Framework Convention on
Climate Change

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Synthesis report for the technical assessment component of the first global stocktake

State of adaptation efforts, experiences and priorities

Prepared by the secretariat under the guidance of the co-facilitators of the technical dialogue of the first global stocktake

Contents

I. Introduction

A. Mandate

1. The CMA requested the secretariat, under the guidance of the co-facilitators of the technical dialogue,[1] to prepare for the technical assessment of the global stocktake a synthesis report on the state of adaptation efforts, experiences and priorities, summarizing the most recent information in the identified sources.[2] The CMA stipulated that the sources of input for the global stocktake will consider information at a collective level on the state of adaptation efforts, support, experience and priorities, including the information referred to in Article 7, paragraphs 2,[3] 10,[4] 11[5] and 14,[6] of the Paris Agreement, and the reports referred to in Article 13, paragraph 8,[7] of the Paris Agreement.[8]

2. The CMA also requested the secretariat to include in the synthesis report:[9]

(a) Information on the adaptation efforts of developing country Parties, in order to facilitate recognition of such efforts in the global stocktake, drawing on, inter alia, the most recent documents that may contain adaptation information, which may include adaptation communications, NAPs, NCs, NDCs, other relevant reports prepared under the transparency framework, and reports of the IPCC and other relevant scientific bodies (see para. 9 below);

(b) An assessment of the support needs for adaptation of developing country Parties drawing on, inter alia, the most recent documents that may contain adaptation information, which may include adaptation communications, NAPs, NCs, NDCs, other relevant reports prepared under the transparency framework, reports of the IPCC and other relevant scientific bodies, and the report on the determination of the needs of developing country Parties related to implementing the Convention and the Paris Agreement.[10]

B. Adaptation-specific aims of the global stocktake

3. While the provisions referred to in paragraphs 1–2 above define the mandate for this synthesis report, the Paris Agreement and the CMA also define adaptation-specific functions for the global stocktake.

4. Article 14, paragraph 1, of the Paris Agreement stipulates that the CMA shall periodically take stock of the implementation of the Paris Agreement to assess the collective progress towards achieving its purpose and its long-term goals, including the global goal on adaptation established in Article 7, paragraph 1, of the Paris Agreement.[11] The stocktake is

[1] See decision 19/CMA.1, para. 6(c).

[2] Decision 19/CMA.1, para. 23(b).

[3] Parties recognize that adaptation is a global challenge faced by all with local, subnational, national, regional and international dimensions, and that it is a key component of and makes a contribution to the long-term global response to climate change to protect people, livelihoods and ecosystems, taking into account the urgent and immediate needs of those developing country Parties that are particularly vulnerable to the adverse effects of climate change.

[4] Each Party should, as appropriate, submit and update periodically an adaptation communication, which may include its priorities, implementation and support needs, plans and actions, without creating any additional burden for developing country Parties.

[5] The adaptation communication referred to in paragraph 10 of this Article shall be, as appropriate, submitted and updated periodically, as a component of or in conjunction with other communications or documents, including a NAP, an NDC as referred to in Article 4, paragraph 2, and/or an NC.

[6] See paragraph 5 below for the provisions of Article 7, paragraph 14, of the Paris Agreement.

[7] Each Party should also provide information related to climate change impacts and adaptation under Article 7, as appropriate.

[8] Decision 19/CMA.1, para. 36(c).

[9] Decision 11/CMA.1, paras. 9 and 31.

[10] Referred to in decision 4/CP.24, para. 13.

[11] This Article establishes the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable

to be conducted in a comprehensive and facilitative manner, considering, inter alia, adaptation in the light of equity and the best available science.

5. Further adaptation-specific provisions for the global stocktake are in Article 7, paragraph 14, of the Paris Agreement, which stipulates that the stocktake shall, inter alia:

(a) Recognize the adaptation efforts of developing country Parties;

(b) Enhance the implementation of adaptation action taking into account the adaptation communication referred to in Article 7, paragraph 10, of the Paris Agreement;[12]

(c) Review the adequacy and effectiveness of adaptation and support provided for adaptation; and

(d) Review the overall progress made in achieving the global goal on adaptation referred to in Article 7, paragraph 1, of the Paris Agreement.

C. Adaptation-related guiding questions for the global stocktake

6. Further to the adaptation-specific aims of the global stocktake outlined in paragraphs 4–5 above, the CMA requested the Chairs of the subsidiary bodies to develop guiding questions for all components of the global stocktake.[13] On 15 September 2021, the Chairs made available questions for the information collection and preparation component of the stocktake, and on 18 February 2022, for the technical assessment component. The adaptation-related questions are contained in the annex to this report.

D. Approach to the report

7. This report responds to the mandates outlined in paragraphs 1–2 above, and, in doing so, provides information that aims to facilitate (1) undertaking of the adaptation-related functions of the global stocktake presented in paragraphs 4–5 above and (2) answering of the guiding questions referred to in paragraph 6 above and presented in the annex.

8. To achieve these overall aims, information from two main sources:

(a) National reports of Parties to the UNFCCC, which included 40 adaptation communications, 151 NDCs, 196 NCs and 34 NAPs;

(b) Scientific reports, and other relevant reports prepared under and outside the UNFCCC process.

9. The preparation of the report was guided by the following principles:

(a) The report should present information relevant to the adaptation-related functions of the global stocktake and the guiding questions presented by the Chairs of the subsidiary bodies, with the understanding that the evaluation of the information will be undertaken by the global stocktake. This report is thus intended as an input to, not as a conclusion of, the consideration of adaptation during the global stocktake;

(b) The report should focus on the aspects of the available information considered most pertinent to its mandate, the adaptation-related functions of the global stocktake and the guiding questions, bearing in mind that a single report cannot fully synthesize all the available information;

(c) The report, when considering specific topics, should direct readers to relevant information in other sources, in particular other global stocktake synthesis reports prepared by the secretariat and reports of UNFCCC constituted bodies, rather than duplicating information from those sources;

development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2. The global goal on adaptation is considered in chap. III below.

[12] See footnote 4 above.

[13] Decision 19/CMA.1, para. 7.

(d) The report, in covering issues on which work is being undertaken under the Convention,[14] should provide general information on the state of such work and orient readers to relevant information, while providing additional information where possible, in order to avoid duplicating information or prejudging ongoing work;

(e) The report, being part of a larger body of information prepared for the global stocktake and having the intention of being read in conjunction with other reports and inputs, should highlight specific linkages with other reports and inputs. In this context, the following section provides an overview of the key linkages of this report with other synthesis reports prepared for the global stocktake.

10. Considering the state of adaptation efforts, support, experiences and priorities collectively involves understanding, in particular, the global dimensions of key climate risks, the assumptions that Parties are making collectively about those risks, the approaches they are adopting to respond, the limitations they face and the support they need. This report aims to provide an overview of key information related to such questions.

11. While there are no globally agreed criteria for characterizing the state of adaptation efforts, experiences and priorities, this report aims to articulate initial parameters for such characterization, which can be further developed based on inputs and discussions among Parties, and further analysis. This report seeks, in particular in its chapter IV, to describe how national adaptation efforts are corresponding to the main global and regional climate risks and adaptation options outlined by the IPCC, both in terms of the assumptions that Parties make about those risks, as well as the types of adaptation efforts they intend to undertake.

12. To this end, the information in chapter IV was prepared through two key steps:

(a) Review of the key scientific findings and projections on ten global climate risks identified by the IPCC (2018), as well as the adaptation options for those risks;

(b) Synthesize information from latest national reports submitted to the UNFCCC on the assumptions, projections, and adaptation efforts related to the ten global climate risks, with the aim of outlining possible convergencies or differences between the scientific information and the national reports;

13. In addition, this report assembles information from national reports and other sources in relation to the global goal on adaptation, the recognition of adaptation efforts of developing countries, the adequacy and effectiveness of adaptation and support, as well as equity, fairness and ambition in relation to adaptation.

1. Overview of adaptation-related synthesis reports for the global stocktake

14. This report is one of several adaptation-related reports prepared for the first global stocktake. As mentioned in paragraph A.1 above, this report summarizes the most recent information identified in decision 19/CMA.1, paragraph 36(c). In paragraph 24 of that same decision, the CMA invited relevant constituted bodies and forums and other institutional arrangements under or serving the Paris Agreement and/or Convention to prepare for the technical assessment synthesis reports on the information identified in paragraph 36 in their areas of expertise. Synthesis reports prepared by the following three constituted bodies contain information identified in paragraph 36(c): the AC, the LEG and the Executive Committee of the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts.[15] In contrast to this report, those reports analyse different primary sources and emphasize different adaptation-related topics. As such, the four reports complement one another in providing an overview of the state of adaptation efforts, support, experiences and priorities. Figure 1 shows the different perspectives provided by each of the four reports.

[14] For example, this includes work related to the global goal on adaptation, reviewing the adequacy and effectiveness of adaptation and support provided for adaptation, recognizing the adaptation efforts of developing country Parties, and various aspects of support.

[15] The report prepared by the Executive Committee of the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts also summarizes information identified in decision 19/CMA.1, para. 36(e).

15. Information related to adaptation also features in other synthesis reports prepared by the secretariat for the global stocktake, including a synthesis report that focuses on the overall effect of NDCs communicated by Parties[16] and one that focuses on finance flows.[17] Similarly, reports prepared by other constituted bodies – including the Consultative Group of Experts, the Facilitative Working Group of the Local Communities and Indigenous Peoples Platform, the Paris Committee on Capacity-Building and the Technology Executive Committee – also contain relevant information on adaptation.

16. Taken together, the synthesis reports prepared by the secretariat and the constituted bodies provide an in-depth exploration of various dimensions of adaptation.

[16] Decision 19/CMA.1, para. 23(c).
[17] Decision 19/CMA.1, para. 23(d).

