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**SIXTH ASSESSMENT REPORT (AR6) PRODUCTS**

**Outline of the Special Report on Climate Change and Oceans and the Cryosphere**

(Prepared by the Scientific Steering Committee for the Scoping of the Special Report)

(Submitted by the Secretary of the IPCC)

# **Special Report on Climate Change and Oceans and the Cryosphere: Information on the Organization of the Scoping of the Special Report**

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## **1. INTRODUCTION**

In paragraph 4 of its Decision IPCC/XLIII-6 on the Sixth Assessment Report (AR6) – Special Reports - the IPCC decided “to prepare a Special Report on climate change and oceans and the cryosphere”.

Furthermore, in paragraph 3 of its Decision IPCC/XLIII-7 on the Sixth Assessment Report (AR6) Products – Strategic Planning, the IPCC decided “to consider the draft Special Report on climate change and oceans and the cryosphere as early as possible during the Sixth Assessment Report cycle”.

Thereafter, the Chair of the IPCC established a Scientific Steering Committee to undertake the scoping of the Special Report under the joint scientific leadership of Working Groups I and II with support from the Working Group II Technical Support Unit.

The Scientific Steering Committee (SSC) was comprised of:

- Ms Ko Barrett (IPCC Vice Chair) (Chair of SSC)
- Ms Valérie Masson-Delmotte (Co-Chair of Working Group I)
- Mr Panmao Zhai (Co-Chair of Working Group I)
- Mr Hans-Otto Pörtner (Co-Chair of Working Group II)
- Ms Debra Roberts (Co-Chair of Working Group II)
- Mr Eduardo Calvo (Co-Chair of the Task Force Bureau)
- Mr Edvin Aldrian (Vice-Chair of Working Group I)
- Mr Gregory Flato (Vice-Chair of Working Group I)
- Mr Andreas Fischlin (Vice-Chair of Working Group II)
- Mr Sergey Semenov (Vice-Chair of Working Group II)
- Mr Amjad Abdulla (Vice-Chair of Working Group III)

## 2. CALL FOR NOMINATIONS

A call for nominations for participation in the scoping meeting was issued on 17 June 2016, to IPCC member Government Focal Points, Observer Organisations, and Bureau Members. Expertise was sought in the following areas:

- 1) Oceans and cryosphere in the climate system: interactions, drivers, mass and energy exchange, carbon storage and fluxes (including submarine and terrestrial permafrost), climate feedbacks (e.g., albedo), timescales of responses, abrupt change, irreversibility
- 2) Global to regional ocean physical and biogeochemical variability and change (circulation, extreme events, heat content, salinity, sea ice, carbon cycle, acidification, oxygen, nutrients, upwelling, etc.): palaeoclimate, observations, processes, modelling and projections, model evaluation, detection and attribution to human influence
- 3) Global to regional variability and change in the cryosphere (including mountain glaciers, ice shelves, ice sheets, permafrost): palaeoclimate, observations, processes, modelling and projections, model evaluation, detection and attribution to human influence
- 4) Global to regional sea level variability and change: drivers, palaeoclimate, observations, processes, modelling and projections, model evaluation, detection and attribution to human influence
- 5) Methods for the detection of climate change impacts on ecosystems and human systems associated with oceans and cryosphere, attribution of impacts to anthropogenic climate change and other human influences: palaeo- and present observations, processes, modelling and projections, model evaluation
- 6) Cryosphere-bound ecosystems and human systems, their observed and projected changes, cryosphere changes and water availability.
- 7) Marine ecosystems, biodiversity, productivity, ecosystem services across latitudes, upwelling areas, their observed and projected changes
- 8) Socioeconomic consequences of ocean and cryosphere changes and their implications for sustainable development across regions (natural resources, food webs, food security, health, habitat security, tourism, transportation, etc.)
- 9) Vulnerability and scope for adaptation of natural, managed, and human systems related to oceans, coasts and the cryosphere (including human infrastructures, cities, indigenous communities, human behaviours, economies, adaptation costs, trade-offs and co-benefits)
- 10) Risk assessments, risk perception, reasons for concern (extreme events, coastal erosion, ocean circulation, sea level rise, cryosphere retreat, ecosystem degradation, e.g., coral reefs; harmful algal blooms, adverse impacts of human response measures; climate interactions with overfishing, eutrophication and pollution, regional differentiation)
- 11) Marine mitigation including nature-based mitigation (conservation, i.e., marine protected areas; blue carbon including changes in carbon stocks and fluxes under emission pathways, their relevance for greenhouse gas inventories and accounting) and technologies (renewable energy, carbon capture and storage and other geoengineering techniques, their feasibility and risks, ethical aspects)
- 12) Climate change policies, instruments, international law and cooperation related to oceans and the cryosphere, regional aspects of sustainable development, equity, poverty eradication

The call for nominations closed on 29 July 2016. 499 nominations were received from 54 member governments, 13 observer organizations and members of the IPCC Bureau. Consolidating for those individuals who were nominated by more than one source resulted in total of 458 experts. Of the total nominations received, 74% were male and 26% were female. Based on the citizenship provided, 71% of nominated experts were from developed countries and 29% were from developing countries or countries with economies in transition.

### **3. PARTICIPANT SELECTION**

#### **3.1 Overview**

Participants to the scoping meeting were selected following a process consistent with the IPCC policies and procedures. Participants were selected by the relevant respective Working Group Bureau Members, facilitated by the Scientific Steering Committee (SSC) for the scoping of the special report, which consisted of one IPCC Vice Chair, the WGI and WGII Co-Chairs, one TFI Co-Chair, two Vice-Chairs from WGI, two Vice-Chairs from WGII and one Vice-Chair from WGIII.

The objective of the selection process was to select around 60 experts considering all criteria as stated in Appendix A of the Principles Governing IPCC Work:

*"In selecting scoping meeting participants, consideration should be given to the following criteria: scientific, technical and socio-economic expertise, including the range of views; geographical representation; a mixture of experts with and without previous experience in IPCC; gender balance; experts with a background from relevant stakeholder and user groups, including governments."*

#### **3.2 Initial Ranking**

Following the close of nominations, the WGII Technical Support Unit compiled nominations into a single spreadsheet and prepared overview statistics of the nominations. Following the decision that the outline would be scoped under the joint scientific leadership of WGI and WGII, the compiled nominations were sent to all members of the WGI and WGII Bureaus for consideration and initial ranking. Each WGI/II Bureau Member was asked to follow a 'ranking' process, focusing on their WG and their own area of expertise, including on nominees from their region, and considering all criteria as stated in Appendix A of Principles Governing IPCC Work. Each Bureau Member was asked to consider the nominations carefully and provide up to ten '1' rankings, which indicates a 'high priority', and up to ten '2' rankings, which indicates a 'secondary priority'. It was noted that there was purposely no '3' or 'low priority' as the intention was not to produce a 'hierarchical ranking', but a focused identification of key individuals that would address the needs of the meeting, given the WGI/II Bureau Members' expertise and regional representation.

The ranking process undertaken had been used in previous selection processes as a way to identify overlaps and agreement across the selection undertaken by the WG Bureau Members. In addition to the individual ranking, each Member also was provided with the opportunity to include additional 'Comments' to allow for additional detail not captured in the nomination that would be useful for others to consider during the next stage of the selection process. At this stage, WG Bureau Members were also informed of the ability to submit additional nominations in the event that key gaps were identified.

#### **3.3 Construction of the Long List**

All input (rankings and comments) received from the WGI/II Bureau members was compiled. A score was calculated for each nominee based on the following calculation: a rank of '1' was equivalent to 2 points and a rank of '2' was equivalent to 1 point. The resulting Long List, consisting of 292 experts, was then sorted by score and returned, along with overview statistics on the Long List and the top scoring experts within the Long List, to the WGI/II Bureau members for a second round of rankings. The original full list of nominations as well as a statistical analysis showing the balance of the various criteria were supplied for reference and support of the next phase in the selection process.

### **3.4 Ranking of the Long List**

The objective of the second phase of the selection process was to refine and optimize the Long List to aid in the pre-selection of a Short List by the SSC for consideration by the WGI/II Bureau Members in the next stage of the selection process. The WGI/II Bureau Members were asked to assign five ranks of '1' indicating a high priority, and five ranks of '2' indicating secondary priority and to carefully consider their ranking allocations towards achieving balance across all selection criteria.

WGI/II Bureau Members were asked to include where appropriate clear comments articulating their choices and views as this would help the SSC to pre-select the Short List for consideration by the WGI/II Bureau Members (examples: wish to highlight a nominee that was less well known among Bureau Members, who had a lower score, but could be a key participant for the scoping meeting, any reservations on nominees with higher scores, wish to highlight the need to consider a nominee who was not in the Long List, looking back at the Full List of nominations).

