

Climate Change 2014

Synthesis Report

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IPCC

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I - Folgefonna glacier on the high plateaus of Sørkjorden, Norway (60°03' N - 6°20' E).

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II - Planting of mangrove seedlings in Funafala, Funafuti Atoll, Tuvalu. © David J. Wilson

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Foreword, Preface and Dedication

Foreword

The Synthesis Report (SYR) distils and integrates the findings of the three Working Group contributions to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), the most comprehensive assessment of climate change undertaken thus far by the IPCC: *Climate Change 2013: The Physical Science Basis*; *Climate Change 2014: Impacts, Adaptation, and Vulnerability*; and *Climate Change 2014: Mitigation of Climate Change*. The SYR also incorporates the findings of two Special Reports on *Renewable Energy Sources and Climate Change Mitigation* (2011) and on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (2011).

The SYR confirms that human influence on the climate system is clear and growing, with impacts observed across all continents and oceans. Many of the observed changes since the 1950s are unprecedented over decades to millennia. The IPCC is now 95 percent certain that humans are the main cause of current global warming. In addition, the SYR finds that the more human activities disrupt the climate, the greater the risks of severe, pervasive and irreversible impacts for people and ecosystems, and long-lasting changes in all components of the climate system. The SYR highlights that we have the means to limit climate change and its risks, with many solutions that allow for continued economic and human development. However, stabilizing temperature increase to below 2°C relative to pre-industrial levels will require an urgent and fundamental departure from business as usual. Moreover, the longer we wait to take action, the more it will cost and the greater the technological, economic, social and institutional challenges we will face.

These and the other findings of the SYR have undoubtedly and considerably enhanced our understanding of some of the most critical issues in relation to climate change: the role of greenhouse gas emissions; the severity of potential risks and impacts, especially for the least developed countries and vulnerable communities, given their limited ability to cope; and the options available to us and their underlying requirements to ensure that the effects of climate change remain manageable. As such, the SYR calls for the urgent attention of both policymakers and citizens of the world to tackle this challenge.

The timing of the SYR, which was released on 2nd November 2014 in Copenhagen, was crucial. Policymakers met in December 2014 in Lima at the 20th Conference of Parties under the United Nations Framework Convention on Climate Change (UNFCCC) to prepare the groundwork for the 21st Session in 2015 in Paris, when they have been tasked with concluding a new agreement to deal with climate change. It is our hope that the scientific findings of the SYR will be the basis of their motivation to find the way to a global agreement which can keep climate change to a manageable level, as the SYR gives us the knowledge to make informed choices, and enhances our vital understanding of the rationale for action – and the serious implications of inaction. Ignorance can no longer be an excuse for tergiversation.

As an intergovernmental body jointly established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), the Intergovernmental Panel on Climate Change (IPCC) has provided policymakers with the most authoritative

and objective scientific and technical assessments in this field. Beginning in 1990, this series of IPCC Assessment Reports, Special Reports, Technical Papers, Methodology Reports and other products have become standard works of reference.

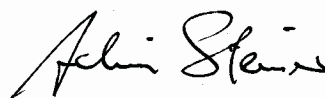
The SYR was made possible thanks to the voluntary work, dedication and commitment of thousands of experts and scientists from around the globe, representing a range of views and disciplines. We would like to express our deep gratitude to all the members of the Core Writing Team of the SYR, members of the Extended Writing Team, and the Review Editors, all of whom enthusiastically took on the huge challenge of producing an outstanding SYR on top of the other tasks they had already committed to during the AR5 cycle. We would also like to thank the staff of the Technical Support Unit of the SYR and the IPCC Secretariat for their dedication in organizing the production of this IPCC report.

We also wish to acknowledge and thank the governments of the IPCC member countries for their support of scientists in developing this report, and for their contributions to the IPCC Trust Fund to provide the essentials for participation of experts from developing countries and countries with economies in transition. We would like to express our appreciation to the government of Wallonia (Belgium) for hosting the Scoping Meeting of the SYR, to the governments of Norway, the Netherlands, Germany and Malaysia for hosting drafting sessions of the SYR, and to the government of Denmark for hosting the 40th Session of the IPCC where the SYR was approved. The generous financial support from the governments of Norway and the Netherlands, from the Korea Energy Economics Institute, and the in-kind support by the Netherlands Environmental Assessment Agency and The Energy and Resources Institute, New Delhi (India), enabled the smooth operation of the Technical Support Unit of the SYR. This is gratefully acknowledged.