Figure 1

Overview of adaptation-related synthesis reports prepared for the global stocktake

2. Structure of the report

17. This report is structured as follows:

(a) Chapter II provides key messages of the report based on the chapters that follow;

(b) Chapter III describes adaptation as a global challenge with various spatial scales, in order to elaborate how adaptation can be understood as a collective endeavour and to provide essential context for this report. It also presents information on the global goal on adaptation, ongoing and future work related to it, and findings to date;

(c) Chapter IV describes the observed and anticipated global climate risks identified by scientific reports, and the adaptation efforts, experiences and priorities vis-à-vis those risks, as identified by Parties in their national reports. Where possible, information on risks reflects the temperature limits of the Paris Agreement and projected temperature increases resulting from the levels of mitigation ambition;

(d) Chapter V provides an overview of the collective state of adaptation efforts, experience and priorities of developing countries to facilitate their recognition;

(e) Chapter VII provides information related to reviewing the adequacy and effectiveness of adaptation and support, including an assessment of the adaptation support needs of developing countries;

(f) Chapter VIII provides a synthesis of how Parties reflect in their national reports the issues of equity, fairness and ambition in the context of adaptation.

II. Key messages

The global goal on adaptation and adaptation as a collective challenge

18. The global goal on adaptation orients adaptation efforts through its objectives – enhancing adaptive capacity, strengthening resilience and reducing vulnerability – all of which should contribute to sustainable development and adequate adaptation in the context of the temperature goal of the Paris Agreement. The Paris Agreement highlights the importance of cooperation and international support, the cross-border nature of impacts and adaptation, and the global benefits of resilience. The AC has analysed possible approaches for reviewing the overall progress made in achieving the global goal on adaptation and several Parties, in their national reports, have begun to elaborate how their adaptation efforts contribute to the global goal. These indicate that approaches remain diverse. The Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation launched at COP 26 provides an opportunity for harmonization regarding (1) understanding the goal, (2) considering how the goal can orient and strengthen national efforts (3) reviewing progress towards the goal on a regular basis; and (d) enabling Parties to better communicate their adaptation priorities.

Adaptation efforts to address key global climate risks

19. On the one hand, recent scientific work, in particular that presented by the IPCC in its sixth assessment report, has provided a comprehensive picture of the anticipated global climate risks under different global warming scenarios consistent with the temperature goal of the Paris Agreement, the specific impacts of those risks, and options to address them. On the other hand, Parties have provided information in their national reports to the UNFCCC about their assumptions and adaptation responses in relation to the key global climate risks. The next paragraphs provide initial observations about national adaptation efforts vis-à-vis such risks.

20. The IPCC has concluded that **global mean surface temperature** has increased by 1.09 °C, and, depending on emissions scenario, can increase by 1.4–4.4 °C by 2100. The direct impacts of temperature increase include increased risks to human health (in particular

disease and heat stress) and impacts on ecosystems, water resources and coastal resources. Most Parties provided projections for national temperature increase, with the highest emissions scenario, RCP 8.5[18] being used by almost all Parties and more than other emissions scenarios. Limited adaptation efforts were identified specifically for mean temperature increase. Adaptation tends to focus on more specific impacts resulting from temperature increase and increased CO2 emissions.

21. The increase in global mean surface temperature will be accompanied by **temperature extremes and heatwaves**, which the IPCC projects will increase in most regions. Marine heatwaves will threaten ecosystems and livelihoods based on natural resources. RCP 8.5 leads to an increase in global extreme heat exposure from about 15 million to 535 billion person-days by 2061-2080. Many Parties identified extreme temperature as a key risk, highlighting concerns in relation to health and mortality, agriculture and food security, infrastructure and ecosystems. The national reports indicate that short-term (e.g. air conditioning) and long-term (e.g. changes in urban planning) adaptation options are available. Parties are pursuing a range of adaptation actions to respond to extreme temperatures, including establishing heat warning systems, switching to heat-tolerant crops, developing policies and plans, and undertaking capacity-building.

22. Around half of the global population currently experiences severe water scarcity due to climatic and other factors for at least one month per year. Some regions are particularly impacted by **droughts and dryness**, where increases in the frequency and intensity of these events have been observed and are projected to rise further. Many Parties identified drought and dryness as a key risk, highlighting impacts on a wide range of sectors; agriculture, water and ecosystems are seen as being particularly affected. Adaptation efforts being made by Parties are generally aligned with those identified in scientific assessments and include water supply improvements, nature-based solutions, early warning systems and contingency plans. However, uncertainties surrounding projections of drought risk may make the task of calibrating adaptation actions to such projections difficult.

23. Scientific reports project increases in **heavy precipitation**, amplifying the risks of flooding and consequent water contamination and disease. Some Parties identified heavy precipitation as a key threat, describing associated impacts, in particular flooding, erosion and landslides, and threats to food, water security and health, while noting increased infrastructure damage and, inter alia, impacts on tourism and population mobility. Projections were uncertain, and in their national reports Parties applied heterogenous timescales and illustrated limited use of RCP-based projections. As adaptation options, the IPCC emphasizes ecosystem-based approaches such as green and blue infrastructure, disaster risk management and early warning systems, while national reports focus on measures related to early warning, infrastructure protection, flood control, adaptation planning and agriculture. The risks of heavy precipitation are closely associated with run-off and fluvial flooding.

24. **River floods** are projected to be more frequent in some regions, and less frequent in others; regional differences in flood risks are influenced in part by local socioeconomic conditions. Observations suggest that changes in **run-off** vary significantly by region, though climate change is projected to lead to an expansion of the global land area that will be subjected to significant increases in run-off. Some Parties reported observations and projections related to floods, generally pointing to increases in the frequency and intensity of these events. Parties reported more projections than observations of run-off, with projections of increases in run-off outnumbering those of decreases. The range of adaptation measures highlighted by Parties to cope with flood risks include knowledge-related measures, early warning systems, structural measures, nature-based solutions and regulatory and policy tools, which correspond closely to those identified in the scientific literature. Adaptation measures targeted specifically at changes in run-off are relatively rare in national reports.

25. Global **sea level** is projected to rise by 0.26–0.77 m by 2100 at 1.5 °C of warming, and by 0.04–0.16 m more at 2 °C and large irreversible sea level rise remains a possibility,

[18] The IPCC uses RCPs to capture various GHG emissions scenarios, considering disparate development and policy pathways. The RCPs, measured in watts per square metre, range from a very high emissions scenario of 8.5 to two intermediate scenarios, 6.0 and 4.

in particular at temperature increases above 3 °C. Without adaptation, more than 100 million people will be exposed to SLR during this century. Many Parties identified SLR as a key threat, projecting, inter alia, ranges from 0.1 to 0.5 m by 2050 and 0.15 to 2.5 m by 2100. SLR threatens infrastructure, freshwater resources, ecosystems, food security, tourism, culturally significant sites and buildings, health, energy production and habitability. The IPCC highlights that while adaptation is occurring, many countries are at the early stages of implementing actions. Parties reported a focus on nature-based and engineered coastal protection, monitoring and early warning, construction guidelines, integrated coastal zone management, and conservation. National SLR projections have ranges with a higher upper figure than those of the IPCC, and the extent to which the projections drive adaptation is unclear. Measures prioritized are consistent with those suggested by the IPCC, but further analysis is needed to assess the level of implementation. SLR relates to other ocean-related hazards such as changes in cyclone frequency and intensity, precipitation, and ocean temperature and chemistry.

26. There is low confidence that the number of **tropical cyclones** is already increasing globally but medium confidence that their intensity will increase, and cyclones of categories 4 and 5 are projected to occur more frequently. Some Parties identified tropical cyclones as a key risk, highlighting related impacts such as landslides, flooding, storm surges and wind damage, as well as sectoral impacts in the areas of infrastructure, agriculture and food security, insurance and tourism. Displacement of people was also highlighted as a key risk. Available adaptation options noted by the IPCC range from strategies based on indigenous and local knowledge – in relation to, for example, food storage – to holistic disaster risk management and infrastructure design. Parties described adaptation actions such as investing in and developing early warning systems, introducing financial instruments such as reinsurance pools or disaster-linked debt instruments, 'climate proofing' infrastructure and implementing ecosystem-based strategies such as conservation.

27. In terms of **ocean warming and circulation change**, the upper ocean has warmed by 0.05–0.11 °C per decade since 1950, and warming is expected to accelerate, contributing to SLR, marine heatwaves, extreme events, coral degradation and species range shifts. Nearly all corals might degrade at 2 °C warming, threatening the livelihoods of 500 million people. Ocean circulation change poses similar risks but also has impacts on salinity, sedimentation and global heat distribution. Some Parties quantified projections of sea surface temperature increase and expressed concern about the impacts of such increase on fisheries, corals and ecosystems. The impacts of ocean circulation and temperature change are closely linked with SLR and ocean chemistry change, and thus few adaptation options address them specifically, with the exception of efforts to monitor water temperature. Synergistic measures addressing multiple risks are likely to be the most effective; adaptation will be achieved by enhancing the resilience of fisheries, protecting coral reefs and coasts, and investing in the 'blue economy'. National reports provide limited projections of ocean temperature change or information on the extent to which projections inform hazard mapping and adaptation.

28. The **chemistry of the oceans** has changed owing to higher carbon dioxide concentrations and higher temperatures, and changes in circulation, SLR and run-off. The oceans have become more acidic, oxygen levels have fallen by 2 per cent, and salinity in some regions has changed because of melting of ice and evaporation. Some Parties reported changes in ocean chemistry, mainly acidification, but also deoxygenation and increased salinity. These changes are projected to continue and will impact marine ecosystems, including coral reefs and other calcifying organisms, algae and fish, and, consequently, societies dependent on them. The Parties concerned about ocean chemistry change highlighted potential damage to coral reefs, fisheries and biodiversity. Potential impacts on societies included harm to food security, economies, tourism, recreation, infrastructure and settlements. The IPCC found that reducing other stresses on the marine environment from human activities, such as coastal pollution and overfishing, as well as using ecosystem-based adaptation can help marine ecosystems cope with changes in ocean chemistry. Of the Parties reporting on adaptation measures, the majority discussed research, monitoring and participation in international institutions. Some identified steps to reduce stress on the marine environment through, for example, implementing integrated coastal zone management, reducing pollution and protecting habitats.

29. The Arctic **sea ice extent** is decreasing by 3.5–4.1 per cent per decade, possibly leading to one ice-free summer per decade at 2 °C warming in comparison with one per century at 1.5 °C warming. Data and projections for the Antarctic are less certain. The impacts of sea ice loss are predominantly regional; however, sea ice loss influences global climate and affects shipping lanes, which, in turn, can have an impact on global trade. The IPCC highlights the impacts of sea ice loss on regional ecosystems and habitats, in particular on species that depend on the ice, but also its impacts on fisheries – potentially increased productivity – and on shipping – altered access to shipping routes. In the national reports of Parties located in northern latitudes, observations and projections were reported of decreasing sea ice extent, thickness and duration. These Parties identified consequent risks to infrastructure, indigenous communities, ecosystems and tourism. Adaptation efforts are focused on research, region-specific tools for enhancing the safety of shipping, and measures to reduce the risks arising from increases in economic activity due to loss of sea ice.