### **3.5 Construction of the Revised Long List**

All input (rankings and comments) received from the WG/II Bureau members was assembled into an updated nominations spreadsheet. All comments received since the beginning of the selection were grouped into one column. Following the same refinement and scoring process a Revised Long List of 105 experts emerged. Two late nominations from WGI/II Bureau Members were submitted during the second round of rankings to address gaps in expertise not represented in the nominations as submitted. These two additions were contained in the Revised Long List.

### **3.6 Construction of the Short List**

The results of the two rounds of rankings, the comments and analysis were then circulated to the SSC members to facilitate the construction of a Short List for proposal to the WGI/II Bureau Members.

In addition to overview statistics of the Revised Long List, a sub-selection of the highest scoring nominees was also analysed. All those with a score of '3' or higher or all receiving at least one '1' during the second round of rankings were compiled into a sub-selection for additional analysis. Overview stats were provided on these 63 experts as well as a more in-depth analysis within the areas of expertise. In addition to the overview of the top 63, an analysis was undertaken to consider the 63 experts alongside the SSC and non-SSC WGI/II Bureau and ExCom members anticipated to attend so as to further consider geographic representation, gender balance, and IPCC experience across a full potential participant list. This analysis highlighted that while regional balance was overall relatively good, there were a number of imbalances within the regions that would need to be addressed when producing the Short List.

Working from the sub-selection of the 63, the SSC, through email and teleconferences, provided feedback on overlaps and gaps within the sub-selection. A resulting Short List of 62 experts was returned to the WGI/II Bureau Members for feedback.

### **3.7 Construction of the Final List**

From the Short List of 64 experts, WGI/II Bureau Members submitted a number of comments and suggestions to help reduce the overall numbers, while also ensuring appropriate coverage of the areas of expertise and broaden geographic representation. In response to gap in expertise and geographic representation, a late nomination was submitted.

The feedback received on the Short List was then considered by the SSC to produce a proposed Final List that would address all the concerns and suggestions. All gaps, overlaps and criteria were discussed and addressed to the extent possible.

A proposed Final List of 59 nominated experts, including a full analysis of the listing, was then returned to the WGI/II Bureau Members. It was noted that any nominees from the Short List or suggestions that were provided during the consideration of the Short List that had not been possible to incorporate in the Final List, were compiled into a priority wait list that would be used when regrets were received after the invitations were extended. The Final List of 59 experts was agreed on 15 September 2016 and invitations were extended on 19 September 2016. The Final List consisted of 53% developed country citizens and 47% were citizens of developing countries or countries with economies in transition; 66% male and 34% female. In response to regrets received, an additional five experts from the reserve list were invited. Two additional experts could not be replaced because of their late cancellation.

### 3.8 Participant List

In addition to the 62 invited experts, 23 Bureau Members participated in the Scoping Meeting. The full list of participants is available in Annex I. Of the total participants, 52% were from developing countries and countries with economies in transition and 48 % were from developed countries. 62% of participants were male and 38% were female. 56% of participants had previous IPCC experience, while 44% were new to the IPCC. The evolution of the selection process from nomination to participation across a number of criteria is available in Figures 1–4. Table 1 provides a break down of participants by country.

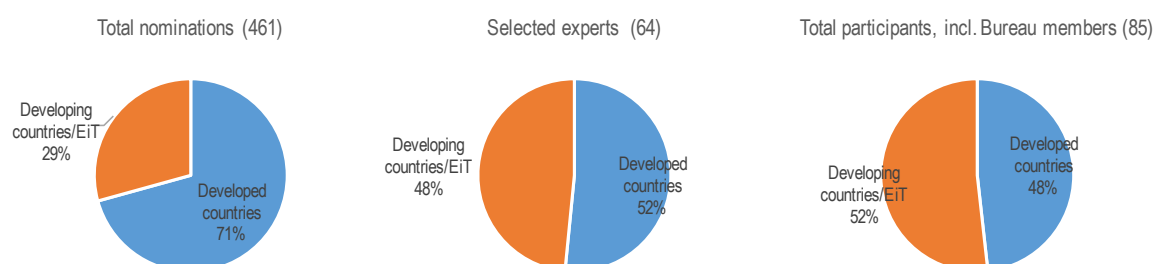
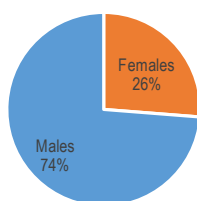


Figure 1: Balance in Developing Countries/Countries with Economies in Transition vs. Developed Countries (based on citizenship only)

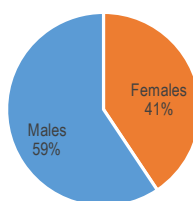


Figure 2: Distribution across WMO regions (based on citizenship only)

Total nominations (461)



Selected experts (64)



Total participants incl. Bureau members (85)

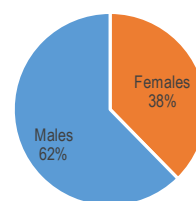
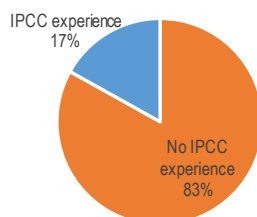
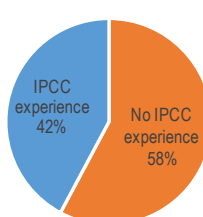


Figure 3: Gender Balance

Total nominations (461)



Selected experts (64)



Total participants incl. Bureau members (85)

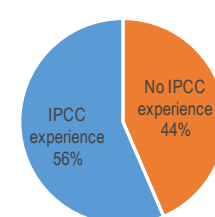


Figure 4: IPCC experience

Table 1: Country distribution

Country	Total nominations (461)	Selected experts (64)	Total participants, incl. Bureau members (85)
Algeria	2		1
Andorra	1		
Argentina	5	2	3
Australia	16	3	3
Austria	1		
Belgium	6	1	1
Brazil	15	2	3
Bulgaria	2		
Canada	14	2	3
Chile	3	1	
China	7	2	3
Colombia	1		
Comoros	1		
Costa Rica	2		
Croatia	1		
Cuba	3	1	2
Denmark	7		
Estonia	1		
Fiji	1	1	1
Finland	2		
France	27	3	4
Germany	14	2	3
Greece	1		
Guatemala	1		
Iceland	2		
India	26	1	1

<b>Country</b>	<b>Total nominations (461)</b>	<b>Selected experts (64)</b>	<b>Total participants, incl. Bureau members (85)</b>
Indonesia	5	1	2
Ireland	5		
Italy	18	1	1
Japan	9	2	3
Kenya	3	1	1
Maldives	1	1	2
Malaysia			1
Mali			1
Mexico	3	3	5
Monaco	4		1
Morocco	2	1	1
Mozambique	2	1	1
Nepal	3		
Netherlands	7	1	1
New Zealand	9	2	2
Nigeria	3		
Norway	20	1	2
Pakistan	2	1	2
Peru	1	1	1
Philippines	2	2	2
Portugal	3		
Republic of Korea	10	1	1
Russian Federation	4	2	3
Saudi Arabia	1		
Senegal	1		
Singapore	3		
South Africa	8	2	2
Spain	9	1	1
Sudan	2		
Sweden	8		
Switzerland	10	2	3
Thailand	1		
Togo	2		
Ukraine	2		
United Arab Emirates	1		
United Kingdom	35	5	6
United Republic of Tanzania	4		
United States of America	92	9	10
Uruguay	1	1	1
Venezuela	1		1
Zambia	1		
Zimbabwe	1		

#### 4. BACKGROUND DOCUMENT

A Background Document was prepared by the SSC and TSU to provide information to the Scoping Meeting participants on the development, scope and aims of the Special Report and its relationship to other products of the AR6 cycle. The main objective of the Background Document was to provide a selection of science issues to stimulate discussions among participants.



The Background Document first provided background information leading to the initiation of a Special Report on Climate Change and Oceans and the Cryosphere and a short summary of scientific issues addressed in earlier IPCC assessments. This was followed by the presentation of a set of pressing and policy-relevant science questions, developed from the government proposals for Special Reports and the questionnaire circulated to country Focal points and observer organisations. It was stressed that these were not prescriptive or exhaustive and were simply provided to stimulate the scoping process. The questions were grouped into: Ocean Physics and biogeochemistry; Cryosphere change and implications; Ocean-cryosphere interactions: sea level rise and impacts; Ecosystem and sectoral impacts, risks and vulnerabilities; Solutions: risk reduction, adaptation and mitigation. It was intended that the questions also promoted cross-WG identification of topics for the Special Report.

Four annexes were provided with the Background Document:

Annex 1: IPCC member Government Proposals. (nine submissions)

Annex 2: Working Group Co-Chair Commentary on Proposal Cluster. Commentary by the co-chairs of WGI and WGII on the relevance of the topics of Government Proposals to the WGs, gaps on the topics in AR5, difference to what is reported elsewhere, the current state of the scientific knowledge and implications for AR6.