We would particularly like to express our thanks to Dr Rajendra K. Pachauri, Chairman of the IPCC, for his leadership and constant guidance throughout the production of this report.



Michel Jarraud
Secretary General
World Meteorological Organization



Achim Steiner
Executive Director
United Nations Environmental Programme

Preface

The Synthesis Report (SYR), constituting the final product of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), is published under the title *Climate Change 2014*. This report distills, synthesizes and integrates the key findings of the three Working Group contributions – *The Physical Science Basis, Impacts, Adaptation, and Vulnerability* and *Mitigation of Climate Change* – to the AR5 in a concise document for the benefit of decision makers in the government, the private sector as well as the public at large. The SYR also draws on the findings of the two Special Reports brought out in 2011 dealing with *Renewable Energy Sources and Climate Change Mitigation*, and *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. The SYR, therefore, is a comprehensive up-to-date compilation of assessments dealing with climate change, based on the most recent scientific, technical and socio-economic literature in the field.

Scope of the Report

This document is the result of coordinated and carefully connected cross Working Group efforts to ensure coherent and comprehensive information on various aspects related to climate change. This SYR includes a consistent evaluation and assessment of uncertainties and risks; integrated costing and economic analysis; regional aspects; changes, impacts and responses related to water and earth systems, the carbon cycle including ocean acidification, cryosphere and sea level rise; as well as treatment of mitigation and adaptation options within the framework of sustainable development. Through the entire length of the SYR, information is also provided relevant to Article 2, the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC).

Other aspects of climate change covered in this report include direct impacts of climate change on natural systems as well as both direct and indirect impacts on human systems, such as human health, food security and security of societal conditions. By embedding climate change risk and issues of adaptation and mitigation within the framework of sustainable development, the SYR also highlights the fact that nearly all systems on this planet would be affected by the impacts of a changing climate, and that it is not possible to draw boundaries around climate change, its associated risks and impacts on the one hand and on the other, development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs. The Report, therefore, also focuses on connections between these aspects and provides information on how climate change overlaps with and mainstreams into other developmental issues.

Structure

The Report comprises a Summary for Policymakers (SPM) and a longer report from which the SPM is derived, as well as annexes. Even though the SPM follows a structure and sequence similar to that in the longer

report, some specific issues covered under more than one topic of the longer report are summarized in one particular section of the SPM. Each paragraph of the SPM contains references to the respective text in the longer report. In turn, the latter contains extensive references to relevant chapters of the underlying Working Group Reports or the two Special Reports mentioned above. The SYR is essentially self-contained, and its SPM includes the most policy relevant material drawn from the longer report and the entire AR5.

All the three contributions to the AR5 including each Summary for Policymakers, each Technical Summary, frequently asked questions as well as the Synthesis Report in all official UN languages are available online on the IPCC website and in electronic offline versions. In these electronic versions, references in the SYR to relevant parts of the underlying material are provided as hyperlinks, thereby enabling the reader to easily find further scientific, technical and socio-economic information. A user guide, glossary of terms used and listing of acronyms, authors, Review Editors and Expert Reviewers are provided in the annexes to this report.

To facilitate access to the findings of the SYR for a wide readership and to enhance their usability for stakeholders, each section of the SPM carries highlighted headline statements. Taken together, these 21 headline statements provide an overarching summary in simple and completely non-technical language for easy assimilation by readers from different walks of life. These headline statements have been crafted by the authors of the Report, and approved by the member governments of the IPCC.

The longer report is structured around four topic headings as mandated by the Panel:

Observed changes and their causes (Topic 1) integrates new information from the three Working Groups on observed changes in the climate system, including changes in the atmosphere, oceans, cryosphere and sea level; recent and past drivers and human influences affecting emission drivers; observed impacts, including changes in extreme weather and climate events; and attribution of climate changes and impacts.

Future climate changes, risks and impacts (Topic 2) presents information about future climate change, risks and impacts. It integrates information about key drivers of future climate, the relationship between cumulative emissions and temperature change, and projected changes in the climate system in the 21st century and beyond. It assesses future risks and impacts caused by a changing climate and the interaction of climate-related and other hazards. It provides information about long-term changes including sea-level rise and ocean acidification, and the risk of irreversible and abrupt changes.