Recognition of adaptation efforts of developing country Parties

30. In the context of recognition of the adaptation efforts of developing country Parties, a wide range of efforts have been made. These efforts include those that developing country Parties have explicitly highlighted for recognition in their national reports, such as mainstreaming adaptation under existing institutional frameworks and implementing actions for key sectors. They also encompass other actions, for example directing domestic resources towards adaptation actions such as health and flood risk management; undertaking adaptation actions independent of international support, including enhancing research and strengthening financial cooperation capacity, as well as technical and institutional capacity for implementing adaptation actions; and engaging in various forms of South-South cooperation.

Adequacy and effectiveness of adaptation and support, including adaptation support needs

31. While progress is being made in implementing adaptation actions, as reported by Parties both in their national reports and in the scientific literature, the IPCC concluded that this progress is unevenly distributed across regions and gaps remain. Moreover, while results of adaptation were sometimes reported, Parties generally stopped short of illustrating the extent to which the actions implemented are adequate or effective under different climate change scenarios and time-horizons. The evaluation of progress is complicated by methodological difficulties in reviewing adequacy and effectiveness of adaptation. To some extent, adequacy and effectiveness is illustrated by the information on challenges, barriers and gaps related to adaptation, which has been widely reported by Parties in their national reports. Some mentioned cases of maladaptation that have already been observed, as well as concerns related to the potential limits to adaptation.

32. In terms of support provided for adaptation, although processes established under the Convention to facilitate the provision of such support are generally continuing to improve in terms of effectiveness, challenges and barriers remain. There is also general recognition that support provided for adaptation in developing countries, particularly in terms of finance, is not yet adequate when compared with current needs. A wide range and significant number of support needs for adaptation were reported by Parties.

Equity, fairness and ambition in the context of adaptation

33. Parties highlighted different dimensions of equity in the context of adaptation, including historical responsibility, equitable access to sustainable development and equitable transfer of finance. They also highlighted public participation and human rights-based approaches. Inclusive approaches and intergenerational- and gender-based approaches, as well as the importance of participation of indigenous peoples and local communities, were also mentioned. Fairness was framed in terms of facets of justice (just transition, social and climate justice) as well as in terms of financial and capacity-building support. Adaptation ambition, meanwhile, was considered in the context of mitigation ambition and national

circumstances. Some Parties showcased in their national reports increases in adaptation ambition, including through prioritizing and developing adaptation measures with corresponding targets and indicators, expanding the sectoral or territorial coverage of adaptation plans and measures, and mainstreaming adaptation in national policies and programmes.

III. Global goal on adaptation and collective perspectives on adaptation at various spatial scales

A. Global goal on adaptation and dimensions of adaptation in the Paris Agreement

34. Article 7, paragraph 1, of the Paris Agreement established the "global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2 of the Paris Agreement". This temperature goal is "holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change". Furthermore, in Article 7, paragraph 2, Parties to the Paris Agreement "recognize that adaptation is a global challenge faced by all with local, subnational, regional and international dimensions". This understanding of adaptation as a global goal and challenge reflects, among other things, recognition of how climate risks and impacts transcend national borders, and, at the same time, how adaptation decisions taken in one jurisdiction can bear (unforeseen and unintended) consequences for the resilience and adaptive capacity of people and systems in a jurisdiction in another part of the world.

B. Existing work related to the global goal on adaptation and adaptation as a global challenge with multiple dimensions

35. In 2021, the AC published a technical paper on approaches to reviewing the overall progress made in achieving the global goal on adaptation.[19] The paper, drawing from both the literature on this topic and existing systems for monitoring and evaluating adaptation action in different jurisdictions and at different governance levels, analysed how such a review could be undertaken. The paper also outlined the advantages, challenges and limitations of the various approaches. Ultimately, the analysis did not identify an optimal approach for reviewing overall progress towards the global goal on adaptation. Indeed, while the paper stressed the importance of such a review, it also underlined challenges – including methodological, empirical, conceptual and political ones – and trade-offs associated with reviewing collective progress on adaptation.[20]

36. Difficulties notwithstanding, various constellations of academics, researchers and organizations have suggested methods for evaluating the global status of and progress on adaptation. These methods include the annual UNEP *Adaptation Gap Report*, which promotes understanding and assessment of the adaptation gap, defined as "the difference between actually implemented adaptation and a societally set goal, determined largely by preferences related to tolerated climate change impacts, and reflecting resource limitations and competing priorities" (UNEP, 2014, p.xii). Since 2020, the *Adaptation Gap Reports* have been redesigned to enable longitudinal assessments of global progress on adaptation planning, finance and implementation against the benchmark set by the analysis contained in

[19] https://unfccc.int/sites/default/files/resource/AC_TP_GlobalGoalOnAdaptation.pdf.

[20] For more information on the work of the AC on the global goal on adaptation, including key findings from the technical paper, see the synthesis report for the technical assessment component of the first global stocktake prepared by the AC, to be made available at https://unfccc.int/topics/global-stocktake/information-portal.

the 2020 edition of the report. These assessments, along with the construct of the adaptation gap itself, can contribute to the understanding of progress towards the global goal on adaptation. The Global Adaptation Mapping Initiative has similarly attempted a global assessment of empirical evidence on adaptation progress in peer-reviewed literature. The mapping sheds light on the hazards addressed by adaptation actions, actors involved, sectors targeted and types of responses documented, though clear evidence of risk reduction and adaptive capacity was minimal partly due to the methodologies and data sources used. While these efforts help paint a partial picture of the global adaptation landscape, they are constrained by limitations relating to the extent to which their findings can inform a review of overall progress towards the global goal on adaptation, including review of data and information gaps on adaptation outputs and outcomes, and uncertainty about enabling conditions for adaptation.

37. Several initiatives have emerged to advance adaptation at the collective level. One example is the Adaptation Research Alliance, which was launched at COP 26 and is a coalition of over 100 organizations aiming to increase investment in action-oriented adaptation research to help climate-vulnerable countries build resilience and prosper.[21] The Race to Resilience, led by the high-level champions for climate action, is a global campaign aiming to build the resilience of four billion people by 2030 by catalysing climate action by non-state actors.[22] The Global Center on Adaptation is another initiative working towards accelerating adaptation action around the world from the local to the international level.[23] Focusing on quantifying adaptation, the International Platform on Adaptation Metrics aims to become an international reference platform for adaptation metrics across scales and sectors, and, in doing so, to help attract finance for adaptation action around the world.[24] At the regional level, the Africa Adaptation Initiative seeks to scale up adaptation on the continent through raising awareness, facilitating knowledge management and capacity-building, supporting and facilitating resource mobilization, promoting cooperation and tracking progress.[25]

38. Beyond the growing literature and landscape of collective-level adaptation action, countries have begun to consider their role in achieving the global goal on adaptation. Progress towards the goal is likely to result from a mosaic of actions and initiatives implemented at the international, national and subnational level; thus, while it is most likely an aggregate-level analysis will ultimately deliver insights into the steps taken towards achieving the goal, it is also critical to understand how the individual pieces fit together to form the bigger picture. Increasingly, however, national governments are orienting their adaptation plans and priorities towards expressly advancing the global goal on adaptation while simultaneously pursuing domestic adaptation objectives. For example, in their national reports, some Parties describe how the measures outlined in their national reports, the process to formulate and implement NAPs, national adaptation goals and supranational climate laws all aim to contribute to achieving and/or assessing progress towards the global goal on adaptation. These Parties also sketch more precisely how the global goal is being translated into national-level action, which is, in turn, expected to translate into overall progress towards achieving the global goal. This work includes mainstreaming evidence-based adaptation planning processes and their implementation into the operations of the public and private sectors, stepping up adaptation action in priority sectors and cross-cutting areas, and improving the availability of information and data.

C. Work programme on the global goal on adaptation

39. In recognition of the further work needed to understand progress towards the global goal on adaptation, Parties at COP 26 established the Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation with the objectives of, inter alia:

[21] https://southsouthnorth.org/portfolio_page/adaptation-research-alliance/.
[22] https://racetozero.unfccc.int/system/resilience/.
[23] https://gca.org/about-us/.
[24] https://adaptationmetrics.org/.
[25] https://africaadaptationinitiative.org/#publication.

(a) Enabling the full and sustained implementation of the Paris Agreement, towards achieving the global goal on adaptation, with a view to enhancing adaptation action and support;

(b) Enhancing understanding of the global goal on adaptation, including of the methodologies, indicators, data and metrics, needs and support needed for assessing progress towards it;

(c) Contributing to reviewing the overall progress made in achieving the global goal on adaptation as part of the global stocktake referred to in Article 7, paragraph 14, and Article 14 of the Paris Agreement with a view to informing the first and subsequent global stocktakes;

(d) Enhancing national planning and implementation of adaptation actions through the process to formulate and implement national adaptation plans and through nationally determined contributions and adaptation communications;

(e) Enabling Parties to better communicate their adaptation priorities, implementation and support needs, plans and actions, including through adaptation communications and nationally determined contributions;

(f) Facilitating the establishment of robust, nationally appropriate systems for monitoring and evaluating adaptation actions;

(g) Strengthening implementation of adaptation actions in vulnerable developing countries;

(h) Enhancing understanding of how communication and reporting instruments established under the Convention and the Paris Agreement related to adaptation can complement each other in order to avoid duplication of efforts.[26]

D. Linking global progress on adaptation with global mitigation ambition

40. The Paris Agreement underscores the fundamental and dynamic relationship between efforts to adapt to climate change and efforts to cut GHG emissions. This is evident in the global goal on adaptation, which refers to the temperature goal in Article 2, paragraph 1(a), of the Paris Agreement. In addition, Parties recognize in Article 7, paragraph 4, "that the current need for adaptation is significant and that greater levels of mitigation can reduce the need for additional adaptation efforts, and that greater adaptation needs can involve greater adaptation costs". Despite this clear link between adaptation and mitigation ambition, efforts to assess adaptation under different mitigation and temperature scenarios remain underdeveloped, and much of the existing literature on vulnerability assessment and adaptation implementation is "largely temperature agnostic" (Berrang-Ford et al., 2021, p.995).