Annex 3: Pre-scoping Questionnaire Analysis (see Section 5)

Annex 4: Non-exhaustive list of relevant published and forthcoming scientific assessment reports. This list was provided to avoid unnecessary overlaps with efforts through other scientific bodies and to identify possible gaps. The criteria for identifying reports (e.g., recent publication from 2012 to present) were given.

## **5. PRE-SCOPING QUESTIONNAIRE**

The SSC and TSU prepared a pre-scoping questionnaire to solicit recommendations on the structure and the content of the Special Report that would compliment the information included in the original proposals. The IPCC Secretariat sent the questionnaire to all IPCC Focal Points and Observer Organizations on 7 October 2016 with a closing date for responses of 7 November 2016. A total number of 44 pre-scoping questionnaire responses were submitted, with 28 submissions from developed countries and 16 from developing countries/economies on transition.

The pre-scoping questionnaire consisted of three main questions:

- 1) What is the main policy-relevant topic that should be addressed in the Special Report on climate change and oceans, and the cryosphere?
- 2) Why should this topic be addressed in the Special Report rather than the Sixth Assessment Report?
- 3) Please highlight any gaps or emerging knowledge (including scientific, technological, policy) that you consider highly relevant for this Special Report?

Many of the submissions provided multiple policy-relevant topics giving a total of 113 topics which were subsequently divided into nine categories. 46% were focused on the ocean (ocean-climate dynamics, impacts, vulnerability and adaptation, and socio-economic consequences), 19% on cryosphere (ice sheet dynamics and sea level rise, cryosphere-climate interactions, permafrost thaw and glacier retreat and consequences for ecosystems and humans, including mountain glacier retreat and freshwater resources). 35% highlighted issues that cut across ocean and cryosphere including mitigation/adaptation interactions (13%), regional aspects (6%), disaster and risk management (6%), governance and finance (5%), uncertainties (4%) and solutions (1%).

As to why topics should be addressed in the Special Report rather than the Sixth Assessment Report, 39% of responses highlighted the urgency given the challenges ahead, importance of being able to address specific subjects related to oceans and cryosphere, and/or the need for integration across Working Groups. The remainder indicated the opportunity to addressing gaps and uncertainties for ocean- and cryosphere-related research, knowledge to manage specific risks and provide information to policy, and to provide information at global and regional scales the socio-economic consequences of changes in the ocean and cryosphere. Gaps identified included impacts on fisheries, tipping points and thresholds, impacts on the carbon cycle and climate feedbacks, geoengineering approaches and attribution of specific changes such as loss of mass of glaciers.

In terms of geographical representation, almost half the responses (20 of 44 submissions) were from Europe, with responses from Asia, North America and Australasia combined providing much of the rest (21 submissions). Only one submission was received from Africa (Kenya) and two from South America (Argentina and Brazil).

Full results of the questionnaire were provided to participants in the Background Document (see Section 4).

## **6. SCOPING MEETING**

The scoping meeting for the Special Report was held in Monaco, from 6 to 9 December 2016. The presentations and meeting documentation are available on the scoping meeting webpage (<http://www.ipcc.ch/report/srocc/>). The Programme for the Scoping Meeting is provided in Annex II.

A pre-defined structure for the report was purposely not provided to the participants. Rather, to stimulate the scoping process, the SSC provided a simple information document. This document gave an overview of some of the key scientific issues that had arisen from earlier IPCC assessments related to the ocean and/or the cryosphere and listed examples of scientific questions that have emerged from the IPCC member Government proposals. Many of these key scientific issues were also addressed in a series of key-note plenary scene setting presentations (see Section 7.1). Scoping meeting participants were encouraged by the SSC to think broadly about the potential topics to be covered in the special report. The programme for this Scoping Meeting was carefully constructed to allow for wide-ranging initial discussions of these potential topics, followed by increasingly focused breakout group sessions, in order to produce a draft chapter outline by the conclusion of the meeting. Hence, the proposed outline for the Special Report was developed in a dynamic and iterative process over the course of the scoping meeting.

### **6.1 Keynote Presentations**

Keynote presentation topics were selected by the SSC to provide a sampling of the range of topics that could be covered by the special report. The keynote presentations were grouped (mostly in pairs), to provide both a WGI and WGII perspective for each topic. Ten minutes was allocated for each presenter, followed by five minutes discussion for each pair. The ten invited keynote speakers were given the following general mandate:

- To provide a general overview of the given topic suited for an audience with diverse backgrounds and expertise, as to lay the groundwork for the discussions to follow
- To extend their coverage of the topic beyond their own core research area
- To give emphasis to new research and publications emerging since the IPCC Fifth Assessment Report

The scene setting keynote presentations and the presenters consisted of the following:

**Keynote 1: Sea Level Rise, Flooding and Coastal Impacts**

*Roderik van de Waal & Bruce Glavovic*

**Keynote 2: Melting Ice, including Terrestrial Glaciers & Impacts, Risks and Adaptation in Indigenous Populations**

*Regine Hock & Ben Orlove*

**Keynote 3: Ocean and Cryosphere Changes & Ecosystem Impacts**

*Vladimir Kattsov & Ove Hoegh-Guldberg*

**Keynote 4: Ocean Carbon Cycle, Fisheries, Economics/Governance, Adaptation of Coastal Areas**

*Nicolas Gruber, William Cheung, Antonina Ivanova Boncheva, Elisabeth Holland*

At the opening of the plenary session the background, history, and general assessment process of the IPCC was introduced by Abdalah Mokssit, Secretary of the IPCC, while Ko Barrett (IPCC Vice-Chair and Chair of the SSC) provided further background on an IPCC special report and the scoping process. The work-flow and objectives of the meeting were clearly laid out, and clarifications provided during a round of open questions.

## **6.2 Breakout Groups and Stocktaking Sessions**

Open exchange of ideas and detailed discussions of possible options for the contents and structure of the report took place during three successive breakout group (BOG) sessions, each followed by a stocktaking session of reporting and discussion in plenary (Figure 1). BOG sessions were designed to progressively distill down from an initial phase of brainstorming on possible topics and questions to be addressed in the report, to discussion around a series of focused themes, and finally to the identification of possible chapter titles and bullets of indicative content. All participants were reconvened in a plenary session after each BOG to take stock of the ideas emerging from across the different groups, discuss and clarify key issues, identify commonalities emerging from the discussions, and highlight key challenges, gaps and overlaps.

### **Day 1**

The first breakout group session (BOGI) was designed to provide all participants an open forum where they could freely express their ideas and priorities for the Special Report. To facilitate this process in an effective and inclusive manner, this initial brainstorming session employed a sticky note approach, capturing the participants' views on the key topics to be included in the Special Report, and importantly, also capturing their views on why these topics should be ideally covered in a Special Report (rather than or in addition to the full AR6). Participants were randomly assigned to one of six BOGs (each comprised of around 15 people), in which they were provided with sticky notes upon which they could write their top two priority topics for the Special Report, and associated rationale for inclusion. The task of each BOG (chaired by a member of the Scientific Steering Committee) was then to identify commonalities by arranging the sticky notes into thematic clusters. To maintain the open and inclusive nature of the exercise, participants could move only their own sticky notes, thereby ensuring nobody had their priority topics 'forced' into a cluster which did not meet with their agreement. The BOG Rapporteurs then presented in plenary the key clusters and discussion points arising from their respective BOGs.

A key theme emerging from across the BOGs was the need for the Special Report to be cross-cutting and framed within a narrative that clearly links the physical and social worlds to address key human-orientated questions, thereby optimizing the value of the report to the policymakers.

