IPCC Reports may be consulted to identify key policy relevant issues. For example, the outlines for the Working Group contributions to the AR5 were developed during a five-day scoping meeting in Venice, Italy in July 2009 (http://ipcc.ch/meeting_documentation/workshops-experts-meetings-ar5-scoping.shtml); this meeting included leading scientists and government representatives who considered advances in scientific knowledge since the literature cut-off date for the AR4 as well as emerging issues and perspectives. Once the outline was agreed, Governments and IPCC Observer Organizations were requested to nominate experts to be coordinating lead authors (CLAs), lead authors (LAs), and review editors (REs). Writing teams (CLAs and LAs) and REs were chosen by the WG Bureau based on attention to scientific

qualifications of individuals and across chapter teams; including a range of institutional and disciplinary perspectives; and regional and gender balance. The full Bureau approves the chapter teams.

As required by the IPCC Principles and Procedures, there are two official reviews of an assessment: Expert Review, and Government and Expert Review, of the First and Second Order Drafts, respectively. Authors are required to take into account and provide written responses to all comments during these reviews. This is a considerable task. For the WGII contribution to the AR4, more than 40,000 review comments were submitted. There were slightly less than 19,000 review comments in the two review periods for the IPCC Special Report on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, with a range of hundreds to more than a thousand per chapter per review period. The Review Editors, a unique feature of IPCC reports, represent the reviewers, making sure that each comment is considered and appropriately addressed.

The last step in the process is for the Summary for Policymakers (SPM) that synthesizes key findings from the report to be approved line-by-line in a Working Group session. Every sentence in a Summary for Policymakers is discussed and agreed (by consensus) between the authors who drafted the SPM and governments in an approval session. When a SPM is approved, the governments then accept the underlying report (IPCC 2011). This close and ongoing dialogue at the science-policy interface ensures an assessment achieves its mandate and requirements, and is a unique feature of IPCC reports. This process was intensively reviewed and endorsed by the InterAcademy Council, with some suggested modifications to improve parts of the process, such as implementing a formal conflict of interest policy (IAC 2010).

IPCC reports are policy neutral because science is only one input into decision-making (Scheraga et al. 2003). Policymakers also take into consideration social and cultural values and perspectives, practical issues (from technological to political), and other factors when developing and implementing policies. Policies need to be specific to a national (or sub-national) context, including level of development, current and projected vulnerabilities, current and projected climate variability and change, and many other factors. For example, coastal protection schemes need to consider the many uses of coastal areas (aquaculture, energy production, tourism, recreation, etc.), current and projected risks, status of current and planned infrastructure, property rights, available human and financial resources to address risks, etc., as well as the priority placed on coastal protection. Science can help identify possible options, including their trade-offs, across sectors as well as across time, and associated potential impacts, costs, and benefits.

Impacts of climate change are a function not just of the climate hazard (whether increasing mean temperatures leading to reducing agricultural productivity in some regions, or increases in the magnitude, extent, duration, and geographic extent of extreme events) but also of who or what is exposed to the hazard and their associated vulnerability. Key messages from the just completed IPCC *Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* that directly compare vulnerability, hazard, and exposure indicate that exposure and vulnerability can be more important than climate change in determining many impacts (Field et al. 2012). In some situations, policies addressing vulnerability will increase resilience more effectively than specifically addressing the risks of climate change. A large number of factors determine vulnerability, from poverty (although all poor people are not equally at risk), to demographics (not all groups within a population are equally vulnerable to each outcome), to a wide range of social and cultural factors that vary across countries. Policies to address these vulnerabilities often have commonalities across regions and sectors, but need to be tailored to specific circumstances. Policies also need to balance competing demands, such as water needs across

agriculture, other economic sectors and tourism, urban areas, recreational use, health concerns, and others. Further, policy needs are likely to change with socioeconomic development, climate change, and other factors.