41. Using the framing of adaptation as a global challenge with dimensions at different spatial scales as well as adaptation's intrinsic links with GHG mitigation as a launchpad, the following chapters (IV to VII) of this synthesis report strive to illustrate the state of collective adaptation efforts, experience and priorities in the context of scientific information on risks anticipated under different temperature scenarios.

IV. Adaptation efforts, experiences and priorities in relation to global climate impacts

42. This chapter seeks to describe how national adaptation efforts reflect the main global and regional climate risks and adaptation options outlined by the IPCC (2018a), both in terms of the assumptions that Parties make about those risks, as well as the types of adaptation efforts they intend to undertake. To this end, each section of this chapter presents key scientific findings and projections, as well as adaptation options identified in scientific

[26] Decision 7/CMA.3, para. 7. For more details on the work programme, see https://unfccc.int/topics/adaptation-and-resilience/workstreams/glasgow-sharm-el-sheikh-WP-GGGA.

reports, in relation a specific risk. Each section also synthesizes the information from latest national reports submitted to the UNFCCC on the assumptions, projections, and adaptation efforts related to the particular risks, with the aim of outlining possible convergencies or differences between the scientific information and the information in national reports.

A. Increase in global mean surface temperature

1. Global observations and projections of changes and impacts

43. In its latest report, the IPCC concluded that from 1850–1900 to 2011–2020, global mean surface temperature increased by 1.09 °C (with a range of 0.99 to 1.20 °C). The increase was much larger over land than over the oceans, with average temperatures over land rising by 1.59 °C (with a range of 1.34 to 1.83 °C) and over the oceans by 0.88 °C (with a range of 0.68 to 1.01 °C) (IPCC, 2021). Warming in the Arctic region is two to three times greater than global mean surface temperature (IPCC, 2018a).

44. In its Sixth Assessment Report, the IPCC updated its projections of future increases in global mean temperatures. The projections are shown in table 1.

Table 1
Increases in global mean surface temperature (°C) projected relative to 1850–1900

RCP[a]	*2021–2040*	*2041–2060*	*2081–2100*
1.9	1.5 (1.2–1.7)	1.6 (1.2–2.0)	1.4 (1.0–1.8)
2.6	1.5 (1.2–1.8)	1.7 (1.3–2.2)	1.8 (1.3–2.4)
4.5	1.5 (1.2–1.8)	2.0 (1.6–2.5)	2.7 (2.1–3.5)
8.5	1.6 (1.3–1.9)	2.4 (1.9–3.0)	4.4 (3.3–5.7)

[a] The IPCC uses RCPs to capture various GHG emissions scenarios, considering disparate development and policy pathways. The RCPs, measured in watts per square metre, range from a very high emissions scenario of 8.5 to two intermediate scenarios, 6.0 and 4.

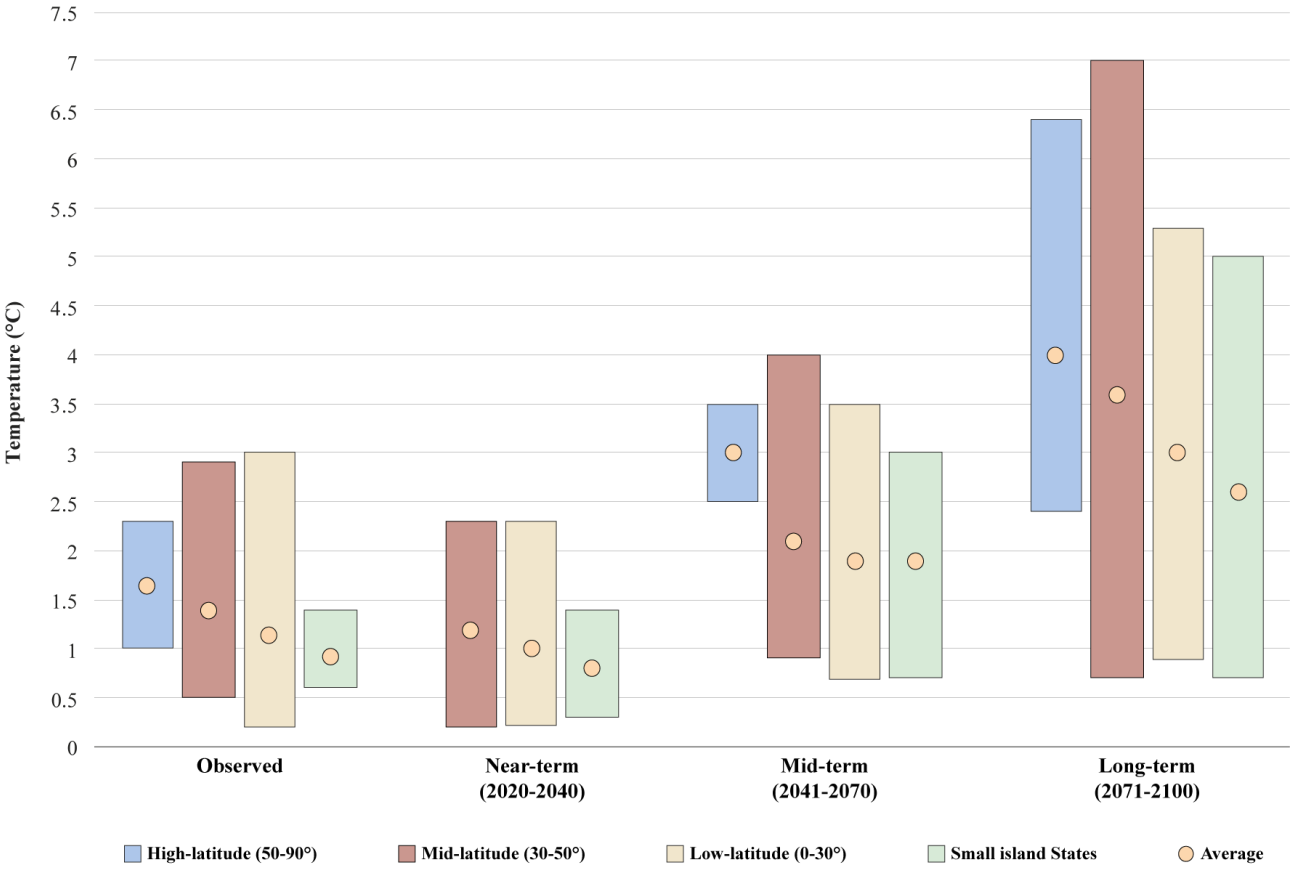
Source: Sixth Assessment Report of the IPCC.

Note: Projections display best estimates and ranges.

2. Observations of mean temperature changes and impacts in national reports

45. In their reports to the UNFCCC, most Parties described observed or projected changes in their national temperatures. Observed increases were reported by many Parties, with most discussing changes since the 1960s and 1970s, but others reporting changes since the beginning of the twentieth century or late nineteenth century. Parties tended to report either total increases or average increases by decade. The IPCC found that increases have been greater in higher latitudes and over land than over ocean. Figure 2 shows the range of reported temperature increases by latitude and for SIDS. Parties were categorized as high latitude (between 60 and 90°N), mid latitude (between 30 and 60°N) and low-latitude (between 0 and 30°N). They were also categorized by whether they are SIDS. Countries straddling 30° or 60° latitude were placed in specific zones on the basis of whether most of the country lies in low, mid or high latitudes. SIDS were placed in a different category because warming in those countries will be dominated by changes in sea surface temperature.

Figure 2
Ranges of observed and projected increases in mean annual surface air temperature by Party location



46. The relative changes in temperature are roughly consistent with the changes reported by the IPCC. Although there is a wide range of reported changes, the largest increases were in high latitude nations and the lowest increases in SIDS. On average, the mid-latitude parties report slightly more of an increase in temperature than lower-latitude parties.

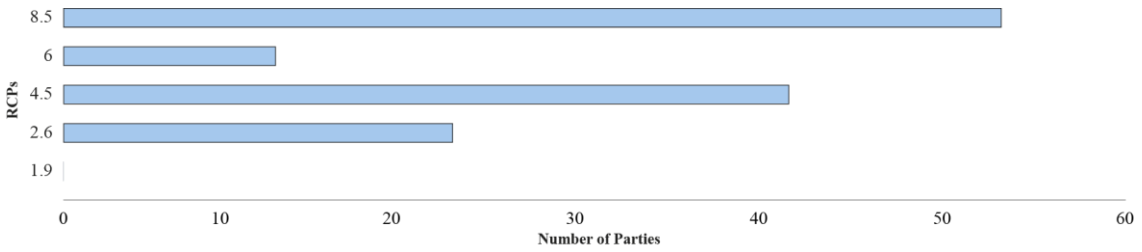
3. Projections of future mean temperature changes and impacts in national reports

47. In their reports, many Parties projected increased temperatures through the rest of the twenty-first century. This section discusses the emissions scenarios and presents the reported projections of increases in mean annual temperature.

(a) Use of emissions scenarios

48. About half of the Parties projecting increased temperatures stated which RCPs they used to derive their projections. Figure 3 shows the number of Parties that mentioned each RCP.

Figure 3
Number of Parties reporting use of specific RCPs



49. Most of the Parties reporting the use of a specific RCP used more than one scenario, and most used the highest scenario, RCP 8.5, in their projections. Many Parties used RCP 4.5, while some used RCP 6.0. These three RCPs are projected to result in global mean surface temperature exceeding 2 °C this century. Some Parties reporting the use of a specific RCP used RCP 2.6, which assumes significant reductions in GHG emissions and would limit temperature increase to under 2 °C. None of the Parties projected temperature increase using RCP 1.9, which would limit global mean surface temperature to about 1.5 °C. In addition to the RCPs, a few Parties used SRES scenarios.