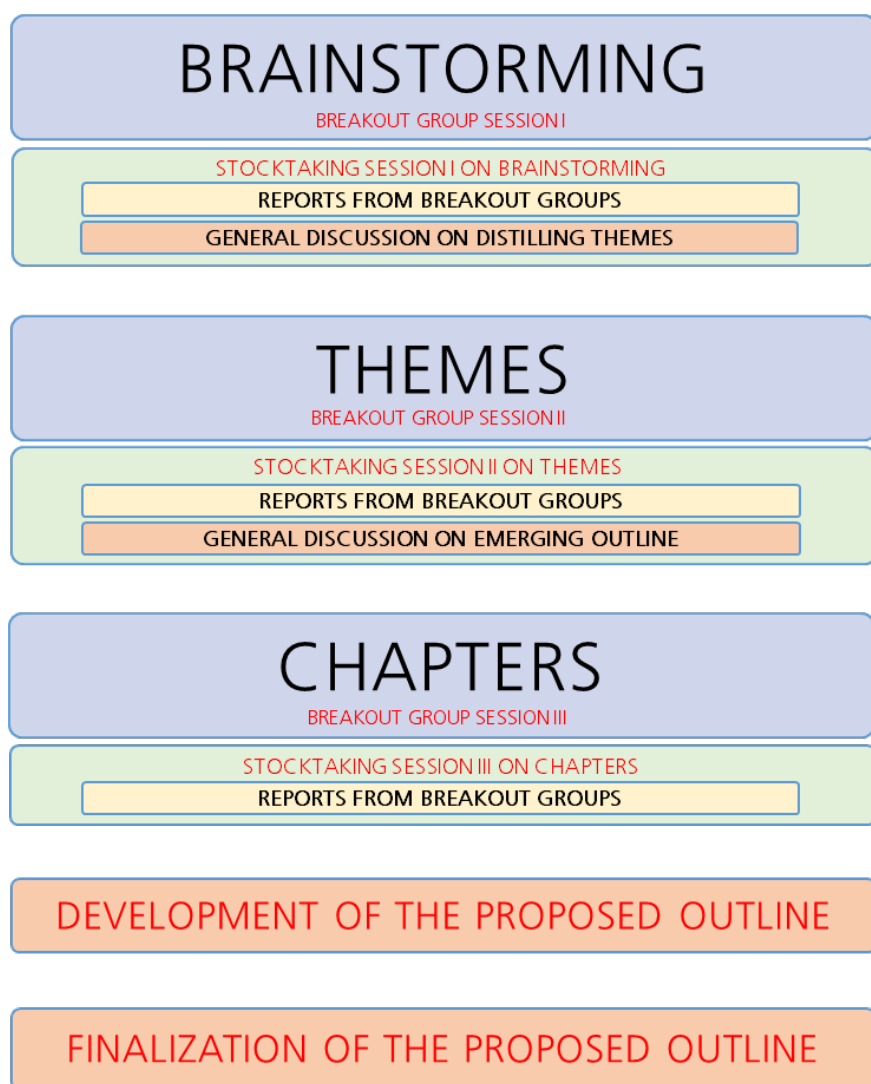


Figure 1: Meeting design and work-flow of the Scoping Meeting

## Day 2

Based on the commonalities emerging out of the brainstorming session and the subsequent plenary discussion, the SSC defined four themes to be addressed in the second breakout group session (BOGII). In BOGII, participants were free to attend the group/theme in which they were most interested. To ensure group sizes did not become too large and ineffective, some themes were split across two groups. Chairs were assigned by the SSC.

BOGII groups were formed on:

- Ocean Ecosystems (2 BOGs)
- Sea Level Risks (2 BOGs)
- Changing Cryosphere (2 BOGs)
- Extremes and Abrupt Changes (1 BOG)

Under each theme the participants were tasked with formulating bullet points that would give content for a proposed narrative that would run throughout the different themes. Possible topics for case-studies (including regional) were also to be identified. Each BOG reported back in the plenary session, providing a basis for fruitful discussion surrounding both refinement of the suggested narrative/structure of the report and content.

### **Day 3**

The SSC reflected upon the material emerging from BOGII to propose a slate of possible chapters that would be elaborated upon in the third breakout group session (BOGIII). In addition, the common narrative to run through the chapters was fine-tuned based on the plenary discussion. Participants could again choose which BOG they attended, and two chairs for each BOG (representing both WGI and WGII) were assigned by the SSC.

The BOGIII groups were formed on:

- Framing
- High-mountain Areas
- Polar Regions
- Rate and Implications of Sea Level Change
- Changing Ocean Ecosystems
- Extremes and Abrupt Changes

The BOG participants were tasked with constructing indicative bullets that would ultimately form the scope of the chapters, with each bullet ideally addressing the common narrative running from: *key processes and feedbacks → impacts on human and natural systems → resilient and sustainable pathways → case studies (including regional)*.

To facilitate maximum clarity and exchange of views, each BOG was given significant plenary time (essentially unconfined) to report their final titles and proposed bullets, and respond to questions from the floor. This was followed by a round of general discussion, with all details being noted and informing the final evening deliberations of the SSC to follow.

### **Day 4**

In the evening the SSC considered and debated the chapter titles and indicative bullets as emerging from BOGIII, and attempted to respond appropriately to the breadth of views expressed by participants throughout the meeting. These discussions converged with the formation of a chapter slate (titles and indicative bullets) that was presented at the final day synthesis plenary. This chapter slate was presented and edited live on-screen based on intense discussion and feedback from the meeting participants. Discussion ensured until consensus agreement was reached for each chapter title, the related set of indicative bullets, chapter ordering, and indicative page lengths (Box 1).

During the discussion, the appropriate coverage of small islands (and other highly vulnerable regions) in the report was revisited and carefully considered with views ranging from the additions of a separate chapter to the incorporation of material across chapters. Consensus emerged that a specific cross-chapter box on Low Lying Islands and Coasts would be included in the proposed outline.

Finally, based on a parallel process whereby all participants had been invited to propose a report title (via sticky-notes placed on a wall), a short-title that best captured these suggestions was proposed and accepted by the participants. It was recognized that the human dimension of the report was not well captured in the short-title. Due to a lack of time in the plenary session, the participants agreed that the communication experts within the IPCC Secretariat were to be tasked with suggesting an appropriate subtitle that best captures these human dimensions. However, an appropriate subtitle that communicated these dimensions while also being both scientifically accurate and consistent with the underlying content of the proposed outline was not identified.

### Box 1: Special Report Proposed Outline

Summary for Policy Makers (~15 pages)

Chapter 1: Framing and Context of the Report (~15 pages)

Chapter 2: High Mountain Areas (~20 pages)

Chapter 3: Polar Regions (~50 pages)

Chapter 4: Sea Level Rise and Implications for Coasts and Communities (~50 pages)

Chapter 5: Changing Ocean, Marine Ecosystems, and Dependent Communities (~65 pages)

Chapter 6: Extremes, Abrupt Changes and Managing Risks (~20 pages)

Case Studies, Frequently Asked Questions and Boxes (~20 pages)

Cross-Chapter Box: Low Lying Islands and Coasts (up to 5 pages)

## 7. ANNOTATED PROPOSED OUTLINE OF CHAPTERS FROM THE SCOPING MEETING

The following text provides additional information on the annotated Special Report outline, based on expert discussions reported throughout the scoping meeting, and particularly those discussions emerging during Breakout Group Session III and the final plenary.

### Chapter 1: Framing and Context of the Report

- Integrated storyline of the report, chapter narrative, chapter sequence and their linkages (including coverage of extremes and abrupt change and irreversible changes)
- Definition of ocean and cryosphere and their components
- Observing capacities, progress and limitations (e.g., time series and spatial coverage)
- Assessment methodologies, including indigenous and community knowledge, risk, and applications of detection and attribution
- Role of ocean and cryosphere in the climate system, including characteristics, key feedbacks and time scales
- Implications of ocean and cryosphere change for resources, natural systems (e.g., loss of habitat, extinctions) and human systems (e.g., psychological, social, political, cultural and economic aspects)
- Linkages of this report to relevant institutional and policy contexts (e.g., Paris Agreement and SDGs, Sendai Framework)
- Treatment of vulnerabilities and marginalized areas and people (e.g., gender) in this report
- Scenarios and time frames considered in this report
- Treatment of uncertainty

The first bullet introduces the reader to the way the report is structured and the content presented. It explains the narrative that each chapter follows, i.e., from key processes and feedbacks to impacts to responses. The rationale for the chapter order will also be introduced, representing the flow of water from mountain areas and polar regions towards the oceans. The linkages between the chapters are to be made explicit.

The second bullet point addresses the need to clarify upfront the meaning of key terms used in the report. As different audiences may understand these terms differently, it was considered important to establish a shared understanding at the onset of the report.

The third bullet point makes explicit the challenges for research on ocean, cryosphere and people. This includes the limitations of observational data, gaps in data, and the challenges of integrating natural and social sciences.

The fourth bullet point describes and explains the underlying core methodologies used to assess changes in the ocean and cryosphere as well as the methodologies used to assess the literature referred to in the report. This includes the use of forms of knowledge such as indigenous and local/community knowledge, which has been identified as a cross-cutting theme across all chapters.

The fifth bullet point provides essential background information for understanding the rest of the report. In particular, it explains the role of the oceans and cryosphere in the climate system. Based on discussions it was decided that the inclusion of this fundamental information upfront would improve the readability of the overall report, free up space in the subsequent chapters, and thus create a tighter report.

The sixth bullet point introduces the implications of change for natural and human systems. For human systems this includes psychosocial, political, cultural and economic aspects. This information helps the reader to understand the interactions between processes that will be discussed in greater detail in the subsequent chapters.

The seventh bullet point positions the report and its content in the wider context within which policy and decision making occurs. These contexts include intergovernmental agreements and frameworks as well as other relevant institutional agendas.

The eighth bullet point makes it explicit how vulnerability and marginalization are both defined and treated in the report, in relation to places and people.

The ninth bullet point clarifies the time frames that are considered in the report (including paleo perspectives, horizons for future projects, etc.), and provides a brief explanation of the range of scenarios that have been included in the chapters.

The tenth bullet point clarifies how uncertainty is treated in the report. This is important to establish at the outset so that the reader is aware of the different types of uncertainty and understands how to interpret the language used to communicate the degree of certainty in the assessment findings throughout the report.