2 WGII contribution to the AR5

The tasks facing the WGII writing teams for the AR5 are much larger than those for the WGII contribution to the AR4. The Plenary Approved Outline for the WGII (available at www.ipcc-wg2.gov) includes 30 chapters, ten more than in the AR4: new topics include oceans systems and the open oceans, key economic sectors, livelihoods and poverty, human security, and economics of adaptation. In addition, to reflect rapid advancements in climate science since the literature cut-off for the AR4 (early 2006), there are chapters on food systems and food security, freshwater resources, and three chapters on adaptation. This organization provides opportunities for providing more policy relevant information to understand the magnitude and extent of possible impacts of climate change, taking into account vulnerabilities and multiple stressors, to support good policy decisions. Key themes to be addressed in the WGII report include:

- Assessing impacts of climate change in the context of other stresses. Increasing scholarship of the current and projected impacts of climate change highlights the multi-stressor context of impacts; climate change is generally one of many drivers of an adverse outcome, and may not even be the most important today. Many of the challenging impacts of climate change emerge from interacting stresses related to populations, societies, economic development, infrastructure, industry, and ecosystems. These stresses can be independent of climate change, or can result from or contribute to climate change. Therefore, in some cases, effective adaptation will focus on stressors other than climate change. In others, it may be useful to adapt simultaneously across several stresses.
- Broader range of assessed impacts. New science has appeared since the AR4 on a range of issues, including studies on ocean acidification, thermal tolerance of fish and other ocean organisms, and food webs. Human security issues range from disputes over resources to population migration to rapid disease emergence. There is new information on the teleconnections of indirect impacts of climate change, such as reduced crop yields in one region leading to food insecurity in another.
- Integration of climate science with impacts. The AR4 began this integration, synthesizing projections of the magnitude and extent of impacts with degrees of temperature change, by scenario and time slice. A much richer body of literature is available to provide greater understanding of and certainty about future impacts under different scenarios. One challenge will be clarifying the distinction between impacts and drivers of climate change. For example, an increase in wildfires might be partially attributed to climate change, but wildfires also can release CO₂ and other GHGs to the atmosphere that amplify warming.
- Support for good policy decisions. Reducing current and projected impacts of climate change requires effective policies that include a portfolio of actions, with implementation at appropriate levels of government. The AR4 Synthesis Report concluded that “responding to climate change involves an iterative risk management process that includes both mitigation and adaptation, taking into account actual and avoided climate change damages, co-benefits, sustainability, equity, and attitudes to risk” (IPCC 2007).

Effective support for good decisions depends on extracting information from the full range of possible outcomes, weighted by probability. Policymakers are asking for consideration not only of impacts resulting from the most likely climate scenarios, but also impacts arising from lower-probability and higher-consequence events, as well as from the consequences of proposed policies and measures.

- Expanded coverage of adaptation. The WGII contribution to the AR5 will assess current practice at local, national, regional, and international scales to identify best practices and lessons learned, opportunities to increase climate resilience, and approaches to overcome barriers to implementation. Governments are seeking additional understanding on opportunities to address institutional, political, and financial barriers and limits to adaptation.
- Integration of adaptation, mitigation, and development. Adapting to climate change and promoting sustainable development share common goals and determinants, including access to resources (including information and technology), equity in the distribution of resources, stocks of human and social capital, access to risk sharing mechanisms, and abilities of decision-support mechanisms to cope with uncertainty. It is increasingly clear that response strategies can be more effective when they include mitigation and adaptation, acknowledging that not all impacts may be avoided. An important component of integrating adaptation and mitigation is estimating the costs and benefits of adaptation, the costs of inaction, and the costs of residual damages. Better understanding is needed not only of the aggregate costs, but of regional and sectoral cost estimates and how they might vary across temporal scales. There is interest in better incorporation of non-market impacts when calculating the costs of climate change.
- Comprehensive treatment of regional aspects with input from WGs I (science of climate change) and III (mitigation). Regional aspects are fundamental to assessing climate science, impacts, adaptation, and vulnerability. Regions vary in important determinants of vulnerability, and they often (but not always) share constraints and opportunities arising from climatic similarities, socioeconomic status, infrastructure, etc.

3 Selected challenges for the WGII contribution to the AR5

Challenges for the WGII report include assessing the growing qualitative literature on, for example, adaptation practice; incorporating local knowledge; and identifying particularly vulnerable groups.