(b) Temperature projections

50. To reflect different relative magnitudes of temperature increase, the many Parties reporting the use of specific RCPs for projecting national average annual temperature increase were categorized by latitude and status as SIDS as in chapter I.A.2 above. The projections of temperature increase in the twenty-first century were divided into near-term (2020–2040) midterm (2041–2070) and long-term (2071–2100) projections. Many countries reported a range of projections covering the different emissions scenarios. For this synthesis report, the midpoint of the range was estimated and an average by category (e.g. low latitude Parties' temperature projections for mid-century) calculated. The calculations do not differentiate by emissions scenario. All the Party projections were combined regardless of source or choice of scenario. Doing so presented the projections for average annual increase in temperature that Parties reported and that may have been used to estimate climate change impacts and to develop adaptation actions. Figure 2 above shows the average of the midpoint of the projections. On average, Parties' projections indicated more of an increase in mean temperature with higher latitude and for land-based nations. Slightly less of a temperature increase was projected for SIDS, all of which lie in low latitudes, than for low latitude land-based countries. The average projected increase in mean summer air temperature is below 2 °C average global temperature increase by mid-century, which is roughly consistent with a 2 °C global increase by late in the century.

4. Key impacts of increased temperature discussed in national reports

51. Some Parties, many of which are Parties not included in Annex I to the Convention, described the key direct impacts of higher temperatures. Parties reported impacts in areas such as human health (e.g. in relation to disease, heat stress and pollution); water resources (e.g. in relation to supply, demand and drought or desertification); food production or security (e.g. in relation to crops, livestock and fisheries); ecosystems (e.g. in relation to forests, biodiversity, corals and mangroves); and other areas such as tourism, energy, infrastructure labour and livelihoods. This analysis does not include impacts such as flooding that are mostly or substantially the result of changes in other climate factors such as precipitation and SLR.

B. Increase in occurrence of temperature extremes

1. Global observations and projections of changes and impacts

52. Hot extremes have become more frequent and intense in most regions since the 1950s, whereas cold extremes have declined in frequency and severity, with high confidence that climate change is the main driver (IPCC, 2021). Marine heatwaves have doubled in frequency since the 1980s, with evidence that human influence has been a driver (IPCC, 2021; IPCC 2018a). Some regions are experiencing such high heat stress that it places them at the upper limits of labour productivity and human survivability (IPCC, 2022). The current experienced exposure to heatwave events globally is 14.8 billion person-days per year (IPCC, 2022).

53. Temperature extremes and hot days are projected to increase in most land regions, with the highest increases expected in the tropics (IPCC, 2018b,). The most impacted regions are likely to include central and eastern North America, Central and Southern Europe, the Mediterranean, Western and Central Asia, and Southern Africa (IPCC, 2018a). Extreme heatwaves are projected to emerge first in the tropics and then occur widely at 1.5 °C global warming (IPCC, 2018a) . Cold extremes will become less frequent and intense whereas hot

extremes will increase in intensity, frequency and duration (IPCC, 2018a). The decrease in cold extremes will be most prominent in Australia, Europe and North America (IPCC, 2018a). Under the SSP3–RCP 8.5 scenario, global extreme heat exposure increases 30 times from approximately 15 billion to 535 billion person-days (IPCC, 2022).

54. Extreme temperatures impact ecosystems, species, and human health and well-being. Heat-related mortality and mental health impacts are set to increase and existing diseases can be exacerbated (IPCC, 2022). However, heatwaves and their impacts are not monitored well by all countries, leading to challenges in providing a global picture of impacts (IPCC, 2022). Marine heatwaves can result in changes in species migration, abundance and distribution, with impacts on fisheries (IPCC, 2022). Heatwaves put pressure on ecosystems and species: they have caused mass mortality, changed feeding patterns, reduced fitness of species and increased health risks to wildlife managers (IPCC, 2022). Heatwaves also impact crop production and livestock value and cause failures of energy systems (IPCC, 2022).

2. Assumptions about temperature extremes in national reports

55. In the national reports, many Parties identified extreme temperature as a key risk, describing its anticipated scope and consequences. Of these Parties, 43 identified heatwaves as a specific climate change impact, 22 cited extreme temperatures in general and 7 identified the urban heat island effect as a specific key risk in the future. Other considerations were increases in the number of both hot days and hot nights. Some Parties noted projected increases in the intensity and frequency of heatwaves. Where Parties mentioned specific projection methods, RCP 8.5 was used most followed by RCP 4.5 and RCP 2.6. Use of timescales varied across Parties and ranged from 2011–2040 to 2100.

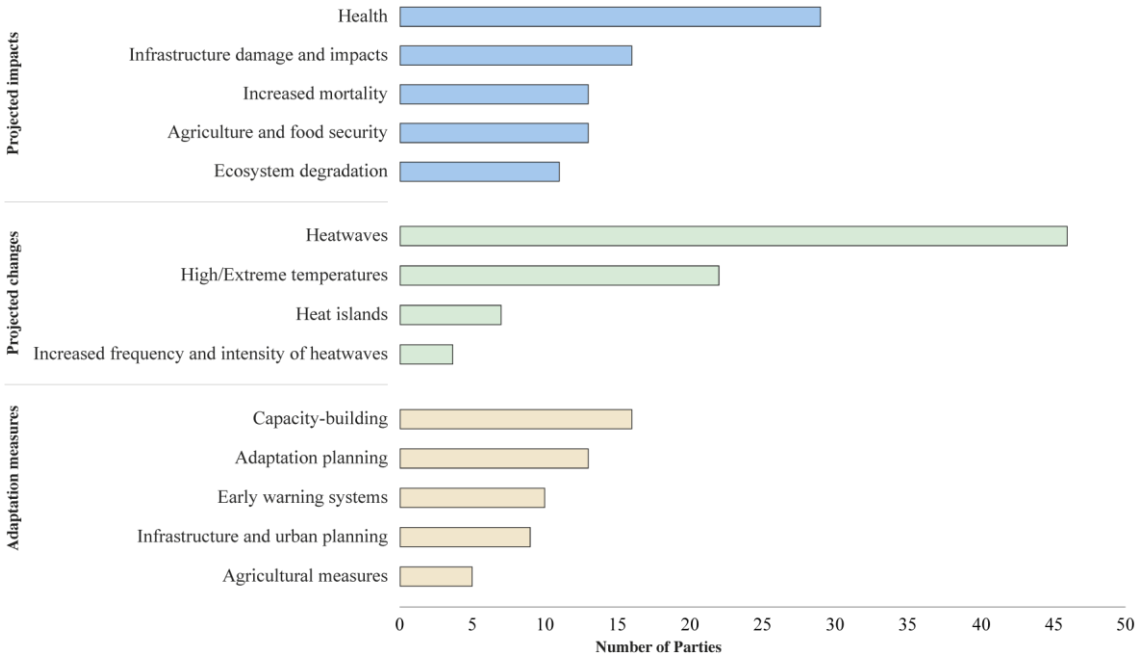
56. Countries also identified many secondary impacts from heatwaves and extreme temperature (see figure 4). The largest impact categories were agriculture and food security, ecosystem degradation, health and increased mortality and infrastructure damage and impacts.

57. Infrastructure damage and impacts included the impact of heatwaves and extreme heat on roads and other transport networks and on energy and health facilities. Specific concerns were increased energy demand during heatwaves, increased costs of cooling, insurance, business disruption, and impacts on industries such as tourism. Secondary impacts in agriculture and food security included impacts on crops and livestock from heat and on marine resources and aquaculture from extreme temperatures.

58. Ecosystem degradation and impacts on ecosystems were a major concern. Specific concerns related to forest damage, invasive species, fires and species extinction. Increased extreme temperature can increase algal blooms and cause other water-related impacts, which, in turn, negatively affect recreational water-based activities relevant for tourism. Some countries also noted how reduced access to and availability of water during heatwaves can lead to mortality and decreased sanitation.

59. Impacts on health and increased mortality were major concerns and included increases in heat-related diseases (waterborne, vector-borne and new diseases) as well as illnesses, shocks and injuries due to increasing heat exposure. Other impacts of extreme temperature were increased visits to emergency service facilities and hospitals, mental and physical stress, increased demand for drinking water, and losses in productivity due to lost work and school days.

Figure 4
Extreme heat: projected impacts and changes, and adaptation measures



3. Adaptation options identified in scientific assessments

60. Various options for adapting to extreme temperatures have been identified in the scientific literature. For extreme heat, adaptation options largely fall into short-term (e.g. air conditioning) and long-term (e.g. changes in urban planning) categories (IPCC, 2022). Some options – air conditioning, for example – have the potential to increase GHG emissions and can increase 'heat inequity' given installation costs.

61. Heatwave action plans linked to weather forecasts can be used to alert the public and authorities of conditions and action such as seeking shelter and shade in, for example, public cooling centres (IPCC, 2022). Heatwave and health warning systems can alert communities about dangerous conditions and communicate response options (IPCC, 2014).

62. Mapping of potential heat hotspots can be used as an adaptation strategy. Options to manage heat for outdoor workers include protective clothing, access to drinking water and scheduling of work outside the hottest periods (IPCC, 2022).

63. Nature-based solutions have also been suggested especially in the form of blue and green infrastructure (e.g. parks and other urban green spaces, and water bodies) that can assist in heat reduction while providing benefits to biodiversity and ecosystems (IPCC, 2014, 2022). Implementation of nature-based solutions needs to be planned carefully; new water bodies, for example, can act as breeding grounds for insects that carry waterborne diseases (IPCC, 2022). In regard to heat reduction, green roofs and parks can be used as part of green infrastructure and planning (IPCC, 2014). Natural infrastructure (blue and green) utilizes ecosystems such as wetlands and freshwater ecosystems (IPCC, 2022).

4. Adaptation efforts, experiences and priorities identified in national reports

64. In their national reports, Parties described measures they were undertaking to manage and adapt to the impacts of extreme temperatures. These largely fall into five categories: early warning systems, infrastructure and urban planning, agriculture, adaptation planning and policies, and capacity-building (see figure 4 above).

65. Improving early warning systems, including, specifically, heat warning services, was reported by many Parties as a key strategy in communicating critical information to communities and stakeholders (including public transport operators) who need to understand both projections and warnings to adapt to heat. Other measures were securing urban green spaces to reduce the impacts of heat in urban areas and building large public evaporative

cooling structures to be used during heatwaves. Some countries are developing maps to communicate which areas are experiencing extreme heat or wildfire smoke, and some are developing tools for monitoring epidemics during extreme heat events.

66. In agriculture, adaptation strategies included introducing heat-tolerant fodder species, livestock breeds and crop varieties; providing cool areas for livestock grazing; enhancing the adaptive capacity of ecosystems and species; and planting multiple species with different ripening periods.