## **Chapter 2: High Mountain Areas**

- Common drivers for changes in mountain cryosphere (glaciers, permafrost, and snow, including tropical regions) and feedbacks (e.g., CH<sub>4</sub> emissions, albedo) to regional and global climate
- Effects of a changing mountain cryosphere on natural hazards and management options for protecting lives, livelihoods, infrastructure, and ecosystems
- Impacts from changes in the mountain environment (e.g., snow cover) on habitability, community livelihoods and culture, and adaptation options
- Risks for societies that depend on mountain cryosphere for water resources (e.g., human consumption, ecosystems and agriculture) and potential response strategies (e.g., national and international water resource management and technologies)
- Impacts of variability and trends in water supply on hydropower production and implications for energy policy and water governance
- Influence of mountain cryosphere run-off on coastal systems and sea level

The chapter is intended to provide a wide-ranging assessment of impacts and risks associated with cryosphere changes in high mountain areas. The scope of the chapter includes all mountain areas across the globe where snow, glaciers, or permafrost are important components, including coverage of tropical regions.

The first bullet recognizes that there are fundamental changes occurring in the mountain cryosphere that effect many of the impacts and risks addressed in the subsequent bullets. This bullet therefore addresses these fundamental drivers upfront, including observed and projected changes in glaciers, permafrost, and snow. Key overarching issues of data scarcity and uneven distribution of data in mountain regions are to be addressed. The group discussed the need for the chapter to address the potential release of CH<sub>4</sub> emissions from thawing permafrost in high mountain Asia. Other important feedback mechanisms that were identified included the role of black carbon and other aerosols in reducing surface albedo, and the effects of a changing cryosphere on monsoon.

The second bullet relates to flood and landslide (slides, rockfalls, avalanches, etc.) hazards resulting from or influenced by a changing mountain cryosphere. Floods include both glacial lake outburst floods, but also other flash floods or seasonal floods that could relate to rapid melting of snow and ice. The chapter is tasked with assessing the potential impact of such hazards on lives, livelihoods, transportation, infrastructure, and ecosystems. Management options were discussed within a framework of risk management and governance, and included community based adaptation options that draw on local and indigenous knowledge.

The third bullet is intended to cover those impacts which directly affect people living in the mountain regions. The example of snow cover was provided, as it was discussed how a change in snow cover could influence local farming practices. Equally, changes in glaciers or permafrost could also impact on food security, economic viability, settlements, and cultural identity. The adaptation options discussed by the group highlighted alternative livelihood strategies, migration, participatory adaptive planning, incl. engineering measures, promotion of ecotourism, financial and other support mechanisms.

The fourth bullet, by contrast, addresses those far-reaching impacts that affect downstream societies who depend on or get benefit from water resources emerging from the mountain cryosphere. Such downstream societies may use this water for consumption, and for sustaining ecosystems and agriculture. The need for a trans-boundary perspective to issues of water resource management was discussed.

The fifth bullet recognises the particular threat that changes in the high mountain cryosphere pose to the hydro-power sector. This relates to changes in the quantity, timing, and quality of runoff coming from the cryosphere. The group discussed how the relative importance of different runoff components (e.g, from glaciers, snow or even permafrost) will vary across different high mountain regions. The chapter will assess implications for national and international energy policy and issues of water governance.

The final bullet serves as input primarily for chapter 4, providing an assessment of the total runoff that will come from the mountain cryosphere and make its way to the ocean. The importance of freshwater runoff potentially changing coastal systems or influencing ocean circulation was also identified as a cross-chapter issue to be addressed (e.g., the influence of the Patagonian ice-cap contribution to ocean circulation).

Tropical mountain glaciers were noted as a particularly relevant theme for a case study, given the unique processes and impacts occurring in these regions.



### Chapter 3: Polar Regions

- Changes in atmospheric and ocean circulation that influence polar regions, including regional feedbacks and teleconnections and paleo perspectives
- Greenland and Antarctic ice sheets and ice shelves, Arctic glaciers, mass change, physics of dynamical instability and accelerated ice discharge; consequences for ocean circulation and biogeochemistry, and sea level
- Changing snow cover and thawing permafrost (terrestrial and subsea); carbon flux and climate feedbacks; impacts on infrastructure and ecosystems; community-based adaptation
- Changing sea ice; effects on climate; implications for ecosystems, coastal communities, transportation and industry
- Changing polar ocean (physical, dynamical and biogeochemical properties), implications for acidification, carbon uptake and release; impacts on ecosystems and fisheries; adaptation options (e.g., ecosystem-based management and habitat protection) and limits to adaptation
- Access to resources and ecological, institutional, social, economic, and cultural consequences of polar change, including issues of international cooperation
- Responses to enhance resilience

The main objective of the chapter is an integrated assessment in the polar regions across natural, social and human dimensions. Knowledge should be synthesized in a holistic manner related to biological and social vulnerability, considering adaptation options and limits.

The first bullet point recognizes the importance of understanding how the changes in the atmospheric and ocean circulation influence polar regions, and how changes in polar climate and regional feedbacks can affect climate at mid latitudes. Atmospheric changes are related to changes in air-sea fluxes and heat transport and redistribution, with implications for biogeochemical feedbacks (e.g., deoxygenation, acidification, dimethylsulphide). Teleconnections are important for regional processes including deep water formation and convection, and ice shelf ocean–sea ice interactions, with major implications for global ocean circulation. The participants discussed how information from past climates can provide knowledge relevant to key uncertainties in future projections, including potential irreversible changes.

The second bullet point addresses the climate-related responses of the Greenland and Antarctic ice sheets and ice shelves, and Arctic glaciers. Topics discussed included the components and drivers of mass balance and flow changes, temporal and spatial patterns of observed and projected changes, new process based understanding (e.g., submarine melt, iceberg calving, instability mechanisms), the detection of the onset of rapid ice sheet retreat and implications for sea level change, as an input for Chapter 4. Progress has been identified in recognising small-scale processes that drive overall large-scale processes.

The third bullet point is related to changing snow cover, snow on sea ice, drivers of changes in snow albedo (including aerosols and black carbon), and regional-specific firn processes in the snowpack that can affect sea level rise (e.g., capacity of Greenland firn to buffer runoff). The discussion included impacts of albedo and black carbon on terrestrial permafrost and the global implications through an assessment of knowledge on carbon feedbacks. Subsea permafrost was highlighted, including impacts of thawing on infrastructure, coastal erosion, ecosystems, health, and implications for community-based adaptation.

The fourth bullet point relates to the impacts of changing sea ice in a broad sense across biological-social-economic systems: implications for sea-ice ecosystems, coastal communities, indigenous people, transportation and industry, resource extraction, pollution, movement, hunting, fishing, changes in Arctic economy, with substantial differences between the Arctic and the Antarctic regions.

The fifth bullet point deals with changes in the polar oceans that are increasingly vulnerable to warming and ocean acidification, with resulting changes in physical, dynamical and biogeochemical properties (including irreversible impacts on carbon uptake, storage and release). The most substantial changes pertain to the impacts on ecosystems and fisheries, with potential loss of functional and structural components of the ecosystems and biodiversity. It was discussed that large uncertainties relate to the impacts of multiple stressors with potentially additive, non-linear effects and associated thresholds. Impacts related to the fisheries and shellfish industry were highlighted, given the regional and/or global economic consequences. Adaptation and its limits needs to be addressed on regional scales with a focus on ecosystem-based management and habitat protection, while considering governance frameworks.

The sixth bullet point focuses on the consequences of access to resources and their extraction in terms of ecological, institutional, social, economic, and cultural aspects. Addressing issues such as associated ecosystem damages (e.g., from deep sea bed mining) through governance frameworks and collaboration on national and international levels was considered.

The seventh bullet point is cross-cutting (cross-chapter) and interdisciplinary in trying to identify responses to enhance resilience in the polar regions, related to either biological, ecological or social resilience.

Several themes for case studies were proposed, including relocation of communities as a consequence of thawing permafrost and coastal erosion; glaciers and/or ice sheets in Greenland or at Pine Island and Thwaites in Antarctica; assessment of the co-production of knowledge concerning sea ice; territorial claims and national boundaries.

#### **Chapter 4: Sea Level Rise and Implications for Coasts and Communities**

- Observations and projections of sea level at global and regional scale, attribution to drivers, factors that influence relative sea level change, and long-term commitment and paleo perspective
- Demographic and socio-economic factors that drive vulnerability and exposure to sea level rise
- Current and future sea level rise risks resulting in biophysical, ecological, economic, political, cultural, social and psychological impacts
- Implications of sea level rise for highly vulnerable coastal zones, particularly SIDS, coastal cities and infrastructure, deltas and low-elevation areas
- Pathways to resilience and sustainable development: measures, safety margins, barriers and enablers

This chapter is aimed at an integrative assessment of new findings (since AR5) on the effect of global and regional sea-level changes on human and natural systems. New knowledge including the synthetic understanding of drivers, impacts, and adaptation. Moreover, the chapter needs to consider the different geographic and time scales of sea-level change, impacts, and adaptation challenges.