Future Pathways for Adaptation, Mitigation and Sustainable Development (Topic 3) addresses future pathways for adaptation and mitigation as complementary strategies for reducing and managing the risks of climate change and assesses their interaction with sustainable development. It describes analytical approaches for effective

decision-making and differences in risks of climate change, adaptation and mitigation in terms of timescale, magnitude and persistence. It analyses the characteristics of adaptation and mitigation pathways, and associated challenges, limits and benefits, including for different levels of future warming.

Adaptation and Mitigation (Topic 4) brings together information from Working Groups II and III on specific adaptation and mitigation options, including environmentally sound technologies and infrastructure, sustainable livelihoods, behaviour and lifestyle choices. It describes common enabling factors and constraints, and policy approaches, finance and technology on which effective response measures depend. It shows opportunities for integrated responses and links adaptation and mitigation with other societal objectives.

Process

The SYR of the AR5 of the IPCC has been prepared in accordance with the procedures of the IPCC to ensure adequate effort and rigor being achieved in the process. For the AR5 the preparation of the SYR was taken in hand a year earlier than was the case with the Fourth Assessment Report (AR4) – while the Working Group Reports were still being completed – with a view to enhancing integration and ensuring adequate synthesis. A scoping meeting specifically for proposing the detailed outline of the AR5 Synthesis Report was held in Liège, Belgium in August, 2010, and the outline produced in that meeting was approved by the Panel in October, 2010 in Busan, Republic of Korea. In accordance with IPCC procedures, the IPCC Chair in consultation with the Co-Chairs of the Working Groups nominated authors for the Core Writing Team (CWT) of the SYR and a total of 45 CWT members and 9 Review Editors were selected and accepted by the IPCC Bureau in March, 2012. In addition, 14 Extended Writing Team (EWT) authors were selected by the CWT with the approval of the Chair of the IPCC, and this latter group contributed substantially to the material and the text provided in this report. During evolution of the contents of the SYR the IPCC Bureau was approached and it approved the inclusion of 6 additional CWT members and an additional Review Editor. This further enhanced and deepened the expertise required for the preparation of the Report. The final draft report which has undergone a combined review by experts and governments was submitted to the 40th Session of the IPCC, held from 27 October to 1 November 2014 in Copenhagen, Denmark, where governments approved the SPM line by line and adopted the longer report section by section.

Acknowledgements

Our profound gratitude and deep indebtedness goes to the members of the Core Writing Team and the substantial help from the Extended Writing Team members, for their tireless efforts, expertise, and amazing level of dedication throughout the production of the SYR. The SYR could not have been completed successfully without their inspirational commitment to excellence and integrity, and their meticulous attention to detail. We also wish to thank the Review Editors for their invaluable help ensuring that the SYR provides a balanced and complete assessment of current information relevant to climate change. Their role was crucial to ensure transparency of the process which the IPCC

can pride itself on. Our thanks go also to all authors of the AR5 and the two Special Reports because without their careful assessment of the huge body of literature on various aspects of climate change and their comments on the draft report, the preparation of the SYR would not have been possible.

Throughout the AR5, we benefitted greatly from the wisdom and insight of our colleagues in the IPCC leadership, especially Dr Thomas Stocker and Dr Qin Dahe, Working Group I Co-Chairs; Dr Chris Field and Dr Vicente Barros, Working Group II Co-Chairs; and Dr Ottmar Edenhofer, Dr Ramón Pichs-Madruga and Dr Youba Sokona, Working Group III Co-Chairs. Their cooperation on issues related to knowledge from the reports of all three Working Groups was a definite asset for the production of a high-quality final document.

We also wish to thank Fredolin Tangang, David Wratt, Eduardo Calvo, Jose Moreno, Jim Skea and Suzana Kahn Ribeiro, who acted as Review Editors during the Approval Session of the SYR, ensuring that the edits made to the SPM during the Session were correctly reflected in the longer report. Their important work guaranteed the high level of trust between the scientists and the governments, enabling them to work smoothly in symbiosis, which is a unique feature of the IPCC and its credibility.

We extend our deep appreciation of the enthusiasm, dedication and professional contributions of Gian-Kasper Plattner, Melinda Tignor and Judith Boschung from the Technical Support Unit of Working Group I, Katie Mach and Eren Bilir from the Technical Support Unit of Working Group II, Ellie Farahani, Jussi Savolainen and Steffen Schlömer from the Technical Support Unit of Working Group III, and Gerrit Hansen from the Potsdam Institute for Climate Impact Research during the Approval Session of the SYR, working as a team with the Technical Support Unit of the SYR, which was indispensable in the successful outcomes of the Session. A special thanks goes to Adrien Michel from the Technical Support Unit of Working Group I for his work on the SYR figures.