67. Infrastructure and urban planning strategies included actions to redesign homes and retrofit schools and other buildings such as health-care facilities to withstand heat better. Parties also referred to, inter alia, a multisectoral infrastructure plan directed at urban cooling, municipal adaptation planning tools, and heat preparedness plans at the national, provincial and local level. Embedding climate adaptation into energy sector and transport sector plans was seen as critical to adapting to extreme temperatures given the significant impacts of extreme heatwaves on roads and other infrastructure. Measures to achieve this end included creating inter-agency working groups and developing risk management guidelines for construction.

68. Capacity-building efforts focused on extreme heat included raising the awareness of heatwaves of the general public and health-care professionals; developing extreme temperature and related adaptation strategies; strengthening the health sector's capacity to adapt; reducing outdoor workers' heat exposure through changing work hours and providing protective clothing; and establishing an international forum to discuss key issues and strategies regarding how to deal with extreme temperatures. Strengthening health services overall, along with strengthening climate adaptation health-related research, was seen as an important strategy for generating specific information as to how the sector can adapt to heatwaves.

5. Observations, including information gaps

69. The information presented in chap. I.B.2 above illustrates the assumptions identified by countries in their national reports regarding increases in extreme temperatures. Many countries projected increases in heatwaves in general terms, but did not include detailed projections on the increase in the number of heatwaves or hot days, the projected frequency or intensity of heatwaves, or the number of additional people that would be at risk.

70. In terms of adaptation priorities, development of early warning systems, including heat warning services, and adaptation planning and policymaking are under way to prepare for a hotter world. Adaptation strategies are targeting the health impacts on humans and aiming to increase awareness before heatwaves occur to enable communities to undertake adaptation actions on time. However, while many developing countries identified heatwaves as key impacts, they rarely reported adaptation strategies for this particular risk. In contrast, several developed countries outlined specific heatwave and extreme temperature policies, plans and initiatives, many of which are already being implemented at different scales. Learning from these ongoing strategies will be crucial in addressing effective adaptation to extreme temperatures, as will learning about the interactions and interlinkages between direct and indirect impacts of heatwaves on vulnerable groups and sectors.

71. Several knowledge gaps remain. For instance, the contribution of Working Group II to the Sixth Assessment Report of the IPCC found no evidence for clear links among heatwaves, air pollution and potential health impacts, as well as the interplay of heatwaves, urban heat island effects and urban mortality (IPCC, 2022). Evaluation of heatwave action plans and associated early warning systems is not yet producing conclusive results of their effectiveness (IPCC, 2022). There is also a need to examine indigenous and non-Western adaptation strategies to heat as these are not well understood but could assist in developing adaptation options (IPCC, 2022). National reports provide limited information on indigenous communities as a key vulnerable group in the context of heatwaves.

C. Increase in heavy precipitation events

1. Global observations and projections of changes and impacts

72. According to the IPCC, weather and climate extremes have already been influenced by anthropogenic climate change (IPCC, 2021). Even if the projections are less robust for precipitation than, for example, temperature, global projections are for increases in intensity, frequency and/or amount of heavy precipitation (IPCC, 2018a). The most significant changes between 1.5 and 2 °C are likely to be seen in high latitudes (Alaska and western Canada; eastern Canada, Greenland and Iceland; Northern Europe; Northern Asia), at high elevations (e.g. the Tibetan Plateau), and particular regions (in Eastern Asia, including China and Japan and in eastern North America) (IPCC, 2018a). Data for other regions are less conclusive.

73. Secondary impacts from increasing heavy precipitation are significant. For example, heavy precipitation can increase the incidence of diseases carried by mosquitos or rodents, as well as waterborne diseases, while some diseases can shift into areas with increasing temperatures and humidity (IPCC, 2022). Heavy precipitation increases water insecurity as excess water can contaminate groundwater while increasing run-off (IPCC, 2022), and it can amplify coastal flooding if tropical cyclones occur with SLR (IPCC, 2018a).

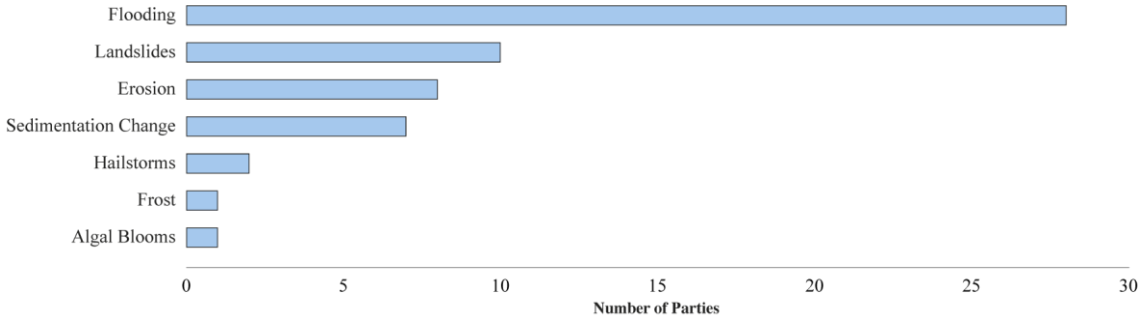
2. Assumptions about heavy precipitation events in national reports

74. In the national reports, some Parties specifically identified heavy precipitation as a key threat, describing its anticipated scope and consequences in both quantitative and qualitative terms; some of these Parties provided information on observed and/or projected increases in heavy precipitation events and noted changes in overall rainfall patterns. The projected assumptions include changes in rainfall patterns, increased intensity of rainfall, increased frequency of heavy rainfall, as well as increased wet season and overall rainfall . A handful of countries noted uncertainty on whether rainfall would decrease or increase.

75. Projected timescales varied significantly between countries: between 2011 to 2100. Only a few countries made direct references to RCPs in their projections

76. Most countries noted that they expected changes in precipitation and listed specific impacts they were concerned about. These included increased flooding, erosion and landslides, with sedimentation change as a result (see figure 5). The main concerns related to flooding (both general and flash flooding), followed by landslides and sedimentation change.

Figure 5
Impacts of heavy precipitation identified by Parties



77. Several social impacts were identified (see figure 6). Parties were particularly concerned about the impacts of heavy precipitation on the following:

(a) Infrastructure. Concerns related especially to energy production, water supply infrastructure, transportation networks, telecommunications, and mining and oil industries. Direct impact on road and pavement quality and increased destabilization of road materials was noted as a concern by some Parties, as was the impact on mobility, in particular in poorly serviced areas, where heavy rainfall might cut off transport networks while also disrupting supply chains and business activities;

(b) Agriculture and food security. Concerns included decreased yields attributable to damage to crops and livestock, impacts on aquaculture and fishing, displacement of

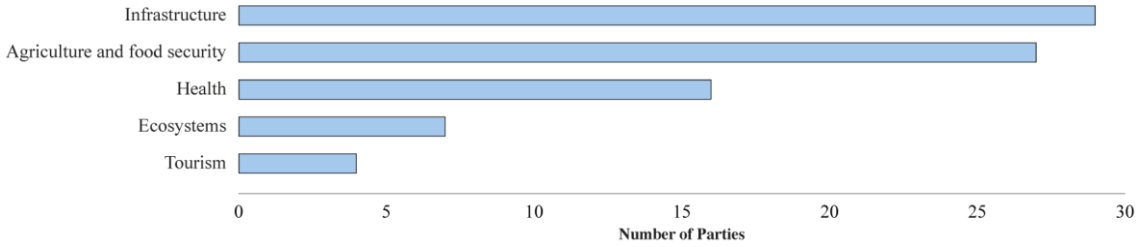
traditional crops and increased food pathogens. Fishery, forestry and agricultural livelihoods were seen as highly vulnerable to heavy rainfall, with fewer catches and poor quality crops leading to food insecurity;

(c) Health. Concerns focused on increased waterborne and vector-borne diseases, water resource contamination, impact on waste treatment systems, increased sewage overflow and its associated impacts on health, and chemical leaching into coastal ecosystems and its consequences for livelihoods and health.

78. Other areas identified as of concern were ecosystem degradation, including increases in invasive species; impacts on forestry; impacts on inland fisheries; and siltation from soil and erosion in key coastal ecosystems, such as mangroves and wetlands.

79. Damage to cultural heritage, loss of life, and impacts on tourism, migration and livelihoods were also noted as concerns. Tourism was noted as a key industry where heavy rainfall is likely to reduce the attractiveness of destinations owing to infrastructure damage and bad weather overall. Transboundary risks were also identified; for example, where countries share rivers and basins, heavy rainfall in one country could accelerate flooding in another.

Figure 6
Social domains identified by Parties as specific concerns for heavy precipitation



3. Adaptation options identified in scientific assessments

80. Various adaptation options that can assist in preparing for increasing heavy precipitation have been identified in scientific assessments. For example:

(a) Wetlands and green spaces: these help manage excess water while also providing spaces for biodiversity (IPCC, 2014). Urban planning and housing services are critical to planning settlements that can accommodate increased precipitation (IPCC, 2014). Ecosystem-based adaptation has become increasingly important in harnessing ecosystems to absorb or control impacts in urban and rural settings (IPCC, 2022, 2014);

(b) Natural infrastructure (blue and green) approaches: these utilize ecosystems such as wetlands and freshwater ecosystems (IPCC, 2022). Green infrastructure (green roofs, parks) can lessen heat island effects and flooding, especially in urban areas, and they have mitigation co-benefits (IPCC, 2014);

(c) Agricultural approaches: in small islands, these approaches include combining plants and crops with trees and shrubs to create more resilient ecosystems that can better withstand excess precipitation or drought (IPCC, 2022);

(d) ‘Building back better’ approaches: these provide for integrated disaster risk management that combines hard infrastructure solutions with livelihood strengthening, development of early warning systems and local capacity-building (IPCC, 2022).

4. Adaptation efforts, experiences and priorities identified in national reports

81. In their national reports, Parties described the measures they were undertaking to adapt to the impacts of heavy precipitation. These largely fall into four categories: investing in and developing early warning systems, protecting infrastructure, planning and building capacity for adaptation, and designing agricultural strategies (see figure 7).

82. Investing in and developing early warning systems included implementing emergency warning systems, weather observation systems for heavy rain and tropical cyclones, rainfall

gauge networks, hazard maps, and actions that focus on reducing flood risk to communities. Some countries have established natural hazard and risk assessment platforms and online resources to increase the accessibility of hazard information, whereas others have invested in satellites to deliver more accurate weather information. Increased technical and financial support and access to weather data and information systems were identified as key factors in adapting to heavy precipitation.