The first bullet refers to new developments on global, regional and relative sea level change, including the discussion of issues such as subsidence/glacial isostatic adjustment, committed change, natural variability, uncertainties, rapid/abrupt change (e.g., due to the collapse of ice sheets), regional variations, anthropogenic drivers, past sea level changes / paleo-evidence, and attribution.

The second bullet encompasses demographic and socio-economic processes that drive vulnerability and exposure to sea level rise and amplify risk (e.g., land use changes, tourism, settlement/ urbanisation, ports/trade). Social settlement patterns should be described as a key process in the human system influencing vulnerability and impacts of sea level change. Moreover, this bullet refers to feedbacks, such as “coastal squeeze” and implications for the hinterland, and cascading effects, involving, e.g., changing coastlines, the spread of diseases, impacts on biodiversity, poverty and inequality.

The third bullet focuses on the various dimensions of impacts observed and future risks, encompassing biophysical (e.g., frequency and intensity of storm surges and peak tides, coastal erosion, coastal flooding, water supply, saline intrusion); ecological (e.g., mangroves, saltmarshes, biodiversity); economic (e.g., tourism, trade, livelihoods, food security); infrastructural (e.g., coastal protection, energy, ports, and transportation); political (e.g., changes to and loss of territory, security); cultural, social, and psychological (e.g., impacts on communities, health, poverty, migration, relocation).

The fourth bullet specifically addresses observed and future risks affecting highly vulnerable coastal zones, particularly SIDS, low-elevation areas, deltas, coastal cities, the built environment and infrastructure. The bullet considers biophysical, ecological, social, and economic dimensions, and including case studies.

The last bullet refers to adaptation options and interventions (i.e., protect, accommodate, retreat), including a discussion of alternative response strategies, involved barriers, enablers, capacities for resilience and sustainable development (e.g., data and information, institutional, economic, cultural, social, technological, financial), pathways to resilience (e.g., coastal zone management, safety margins, costs, lock-in, flexibility), linking Climate Change to Disaster Risk Management and Sustainable Development Goals.

## **Chapter 5: Changing Ocean, Marine Ecosystems, and Dependent Communities**

- Changes in key physical and biogeochemical properties and processes, including the deep ocean, their feedbacks on the climate system
- Specific and combined effects of changes in climate related variables (e.g., warming, acidification, and oxygen loss) on e.g., species distribution and exclusion, habitat compression, food webs
- Impacts of ecosystem changes on key ecosystem services (e.g., carbon uptake, biodiversity, coastal protection, food security and tourism)
- Degradation in benthic habitat (e.g., storm-driven) and improved resilience through conservation and restoration
- Interactions of climate and non-climatic drivers (e.g., pollution, fishing practices, resource extraction, habitat changes); impacts on marine environments, ecosystems, and human health
- Blue carbon, nature-based solutions, and ocean implications of different mitigation measures
- Climate change impacts and trade-offs in ocean economies and governance across all scales
- Adaptation options for marine ecosystem dependent communities and their livelihoods

The first bullet refers to past, current and possible future changes in marine physical and biogeochemical processes and properties, within the context of anthropogenic emissions of greenhouse gases and consequences for marine ecosystems. Warming, freshening/salinification, deoxygenation and acidification were identified as key climatic stressors. Salinity was noted to be particularly relevant in the context of cryospheric change, linking to Chapter 3, being influenced by freshwater inputs from sea and land ice melt. Participants highlighted the role of salinity and temperature in controlling ocean stratification and resulting effects on surface nutrient concentrations and marine ecosystems (e.g., warming reducing mixing/upwelling through enhanced stratification, resulting in decline in surface nutrients and primary productivity). Participants stressed consideration of deep sea environments and habitats (e.g., low oxygen areas), in addition to those in surface waters. The importance of considering modes of climate variability (e.g., Pacific Decadal Oscillation, North Atlantic Oscillation) was also noted. Finally, the bullet also makes explicit reference to ocean feedbacks on the climate system, such as those related to the ocean's role in heat and carbon uptake.

The second bullet considers how change in the key physical and biogeochemical processes and parameters referenced in the first bullet can, singularly and in tandem, affect marine organisms and ecosystems. Types of impacts highlighted included disruption of organismal physiology, alteration of species abundances, compositions and distributions (laterally and vertically), modification of harmful algal blooms, propagation of invasive species and marine diseases, and development of novel food webs. Participants highlighted that insight into future changes may come from knowledge of past climate events (e.g., acidification events from the geological history), along with recent developments in marine biogeochemical modelling. Several ecosystems and regions were identified being particularly vulnerable to climate change including sea ice and deep sea ecosystems, mangroves, coral reefs (warm and cold) and deltas.

The third bullet refers to how the impacts on marine organisms and ecosystems considered in the second bullet can affect related ecosystem services. Types of ecosystem services highlighted in this context included provisional (e.g., fisheries) and regulatory (e.g., heat and carbon uptake, coastal protection). An example would be sea level rise causing salinization of coastal and estuarine systems, with resulting implications for coastal protection. Fisheries (both catch and aquaculture) were noted to be a key ecosystem service (affecting food security), and one potentially vulnerable to climate change through impacts on species and primary productivity, among other mechanisms.

The fourth bullet concerns degradation of coastal and deep ocean benthic habitats in the context of climate change (e.g., increased storm intensity driving loss of benthic species, with resulting implications for coastal protection). An example provided for the deep ocean was warming and organic matter increase leading to oxygen decline and habitat loss, and resulting consequences for fisheries. Participants highlighted ecosystem conservation (e.g., abatement of nutrient pollution to reduce eutrophication) and habitat restoration (e.g., of mangrove swamps) as examples of response strategies for increasing resilience.

The fifth bullet concerns the broader context of human impacts on the marine environment into which climatic stressors fit. Human activities noted in this regard included fisheries and aquaculture, marine transportation, resource extraction (e.g., oil, gas, mineral) and marine renewable energy. Participants highlighted chemical and noise pollution and overfishing as examples of impacts that can result from these activities. The bullet point recognises that interactions between such non-climatic stressors and those from climate change can result in synergistic effects, different from those that would result if only the climatic stressors operated in isolation.

The sixth bullet refers to strategies for enhancing the carbon storage capabilities of marine ecosystems (i.e., 'blue carbon') through conservation and restoration measures. Carbon-rich coastal ecosystems are a particular focus of such mitigation methods (e.g., mangroves, saltmarshes and seagrasses). The bullet also more generally considers the effects that these so-called 'nature-based solutions' and other (e.g., non-marine) mitigation strategies can have on the marine environment.

The seventh bullet references the challenge of managing climatic risks (and benefits) to marine ecosystems in light of their trans-boundary nature (e.g., coastal to open ocean) and possible presence of multiple-stressors. Several governance frameworks spanning a range of scales were identified by participants in this context, including coastal zone management, marine spatial planning, and the UN Sustainable Development Goals. Participants noted that trade-offs can exist between marine economic activities and strategies to enhance resilience to climate change (e.g., trade-offs between marine protected areas and fishing activities).

The final bullet addresses possible response strategies that communities dependent upon marine ecosystem services (e.g., through food security and livelihoods) can take to enhance their resilience to climate change. Such strategies were noted to range from short-term preventative measures to more in-depth transformational change actions. Examples provided included amelioration of existing non-climatic stressors (e.g., abatement of nutrient pollution to reduce eutrophication, use of sustainable fishing and aquaculture practices), real-time monitoring of physical and biogeochemical properties, education and capacity building. The importance of considering social, economic and cultural elements in adaptation planning was also noted, including use of relevant indigenous knowledge where available (e.g., from SIDS and Arctic communities).

Case studies were proposed on several regions/communities, including regional marginal seas; eastern boundary upwelling regions; deep ocean; deltas; blue belts; mangroves; coral reefs; and SIDS.

## **Chapter 6: Extremes, Abrupt Changes and Managing Risks**

- Risks of abrupt change in ocean circulation and cryosphere and potential consequences
- Extreme ENSO events and other modes of variability and their implications
- Marine heat waves and implications
- Changes in tracks, intensity, and frequency of tropical storms and associated wave height
- Cascading risks, irreversibility, and tipping points
- Monitoring systems for extremes, early warning and forecasting systems in the context of climate change
- Risk management, including disaster risk reduction and enhancing resilience

The rationale for this chapter is that while certain classes of marine and cryospheric extreme and abrupt change events could logically be integrated elsewhere within the report, several cannot due to their inherently cross-cutting nature. Types of events fitting this category include those cross-cutting across multiple aspects, including drivers, polar regions, impacts (e.g., related to meridional ocean overturning circulation processes), and those with implications of broader scope than could adequately be addressed elsewhere (e.g., marine heat waves). A dedicated chapter was thus seen as allowing for more holistic and synergistic coverage of such events, spanning the common chapter narrative from key processes and feedbacks to impacts and responses. Meeting discussions touched upon the broad-range of impacts of recent marine and cryospheric extremes on human and natural systems, and how risks from abrupt changes may be particularly challenging to manage in comparison to those from more gradual shifts.