Our thanks go to Leo Meyer, Head of the Technical Support Unit of the Synthesis Report, and the members of the Technical Support Unit Sander Brinkman, Line van Kesteren, Noemie Leprince-Ringuet and Fijke van Boxmeer for their capacity to expand their strengths and carry out the mammoth task of coordinating the development and production of the SYR. Each one of them put in tireless efforts, displaying deep commitment and dedication to ensure the production of an outstanding SYR.

We would like to acknowledge the work and innumerable tasks performed in support of the preparation, release and publication of the Report by the staff of the IPCC Secretariat: Gaetano Leone, Carlos Martin-Novella, Jonathan Lynn, Brenda Abrar-Milani, Jesbin Baidya, Laura Biagioni, Mary Jean Burer, Annie Courtin, Judith Ewa, Joelle Fernandez, Nina Peeva, Sophie Schlingemann, Amy Smith and Werani Zabula. Thanks are also due to Francis Hayes and Elhousseine Gouaini for acting as conference officers at the approval Session.

We are appreciative of the member governments of the IPCC who graciously hosted the SYR scoping meeting, four of our Core Writing Meetings and the 40th Session of the IPCC: Belgium, Norway, The Netherlands, Germany, Malaysia and Denmark. We express our thanks

to the governments, WMO, UNEP and the UNFCCC for their contributions to the Trust Fund which supported various elements of expenditure. We wish to particularly thank the Governments of Norway and The Netherlands, and the Korea Energy Economics Institute for their generous financial support of the SYR Technical Support Unit, and The Netherlands Environmental Assessment Agency PBL and The Energy and Resources Institute, New Delhi, for their in-kind support of the SYR Technical Support Unit. We also acknowledge the support of IPCC's parent organizations, UNEP and WMO, and particularly WMO for hosting the IPCC Secretariat and our first Core Writing Team meeting. May we convey our deep gratitude to the UNFCCC for their cooperation at various stages of this enterprise and for the prominence they give to our work in several appropriate fora.



R.K. Pachauri
Chairman of the IPCC



Renate Christ
Secretary of the IPCC

Dedication



Stephen H. Schneider
(11 February 1945 – 19 July 2010)

The Synthesis Report of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) is dedicated to the memory of Stephen H. Schneider, one of the foremost climate scientists of our time.

Steve Schneider, born in New York, trained as a plasma physicist, embraced scholarship in the field of climate science almost 40 years ago and continued his relentless efforts creating new knowledge in the field and informing policymakers and the public at large on the growing problem of climate change and solutions for dealing with it. At all times Steve Schneider remained intrepid and forthright in expressing his views. His convictions were driven by the strength of his outstanding scientific expertise. He was highly respected as Founding Editor of the interdisciplinary journal *Climatic Change* and authored hundreds of books and papers, many of which were co-authored with scientists from diverse disciplines. His association with the IPCC began with the First Assessment Report which was published in 1990, and which played a major role in the scientific foundation of the UN Framework Convention on Climate Change. Subsequently, he was Lead Author, Coordinating Lead Author and Expert Reviewer for various Assessment Reports and a member of the Core Writing Team for the Synthesis Report of the Fourth Assessment Report. His life and accomplishments have inspired and motivated members of the Core Writing Team of this Report. Steve Schneider's knowledge was a rare synthesis of several disciplines which are an essential part of the diversity inherent in climate science.

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In the Summary for Policymakers, the references refer to the numbers of the sections, figures, tables and boxes in the underlying Introduction and Topics of this Synthesis Report.

In the Introduction and Topics of the longer report, the references refer to the contributions of the Working Groups I, II and III (WGI, WGII, WGIII) to the Fifth Assessment Report and other IPCC Reports (in italicized curly brackets), or to other sections of the Synthesis Report itself (in round brackets).

The following abbreviations have been used:

SPM: Summary for Policymakers

TS: Technical Summary

ES: Executive Summary of a chapter

Numbers denote specific chapters and sections of a report.

Other IPCC reports cited in this Synthesis Report:

SREX: Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

SRREN: Special Report on Renewable Energy Sources and Climate Change Mitigation

AR4: Fourth Assessment Report