83. Infrastructure protection included investing in blue, grey and green infrastructure; enhancing overall infrastructure resilience; improving supply chain resilience; and strengthening critical infrastructure such as coastal defences and flood control functions of existing dams and agricultural reservoirs. Other strategies were improving electricity storage systems, water supply systems, emergency power sources and emergency action plans for dam safety, as well as retrofitting schools to enhance resilience.

84. Adaptation planning and capacity-building strategies centred on municipal adaptation planning and included development of planning tools, adaptive capacity-building through local knowledge, awareness-raising and education, investment in business continuity, investment in green and blue infrastructure, and implementation of a research programme to provide timely information for adaptation decision-making.

85. Agricultural strategies included measures such as the development of farm irrigation and the use of paddy fields and agricultural reservoirs as rainwater storage and for infiltration; the diversification of crops and of small ruminant rearing; and gender-sensitive, agriculture-specific impact analysis. Responses to health-related impacts of heavy precipitation included measures to manage increases in vector-borne and waterborne diseases.

86. Financial measures included a new regional debt instrument that links domestic and foreign sovereign debt with a natural disaster clause that enables extension of debt due to disasters, including rainfall, earthquakes and hurricanes, and is triggered when the disaster exceeds the prearranged threshold of material loss. Other financial options were credit facilities specialized in managing natural disaster financial risk, and index-based insurance to assist farmers in recovering from damage caused by heavy rainfall.

Figure 7
Adaptation options for heavy precipitation and associated impacts identified by Parties

5. Observations, including information gaps

87. The information presented above illustrates assumptions identified by countries in their national reports regarding increases in heavy precipitation events. These assumptions often do not refer to specific timescales for the expected changes and are not derived from RCPs. The national reports provide an unclear picture about the extent to which national adaptation efforts are specifically based on projected increases in heavy precipitation. This may be partly because precipitation projections are currently less well developed and more uncertain than temperature projections (IPCC, 2021). Further, countries might identify increased intensity of rainfall as a key risk but do not necessarily outline specific adaptation strategies to address the risk.

88. In terms of adaptation priorities, activities prioritized by countries have a key focus on enhancing infrastructure resilience and early warning systems. In their national reports, Parties generally frame responses to risks associated with heavy precipitation in terms of adapting to flooding and extreme weather. This way, adaptation efforts are designed to address a cluster of risks associated with heavy precipitation, and there is limited information

about adaptation solutions that specifically target heavy precipitation. Thus, this section should be read in conjunction with chapter IV.E below, which provides further information on efforts to adapt to river flooding.

89. The IPCC, in the contribution of Working Group II to the Fifth and Sixth assessment reports, outlines multiple adaptation options that can assist in managing heavy precipitation, which are recognized and included in many country plans.

D. Changes in cyclone activity

1. Global observations and projections of changes and impacts

90. According to the IPCC, there is low confidence that the number of tropical cyclones is increasing globally but medium confidence that their intensity will increase (i.e. cyclones of categories 4 and 5), and more intense cyclones are projected to be more frequent (IPCC, 2018a). There is more confidence that heavy precipitation is increasing with tropical cyclones (IPCC, 2021; IPCC, 2022). It is likely that the tropical cyclone zone where cyclones reach peak intensity will shift northward in the western North Pacific region (IPCC, 2021).

91. Tropical cyclones damage, inter alia, housing, roads and energy infrastructure; injure humans (via flying debris); and can lead to displacement (IPCC, 2022). Wind and waves can damage coastal communities and ecosystems, such as mangroves (IPCC, 2018a). Indirect impacts include increased incidence of waterborne diseases and decreased human well-being through injury and mental health disorders, such as post-traumatic stress disorder (IPCC, 2022). When tropical cyclones are combined with heavy precipitation and SLR, coastal flooding is projected to increase (IPCC, 2018a). Small islands in particular are highly vulnerable to these impacts as tropical cyclones are associated with rises in extreme sea levels (IPCC, 2018a). Tropical cyclones can also increase both short- and long-term displacement owing to their multiple impacts on housing, infrastructure and livelihoods and they can lead to non-economic losses such as loss of identity and emotional distress (IPCC, 2022).

2. Assumptions about changes in cyclone activity in national reports

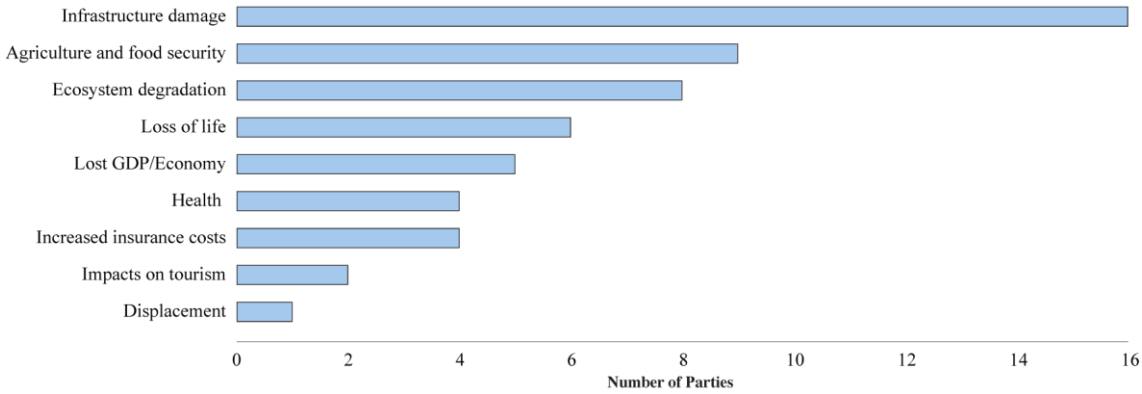
92. In the national reports, some Parties specifically identified tropical cyclones as a key risk, describing their anticipated scope and consequences. Most countries that specifically mentioned tropical cyclones as a current and projected impact of climate change also noted the uncertainties around the projections. Some noted that tropical cyclones are expected to decrease in number globally but their intensity is projected to increase, while others noted projected increases in both intensity and frequency.

93. Many countries identified potential direct and indirect impacts of tropical cyclones on the environment and communities (see Figure 8). Cyclones are for example increasing the potential for landslides, flooding, storm surges, wave overwash, wind damage and increased river flow rate to occur. Cyclones are also associated with much damage across sectors: infrastructure damage is expected to increase, especially in transport and energy systems and networks, oil drilling platforms and pipelines, and water supply infrastructure, and significant damage is expected to social infrastructure such as schools and health-care facilities. Communities living in vulnerable areas and are often unable to insure their homes, leading to significant financial loss and damage from cyclones.

94. Agriculture and food security are impacted through damage to crops and livestock. Ecosystem degradation is also likely as a result of damage caused by cyclones to coral reefs and forests, as well as of salinization of water and soil. Such degradation tends to further degrade the resilience of coastal areas, and recovery from intense cyclones can take more than a decade.

95. Economic impacts are likely to occur in the form of increased insurance costs, lost GDP, decreased tourism and increased displacement. Loss of life and health impacts, including on mental health and on waterborne and vector-borne disease, are also concerns.

Figure 8
Direct and indirect impacts of cyclones identified by Parties



3. Adaptation options identified in scientific assessments

96. Various options for adapting to tropical cyclones have been identified in scientific assessments. For example, many disaster preparedness and adaptation strategies of small islands are based on indigenous and local knowledge, such as the need for storing emergency food supplies (IPCC, 2018a). Also on small islands, communities relocate gardens to protect future crops after a garden has been destroyed by storm (IPCC, 2022). Some countries, including Jamaica, have relocated communities; Jamaica has developed a resettlement policy framework aligned with its national development plan, which includes vulnerability and risk assessments for communities most at risk from climate change (IPCC, 2022).

97. Overall, holistic approaches to disaster risk management that include a number of strategies, including strengthening livelihoods, investing in early warning systems and increasing adaptive capacity, are important (IPCC, 2022). Also, infrastructure design improvements such as revising building codes and redesigning roofs to withstand hurricanes are being implemented on some small islands as anticipatory adaptation (IPCC, 2022).

98. Early warning systems can deliver a range of benefits for climate adaptation and disaster risk reduction, especially in urban areas, as climate forecasts are becoming increasingly accurate (IPCC, 2022). Other measures for cyclone preparedness include land-use planning and control in areas highly vulnerable to cyclone and hurricane damage, and investment in flood control measures (IPCC, 2022). Given that cyclones often bring heavy rainfall, nature-based strategies such as green infrastructure can reduce risks to communities from storm events, as can investments in urban stormwater management and sustainable urban drainage systems (IPCC, 2022).

4. Adaptation efforts, experiences and priorities identified in national reports

99. In their national reports, Parties described measures that they were undertaking to manage and adapt to the projected impacts of cyclones (see figure 9).

100. Financial instruments and institutions involved in the response to cyclone risks included a reinsurance pool for cyclone and flood damage that can increase the accessibility and affordability of insurance; insurance and credit facilities that support the development of strategies for natural disaster risk finance management; debt instruments in which a disaster clause is embedded (covering disasters such as hurricanes and rainfall) that enable countries to postpone debt payments in the event of a disaster; and programmes that deliver funding to help communities prepare for disasters and become more resilient to cyclones.

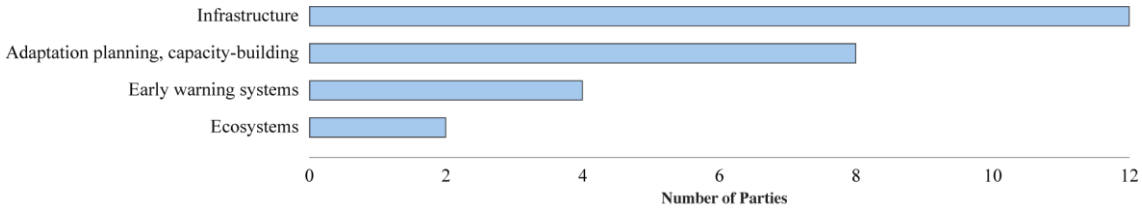
101. Investing in and developing early warning systems includes improving emergency warning and monitoring systems and strengthening weather observation systems, including by deploying new satellites. It also involves securing financial and technical investment to make sure these systems remain up to date. Other strategies include developing climate risk information assessments on storm surges and potential impacts on airports and investing in climate information services.