The first bullet pertains to possible rapid transitions in the ocean overturning circulation and, in addition, abrupt shifts in components of the cryosphere. Abrupt change in the Atlantic Meridional Overturning Circulation (AMOC) was discussed, including beyond 2100, with relevant monitoring networks and early warning systems highlighted. Participants noted a broad range of potential impacts from abrupt changes in AMOC including alteration in the uptake and distribution of ocean heat and carbon. Various types of cryospheric abrupt changes were discussed including rapid sea ice retreat, abrupt releases of CH<sub>4</sub> and CO<sub>2</sub> from permafrost/hydrates and collapse of the WAIS. Each was recognized as an important cross-cutting theme requiring coordination with other chapters, particularly with Chapters 3 and 4.

The second bullet concerns extremes in modes of atmosphere-ocean variability such as the El Niño Southern Oscillation (ENSO), Tropical Atlantic Variability and the Indian Ocean Dipole. Participants discussed information from paleoclimate archives as well as recent examples of extreme ENSO events, including the 2015/2016 El Niño. It was noted that such extremes can have broad-ranging, wide-scale impacts, with effects upon tropical cyclones, heatwaves, floods, droughts, forest fires, disease, and marine ecosystems such as coral reefs, and implications for fisheries and agriculture. Examples of possible response strategies included enhancement of water storage, use of desalinization, prevention of forest clearing, modification of agricultural practices and disease prevention.

The third bullet refers to marine heatwaves – episodes of unusual ocean warmth that are the subject of an emerging field of literature since AR5 and SREX. Like extremes in atmosphere-ocean modes, these were recognized as potentially having wide-ranging consequences, including impacts upon marine ecosystems, fisheries, and human health. Participants highlighted the recent heatwave-related marine ecosystem regime shift in Western Australia, impacts upon fisheries from the so-called North Pacific ‘warm blob’, and human health effects from *vibrio* outbreaks in the Baltic Sea. Although a cold rather than a warm extreme, the so-called North Atlantic ‘cold blob’ was also identified as a relevant topic.

The fourth bullet relates to the influence of climate change on key characteristics of tropical cyclones. These form and evolve through complex coupled atmosphere-ocean interactions, with potential influence from atmospheric teleconnections (e.g., El Niño); processes largely beyond the scope of other chapters. Corresponding impacts discussed included disruption of marine economic activities (e.g., shipping) and coastal inundation. The recent 2013–2015 record-setting tropical cyclone seasons in the Pacific were highlighted as a strong candidate for a case study.

The fifth bullet references cascading risks resulting from so-called compound extreme events (e.g., storm surges superimposed on sea level rise and resulting implications for flooding and coastal inundation). Phenomena within this theme include ice sheet instabilities, complete loss of sea ice and glaciers, and stability of the AMOC. This bullet also highlights the theme of irreversibility and tipping points, a subject that was not explicitly mentioned in the context of the other chapters.

The sixth bullet concerns the importance of monitoring and forecasting systems within the context of risk management of ocean and cryosphere extremes influenced by climate change. Participants noted the need to assess the state of existing monitoring systems, including gaps, as well as current forecasting, preparation and risk management capabilities. Predictability of abrupt events was noted as a key challenge, particularly early warning within the context of transitions between states. It was suggested the chapter be explicit about current limits to knowledge, making clear what can and cannot be said from the literature about abrupt changes, tipping points and irreversibility.

The final bullet emphasizes the expressed desire of combining output from the Physical Sciences with knowledge from Disaster Risk Reduction/Management in the context of managing risks from marine/cryosphere extremes/abrupt changes, including dealing with compounding effects and compounding risks. Discussions recognized that response and recovery can involve multiple scales of governance (e.g., community-level, national, international), with the recently adopted Sendai Framework for Disaster Risk Reduction highlighted as important example of intergovernmental cooperation. The importance of considering event duration was also stressed, with time-scales noted to vary widely both within and between different event types (months to seasons in the case of ENSO).

### **Cross-Chapter Box: Low Lying Islands and Coasts**

- Key climate drivers and changes relevant for low lying islands and low lying coastal areas
- Impacts and cascading risks of climate driven changes (e.g., sea level rise, ocean circulation, extreme events), interacting with other drivers, on habitability, infrastructure, communities, livelihoods, loss of lives and assets and territories, infrastructure, ecosystems, coral reefs, access to resources, and on institutional, social, economic, and cultural aspects
- Resilience pathways and adaptation options and their limits to address these changes

The cross-chapter box will benefit from a wide range of expertise drawn from across the report author teams to provide a summary of key assessment findings relating to Low Lying Islands and Coasts. The authors will require a clear and workable definition of *Low Lying Coasts*, to ensure the geographical scope of the box does not become too wide.

The first bullet will summarize the key climate drivers and changes that lead to impacts and risks for low lying islands and coastal areas. This is also intended as an opportunity to identify specific knowledge gaps or challenges that may hinder scientific understanding of these drivers.

The second bullet recognizes the wide-ranging impacts and risks faced by low lying Islands and Coasts, with emphasis given to cascading risks.

Lastly, adaptation options and pathways to a sustainable and resilient future will be summarized under the final bullet. Locally managed adaptation was highlighted, including, e.g., the use of risk planning tools by local communities. The box will consider key knowledge requirements to inform such adaptation options, and will summarize limits to adaptation that are evident in highly vulnerable environments.

## **8. TIME SCHEDULE**

A call for the nominations of experts to serve as Coordinating Lead Authors, Lead Authors and Review Editors will be issued in early April 2016, immediately following the 45th Session of the IPCC. Approval and acceptance of the Special Report is planned for the 51st Session of the IPCC in September 2019. In order to achieve this, the timetable for the Special Report is as follows:

<b>2017</b>	
7 April – 12 May	Call for author nominations
30 June	Selection of authors
2–6 October	First Lead Authors Meeting
<b>2018</b>	
12–16 February	Second Lead Authors Meeting
4 May – 29 June	Expert Review of the First Order Draft
23–28 July	Third Lead Authors Meeting
16 November – 11 January	Expert and Government Review of the Second Order Draft
<b>2019</b>	
25 February – 2 March	Fourth Lead Authors Meeting
14 June – 9 August	Final Government Distribution of the Final Draft and Final Government Review of the Summary for Policymakers
23–27 September	IPCC approval of the Summary for Policymakers and acceptance of the Special Report



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## SCOPING MEETING PROGRAMME

Tuesday, 6 December 2016

<b>08:00</b>	<b>Registration</b> (Atrium)
<b>OPENING CEREMONY</b> (Plenary Room)	
<b>09:00</b>	<b>Welcome and Opening [Chair: Ko Barrett]</b> <b>Welcome Remarks:</b> ♦ <i>Mr Hoesung Lee, IPCC Chair</i> ♦ <i>HSH Prince Albert II of Monaco</i>
<b>10:00</b>	<b>Break</b> (Atrium)
<b>PLENARY SESSION I</b> (Plenary Room) [Chair: Zhai Panmao]	
<b>10:30</b>	<i>The IPCC Scoping Process</i> (Abdalah Mokssit)
<b>10:40</b>	<i>Introductory Presentation</i> (Ko Barrett)
<b>10:55</b>	<i>Sea Level Rise, Flooding and Coastal Impacts</i> (Roderik van de Wal & Bruce Glavovic)
<b>11:20</b>	<i>Melting Ice, including Terrestrial Glaciers &amp; Impacts, Risks, and Adaptation in Indigenous Populations</i> (Regine Hock & Ben Orlove )
<b>11:45</b>	<i>Ocean and Cryosphere Changes &amp; Ecosystem Impacts</i> (Vladimir Kattsov & Ove Hoegh-Guldberg)
<b>12:10</b>	<i>Introduction to Breakout Group Session I</i> (Ko Barrett)
<b>12:30</b>	<b>Lunch Buffet</b> (Novotel Restaurant)
<b>BREAKOUT GROUP SESSION I ON BRAINSTORMING</b>	
<b>14:00</b>	<b>Breakout Groups:</b> BOGI-1 (BOG Room 1) [Chair: Valérie Masson-Delmotte; Rapporteur: Manuel Barange] BOGI-2 (BOG Room 2) [Chair: Debra Roberts; Rapporteur: Nathan Bindoff] BOGI-3 (BOG Room 3) [Chair: Eduardo Calvo; Rapporteur: Ayako Abe-Ouchi] BOGI-4 (BOG Room 4) [Chair: Greg Flato; Rapporteur: Nathalie Hilmi] BOGI-5 (BOG Room 5) [Chair: Andreas Fischlin; Rapporteur: Phil Williamson] BOGI-6 (BOG Room 6) [Chair: Zhai Panmao; Rapporteur: Alessandra Sgobbi]
<b>16:00</b>	<b>Break</b> (Atrium)