3.1 Assessing qualitative literature

It is relatively straightforward (although still complex) to assess quantitative data and projections on weather factors and associated impacts. The complexities increase when assessing qualitative research on climate change vulnerabilities, impacts, and adaptation. For example, community-based adaptation is a rapidly expanding area of research and practice, with most publications (peer-reviewed and non-peer-reviewed) place-based and primarily descriptive of the situation, research methods, and results. Different approaches can be used to assess the strengths, weaknesses, and quality of this research (e.g. Armstrong et al. 2007). Further, it can be difficult to assess the degree to which particular results depend on the local context and where results can be generalized to other regions and times. Yet decision- and policy-makers would like as specific conclusions as possible, not just that community-based adaptation can effectively decrease vulnerability, but also the minimum

necessary human and financial resources, the institutional and other conditions that facilitate effectiveness, approaches to overcome constraints and limits, etc.

3.2 Incorporating local knowledge

The social memories of communities can include detailed knowledge of driving forces, impacts, and response options to adapt to changing environmental conditions (Ford et al. 2011; Van de Noort 2011). Indigenous peoples, fisherfolk, rural farming communities, and other populations often live in environments vulnerable to changes in climate and rely heavily on natural resources. Some of these communities have long experience with monitoring weather and climate, as well as with responding to changes in the mean and variance of weather. This local knowledge is a potentially rich source of information on vulnerabilities, impacts, and effective adaptation and mitigation measures to better manage changing risks (Reid et al. 2006). International assessments, including the WGII contributions to IPCC reports, have incorporated local and specific information on all aspects of vulnerability, impacts, and adaptation. A challenge is incorporating knowledge that lacks specifics on the magnitude and extent of climate variability and change over identified time periods and on the process, sequence, and evidence for measures taken in response. Further, there are tensions about the degree to which typical scientific approaches can capture the relationships between climate change and indigenous cultures (e.g. Deer 2006) and the implications for development policies of focusing on knowledge rather than people in their social and cultural context (Agrawal 2002).

Efforts to incorporate local knowledge into international assessments date back to at least the Global Environment Assessment project at Harvard University that was initiated in 1995 (<http://www.hks.harvard.edu/gea/geadescr.htm>). One of the synthesis volumes was written for scholars concerned about the tensions between political power, governance, and globally and locally referenced knowledge that is mobilized or marginalized in environmental assessment practice (Jasanoff and Martello 2004). Assessment of local knowledge was included in the IPCC 3rd Assessment Report (McCarthy et al. 2001), the Millennium Ecosystem Assessment (MEA; Hassan et al. 2005), the Arctic Climate Impact Assessment (ACIA 2005), the IPCC 4th Assessment Report (Parry et al. 2007), the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD; McIntyre et al. 2009), and the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX; Field et al. 2012). Reid et al. (2006) published some of the lessons learned from the MEA on approaches to overcome the challenges of incorporating local scale information into an international assessment.

In addition, these assessments increased awareness of the need for additional scholarship on local knowledge. For example, the initial concept for the project Assessments of Impacts and Adaptations to Climate Change (AIACC) came from the authors of the IPCC 3rd Assessment Report. Sir Robert Watson, Osvaldo Canziani, and James McCarthy, the IPCC Chair and IPCC Working Group II Co-Chairs, respectively, championed the project that developed new insights about knowledge and experience in Africa, Asia, and Latin America (Leary et al. 2008a, b). More than 250 investigators undertook the AIACC case studies; several are involved in the AR5 as CLAs, LAs, REs, and contributing authors.

3.3 Identifying particularly vulnerable groups

As scholarship increases understanding of the possible consequences of climate change, more populations, communities, ecosystems, sectors, and geographic regions are identified

as being at particular risk. Understanding of vulnerability (the propensity to be harmed) is important from multiple perspectives. One is Article 2 of the United Nations Framework on Climate Change that commits signatory nations to stabilizing greenhouse gas concentrations in the atmosphere at a level that “*would prevent dangerous interference with the climate system*” (UNFCCC 1992). Of course, the determination of what concentration is deemed dangerous is a value judgment, with science providing important input. For example, the loss of a particular species or a section of coastline will be valued differently by different groups. Further, selecting a particular concentration as the threshold for dangerous interference with the climate system implies that the adverse impacts already experienced and those that will occur up to the threshold are acceptable.