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**STOCKTAKING SESSION I (Plenary Room) [Chair: Hans-Otto Pörtner]**

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**16:30 Reports from Breakout Groups** [5 min presentations with one ppt slide each]

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**17:00 General Discussion on Distilling Themes**

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**18:00 Adjourn**

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**18:30 Welcome Reception** (Novotel)  
*Sponsored by the Government of Monaco and Prince Albert II of Monaco Foundation*

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**Wednesday, 7 December 2016**

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**PLENARY SESSION II (Plenary Room) [Chair: Debra Roberts]**

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**08:30 Ocean Carbon Cycle, Fisheries, Economics/Governance, Adaptation of Coastal Areas**  
(Nicolas Gruber, William Cheung, Antonina Ivanova Boncheva, Elisabeth Holland)

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**09:20 Introduction to Breakout Group Session II** (Ko Barrett)

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**BREAKOUT GROUP SESSION II ON THEMES**

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**09:45 Breakout Groups**

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**11:00 Break** (Atrium)

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**11:30 Breakout Groups Continued**

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**13:00 Lunch Buffet** (Novotel Restaurant)

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**STOCKTAKING SESSION II (Plenary Room) [Chair: Valérie Masson-Delmotte]**

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**14:30 Reports from Breakout Groups**

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**15:30 Break** (Atrium)

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**STOCKTAKING SESSION II CONTINUED**

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**16:00 Plenary Discussion of Emerging Outline**

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**17:15 Adjourn**

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**18:00 Excursion and Conference Dinner at the Oceanographic Museum of Monaco**  
*Sponsored by the Government of Monaco and Prince Albert II of Monaco Foundation* [Bus transfer to venue departs at 17:45]

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**Thursday, 8 December 2016**

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**PLENARY SESSION III (Plenary Room) [Chair: Edwin Aldrian]**

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**09:00 Introduction to Breakout Group Session III** (Ko Barrett)

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**BREAKOUT GROUP SESSION III ON CHAPTERS**

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**09:30 Breakout Groups**

**10:45 Break** (Atrium)

**11:00 Breakout Groups Continued**

**13:00 Lunch Buffet** (Novotel Restaurant)

**STOCKTAKING SESSION III** (Plenary Room) [Chair: Sergey Semenov]

**14:30 Reports from Breakout Groups**

**16:00 Break** (Atrium)

**PLENARY SESSION IV** (Plenary Room) [Co-Chairs: Ko Barrett and Thelma Krug]

**16:30 Development of the Outline**

**18:30 Adjourn**

**19:00 Monégasque Buffet Dinner** (Novotel Restaurant)  
*Sponsored by the Government of Monaco and Prince Albert II of Monaco Foundation*

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**Friday, 9 December 2016**

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**SYNTHESIS PLENARY** (Plenary Room) [Co-Chairs: Ko Barrett and Youba Sokona]

**08:30 Finalization of the Outline**

**10:30 BREAK** (Atrium)

**SYNTHESIS PLENARY CONTINUED**

**11:00 Discussion on Structural Issues**

**12:50 Closing Remarks**

**13:00 End of Scoping Meeting**

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## **SCOPING MEETING PROPOSED OUTLINE OF CHAPTERS**

Title:

**IPCC Special Report on the Ocean and Cryosphere in a Changing Climate**

**Summary for Policymakers (~10 pages)**

**Chapter 1: Framing and Context of the Report (~15 pages)**

- Integrated storyline of the report, chapter narrative, chapter sequence and their linkages (including coverage of extremes and abrupt change and irreversible changes)
- Definition of ocean and cryosphere and their components
- Observing capacities, progress and limitations (e.g., time series and spatial coverage)
- Assessment methodologies, including indigenous and community knowledge, risk, and applications of detection and attribution
- Role of ocean and cryosphere in the climate system, including characteristics, key feedbacks and time scales
- Implications of ocean and cryosphere change for resources, natural systems (e.g., loss of habitat, extinctions) and human systems (e.g., psychological, social, political, cultural and economic aspects)
- Linkages of this report to relevant institutional and policy contexts (e.g., Paris Agreement and SDGs, Sendai Framework)
- Treatment of vulnerabilities and marginalized areas and people (e.g., gender) in this report
- Scenarios and time frames considered in this report
- Treatment of uncertainty

**Chapter 2: High Mountain Areas (~20 pages)**

- Common drivers for changes in mountain cryosphere (glaciers, permafrost, and snow, including tropical regions) and feedbacks (e.g., CH<sub>4</sub> emissions, albedo) to regional and global climate
- Effects of a changing mountain cryosphere on natural hazards and management options for protecting lives, livelihoods, infrastructure, and ecosystems
- Impacts from changes in the mountain environment (e.g., snow cover) on habitability, community livelihoods and culture, and adaptation options
- Risks for societies that depend on mountain cryosphere for water resources (e.g., human consumption, ecosystems and agriculture) and potential response strategies (e.g., national and international water resource management and technologies)
- Impacts of variability and trends in water supply on hydropower production and implications for energy policy and water governance
- Influence of mountain cryosphere run-off on coastal systems and sea level



### **Chapter 3: Polar Regions (~50 pages)**

- Changes in atmospheric and ocean circulation that influence polar regions, including regional feedbacks and teleconnections and paleo perspectives
- Greenland and Antarctic ice sheets and ice shelves, Arctic glaciers, mass change, physics of dynamical instability and accelerated ice discharge; consequences for ocean circulation and biogeochemistry, and sea level
- Changing snow cover and thawing permafrost (terrestrial and subsea); carbon flux and climate feedbacks; impacts on infrastructure and ecosystems; community-based adaptation
- Changing sea ice; effects on climate; implications for ecosystems, coastal communities, transportation and industry
- Changing polar ocean (physical, dynamical and biogeochemical properties), implications for acidification, carbon uptake and release; impacts on ecosystems and fisheries; adaptation options (e.g., ecosystem-based management and habitat protection) and limits to adaptation
- Access to resources and ecological, institutional, social, economic, and cultural consequences of polar change, including issues of international cooperation
- Responses to enhance resilience

### **Chapter 4: Sea Level Rise and Implications for Coasts and Communities (~50 pages)**

- Observations and projections of sea level at global and regional scale, attribution to drivers, factors that influence relative sea level change, and long-term commitment and paleo perspective
- Demographic and socio-economic factors that drive vulnerability and exposure to sea level rise
- Current and future sea level rise risks resulting in biophysical, ecological, economic, political, cultural, social and psychological impacts
- Implications of sea level rise for highly vulnerable coastal zones, particularly SIDS, coastal cities and infrastructure, deltas and low-elevation areas
- Pathways to resilience and sustainable development: measures, safety margins, barriers and enablers

### **Chapter 5: Changing Ocean, Marine Ecosystems, and Dependent Communities (~65 pages)**

- Changes in key physical and biogeochemical properties and processes, including the deep ocean, their feedbacks on the climate system
- Specific and combined effects of changes in climate related variables (e.g., warming, acidification, and oxygen loss) on e.g., species distribution and exclusion, habitat compression, food webs
- Impacts of ecosystem changes on key ecosystem services (e.g., carbon uptake, biodiversity, coastal protection, food security and tourism)
- Degradation in benthic habitat (e.g., storm-driven) and improved resilience through conservation and restoration
- Interactions of climate and non-climatic drivers (e.g., pollution, fishing practices, resource extraction, habitat changes); impacts on marine environments, ecosystems, and human health
- Blue carbon, nature-based solutions, and ocean implications of different mitigation measures
- Climate change impacts and trade-offs in ocean economies and governance across all scales
- Adaptation options for marine ecosystem dependent communities and their livelihoods

## **Chapter 6: Extremes, Abrupt Changes and Managing Risks (~20 pages)**

- Risks of abrupt change in ocean circulation and cryosphere and potential consequences
- Extreme ENSO events and other modes of variability and their implications
- Marine heat waves and implications
- Changes in tracks, intensity, and frequency of tropical storms and associated wave height
- Cascading risks, irreversibility, and tipping points
- Monitoring systems for extremes, early warning and forecasting systems in the context of climate change
- Risk management, including disaster risk reduction and enhancing resilience

## **Case Studies, Frequently Asked Questions and Boxes (~20 pages)**

### **Cross-Chapter Box: Low Lying Islands and Coasts (*up to 5 pages*)**

- Key climate drivers and changes relevant for low lying islands and low lying coastal areas
- Impacts and cascading risks of climate driven changes (e.g., sea level rise, ocean circulation, extreme events), interacting with other drivers, on habitability, infrastructure, communities, livelihoods, loss of lives and assets and territories, infrastructure, ecosystems, coral reefs, access to resources, and on institutional, social, economic, and cultural aspects
- Resilience pathways and adaptation options and their limits to address these changes