On a global scale, the IPCC 3rd and 4th assessment reports identified key vulnerabilities based on five “reasons for concern”: risk to unique and threatened systems; risk of extreme weather events; distribution of impacts; aggregate damages; and risk of large-scale discontinuities (Smith et al. 2009). Smith et al. (2009) assessed the climate change consequences of these reasons for concern against increases in global mean temperature to show global levels of risk. This assessment did not address when impacts might be realized or take into account how different development pathways could affect vulnerability. The analysis showed more impacts have occurred, with more severe impacts expected with lower degrees of warming, than a similar analysis in the TAR. Further, the analysis suggested that dangerous interference with the climate system has already occurred for some populations, sectors, and regions. The question then is more one of the magnitude and extent of possible impacts under different scenarios of climate change, and how much damage could be avoided through adaptation and mitigation.

Another perspective on vulnerability comes from donors and funders asking who is most vulnerable in order to prioritize adaptation and research needs. However, it is a socio-political choice as to who is most vulnerable to the impacts of climate change (Downing et al. 2001). The causes of vulnerability can be complex and are often place-based. Vulnerability to one hazard is often quite different from vulnerability to another; vulnerability to sea level rise does not imply vulnerability to heatwaves. For human systems, vulnerability often relates more to the consequence of exposure to a hazard than to the hazard itself (e.g. people and communities are more vulnerable to damage and loss from flooding rather than to the physical flood itself). For example, cities and nations have implemented various degrees of early warning systems and flood protection schemes; therefore, similar flooding events in different regions have very different impacts (UNISDR 2009). Further, vulnerability to a hazard has socioeconomic and biogeophysical dimensions that vary over spatial and temporal scales. Recovery and reconstruction after an extreme weather event can result in better preparation for the next event, thereby reducing future vulnerability.

Therefore, defining levels of vulnerability is a socio-political process that depends on the specific question asked. Studies of who is most vulnerable create different rankings, depending on the criteria used. For example, Brooks et al. (2005) concluded that key indicators of mortality risk in disasters include access to sanitation, literacy rate, maternal mortality, caloric intake, voice and accountability, civil liberties, political rights, government effectiveness, and life expectancy at birth. Asking a different question, Prasad et al. (2009) identified cities vulnerable to climate change-related disasters based on economic or political significance of the city to a country or region that had a moderate to high level of one or more hazard; medium or high observed vulnerability to past disasters; moderate to high sectoral vulnerability to climate change; poor or non-existent urban development plan; poor compliance with an urban development plan; poor quality of building stock; high population density; medium or high slum density; and no comprehensive disaster response system. As would be expected, the result is a

very different ranking from that of Brooks et al. (2005). A consequence is that assessments of studies of who is most vulnerable tend to focus on identifying consistent themes.

Population groups vulnerable to climate change, including indigenous peoples, populations living in coastal areas vulnerable to sea level rise and storm surges, agricultural communities in areas where changing weather patterns put crop productivity at risk, older adults at risk during heatwaves, etc., often have valuable experiences with managing and coping with changing weather patterns. The WGII report, through the expertise of the chapter teams, contributing authors, and reviewers, aims to capture best practices and lessons learned from all these groups, to inform decision- and policy-makers about approaches to increase resilience in a changing climate.

4 Expertise and commitment of the WGII AR5 authors

One of the key responsibilities of a WG Bureau is the selection of a writing team with the highest scientific merit that includes the needed range of institutional and disciplinary perspectives, while ensuring the requisite regional and gender balance, and involving the next generation of climate scientists. IPCC Focal Points from 79 countries, Observer Organization representatives, and WGII Bureau members nominated 1,217 scientists from 92 countries for the WGII writing team. The WGII Bureau selected the AR5 writing team following the relevant IPCC Procedures. Each nomination was thoroughly evaluated; additional input was sought from IPCC Focal Points, representatives of observer organizations, and senior leaders in climate science. The 310 authors and reviewer editors chosen for the WGII writing team include scientists from 73 nations, 127 scientists from developing countries and economies-in-transition, 83 female scientists, and 187 scientists new to the IPCC process (not engaged in the 4th Assessment Report or one of Special Reports conducted during the AR5 assessment cycle).

IPCC Coordinating Lead Authors (CLAs) and Lead Authors (LAs) are remarkable in the breadth and depth of their expertise and in their willingness to donate considerable time and intellect to an IPCC assessment. The letters of invitation to participate in the WGII contribution to the AR5 estimated that CLAs could expect to commit approximately 6 months of full-time activity between appointment and the WGII approval session in 2014; LAs were told to expect approximately 4 months of full-time activity. The time committed is voluntary; the IPCC does not support the time scientists spend working on an assessment. A WG Technical Support Unit provides support for limited aspects of report development, but not for reviewing literature and writing text. The only compensation is for travel costs to lead author meetings (and some developed country governments do not even provide that for their authors and review editors; the IPCC Trust Fund provides travel costs for authors and review editors from developing countries and countries with economies in transition).

Although authors are representative, cover many disciplines, and can assess science outside their core expertise, no chapter team has experts for every issue that will be covered. Equally, most disciplinary groups feel under-represented. Nearly all WGII writing teams have two CLAs and six LAs to deliver comprehensive assessments on a broad range of topics (e.g. for the human health chapter, including the current burden of climate-sensitive health outcomes; vulnerability of children and older adults; projected changes in malnutrition, infectious diseases, emerging zoonotic diseases, morbidity and mortality due to extreme weather events; experience with adaptation; costs of action and of inaction on climate change; co-benefits of mitigation policies, etc.). In addition, authors frequently contribute to

other chapters where their expertise is needed. Chapters will have up to 1,000 references, each of which will have been evaluated for quality, robustness, and validity. This level of effort is one reason why Steve Schneider frequently referred to the IPCC as his pro-bono job.

To augment expertise, the writing teams select Contributing Authors (CAs) as needed to write about a specific topic or contribute a case study to illustrate a particular point. They are valuable additions to a writing team and, as such, their names are listed on the title page of a chapter.

5 Concluding remarks

IPCC assessments are significant undertakings that have been used to inform national and international decisions on actions to avoid, prepare for, and respond to the risks of climate change. The authors engaged in an assessment conduct comprehensive and balanced evaluations of the body of literature on a particular topic, irrespective of their personal opinions about individual publications, synthesizing current knowledge into policy relevant findings and describing the degree of scientific certainty in those findings. These assessments are a real service to the scientific community and to decision- and policy-makers. Experts not engaged as authors play a critical role in providing the literature to assess and through providing peer-review of the First and Second Order Drafts.

Quality, relevant research and expert review are critical to an IPCC report. Increased scholarship will enhance the breadth and depth of coverage on all aspects of vulnerabilities, impacts, and adaptation covered in the WGII contribution to the AR5. The literature cut-off dates for papers assessed in the WGII report are 31 January 2013 for submitted papers and 31 August 2013 for accepted papers (i.e. DOI or volume/page number).

The First Order Draft of the WGII contribution to the AR5 goes out for expert review in June 2012, providing an opportunity for the scientific community to comment on the content and direction of the report, ensuring that it is comprehensive, objective, and balanced. Experts are invited to register to review the First Order Draft. Information on how to register will be available at <<ipcc-wg2.gov>> in May 2012. The review period will be 8 weeks.

The governments asked the WGII writing teams to identify approaches for assessing vulnerabilities and impacts in a multi-stressor context to help them better manage current and emerging risks due to climate change. Governments are looking for effective and efficient approaches to iteratively identify, implement, and evaluate adaptation and mitigation options, and for lessons learned that will help them achieve climate-resilient and sustainable development. These lessons will come from comprehensively assessing all relevant literature. Active engagement of the wider scientific community in IPCC assessments will enhance their relevance to decision- and policy-makers.

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