102. Strengthening infrastructure was a frequently cited adaptation measure, with particular focus on 'climate proofing' infrastructure. Measures included 'climate proofing' houses and improving drainage, electricity storage systems and emergency water supply. Some countries identified specific plans to fortify and retrofit homes, public buildings and commercial facilities to specifically withstand, for example, category 4 hurricanes. A common tool for achieving this is a hurricane resistance building code.

103. Ecosystem-based strategies were also highlighted in national reports, with some Parties noting that ecosystem maintenance and conservation strategies are key to climate adaptation. Some Parties emphasized the need to use both eco-disaster risk reduction and ecosystem-based adaptation in nature-based solutions; for example, developing coastal disaster-prevention forests and increasing disaster-resilient fishery areas. Ecosystem-based strategies included planting forests in high-risk coastal areas and planting wave-protection bamboo forests as flood and typhoon prevention dykes. Increasing the resilience of agriculture and fisheries by applying climate-smart strategies was also noted.

104. Adaptation planning and capacity-building efforts were also mentioned. These included formulating and implementing NAPs and integrating climate adaptation into disaster risk reduction plans and practices. Building institutional and staff capacity to deal with disasters and shifting towards risk-informed land-use planning were seen as important adaptation options. In addition, countries are taking actions such as updating stormwater management plans and planning to account for climate change in future infrastructure and building projects.

Figure 9
Adaptation options for cyclones identified by Parties



5. Observations, including information gaps

105. The information presented above illustrates assumptions identified by countries in their national reports regarding tropical cyclones. Some countries are expecting tropical cyclones to occur in the future, but they have differing expectations as to whether they will occur with increasing intensity and frequency or whether mainly intensity will increase. Most countries did not provide a time frame for the projected changes, other than towards the end of the century.

106. The scientific basis for projecting changes in the intensity and frequency of tropical cyclones is not well defined. Evidence and projections remain somewhat contradictory; for some time periods, there is no statistically significant difference in increase, whereas some studies show an increase and others a decrease in the observed and expected number of cyclones (IPCC, 2018a). There are also data limitations in preparing robust projections, including limitations in modelling storm tracks and associated precipitation due to model biases (IPCC, 2021). Therefore, numerous knowledge gaps remain.

E. Changes in run-off and river flooding

1. Global observations and projections of changes and impacts

107. The IPCC projects that river floods will be more frequent in parts of Central Africa and northern high latitudes, and less frequent in southern North America, southern South America, the Mediterranean, parts of Australia, and Southern Europe (IPCC, 2022,). With medium confidence, the frequency and magnitude of floods in some regions will be smaller under 1.5 °C than under 2 °C of warming, and human exposure to flooding will be substantially lower at 1.5 °C than at 2 °C (IPCC, 2018a). At 1.5 °C global warming (compared with 2 °C), 26–34 million less people could be at risk of increased flooding by

2050, and increases in potential flood fatality (of 5.7 per cent) and economic loss (of 0.9 per cent) could be avoided. Approximately half of the increase in economic losses may be mitigated by adaptation (IPCC, 2018a).

108. Run-off observations suggest that, from 1950 to 2012, precipitation and run-off increased over, inter alia, south-eastern South America, central and northern Australia, central and north-eastern United States, central and northern Europe, and most of Russia, and decreased over most of Africa, East and South Asia, eastern coastal Australia, south-eastern and north-western United States, western and eastern Canada, the Mediterranean and parts of Brazil (IPCC, 2018a). The IPCC (2018a) projects that warming of both 1.5 °C and 2 °C would expand the global land area with significant increases in run-off, and that warming of 2 °C would expand such areas more than 1.5 °C would (medium confidence).

109. These changes are expected to impact many sectors and economic activities; for example, increased run-off and reduced groundwater resources are expected to decrease water resources for livestock (IPCC, 2018a), and flooding and extreme weather can impact road, air, rail, shipping and pipeline transportation (IPCC, 2018a).

2. Observations and projections of run-off and river flooding in national reports

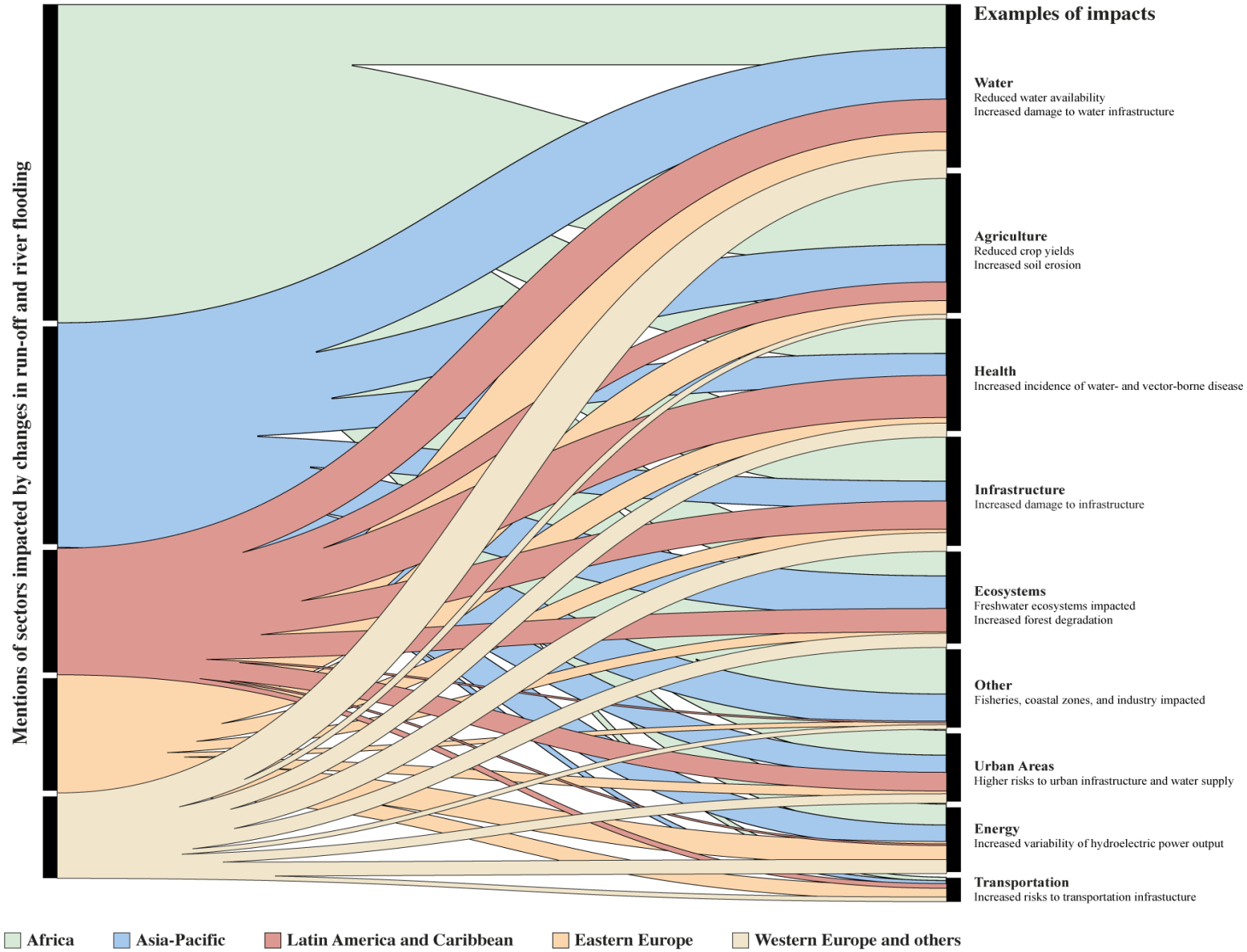
110. Some countries reported instances of major flooding, and some reported observed trends wherein the intensity and/or frequency of flooding has increased within their borders. Countries reported significant economic damage, livelihood loss and other adverse impacts of flood events. Such impacts were reported by both developed and developing countries, though the dynamics differ significantly given that flood risk is determined not only by the magnitude or frequency of flooding, but also by, inter alia, vulnerabilities of the population, the value of assets affected, and the capacity to cope with flood risks, which are linked to socioeconomic development and other conditions (IPCC, 2018a). Some Parties described their vulnerabilities to flood events only in general terms.

111. Some countries projected changes in flooding; these changes were often expressed qualitatively as expected increases in the frequency or magnitude of flood events, but sometimes quantitatively in terms of, for example, the percentage of the country expected to be affected by recurrent flooding or the number of floods expected per year. As observations and projections of run-off and river flooding are closely linked with heavy precipitation, this section should be read in conjunction with chapter IV.C above, which focuses on heavy precipitation. Information related to coastal flooding linked with SLR is available in chapter IV.G below.

112. Changes in run-off and river flooding are impacting, and are projected to increasingly impact, a wide variety of sectors. Examples include damage to infrastructure, energy production and transportation; reduction of crop yields and increased susceptibility of croplands and rangelands to degradation; increased stress on ecosystems; disruption to fisheries; and water supply contamination and damage to sanitation infrastructure. Urban areas are also at risk from flooding (see figure 10).

Figure 10

Impacts of river flooding and changes in run-off on various sectors



113. The increasing frequency and intensity of floods associated with climate change in some regions is linked with direct and indirect impacts on human health, including injury and death due to floods and increased incidence of vector-borne and waterborne diseases (e.g. cholera, malaria). The risk exists of potential reintroduction of malaria in currently malaria-free countries owing to climate change impacts such as floods. Beyond the adverse effects on physical health, potential increases in mental health issues linked to the trauma of extreme events such as flooding were also noted.

114. The national reports also point to social trends that may manifest partially as a result of flooding. These trends include increasing migration, both within and across borders.

115. Some countries outlined observations or projections related to run-off. Of these, some countries projected decreases in annual river run-off (e.g. a decrease between 3.4 per cent (RCP 2.6) and 10.9 per cent (RCP 8.5) by 2050 and between 3.15 per cent (RCP 2.6) and 13.5 per cent (RCP 8.5) by 2100), though more countries projected intensity of run-off to increase. Observed and projected changes often varied within countries from basin to basin.

3. Adaptation options identified in scientific assessments

116. Options for adapting to flood risk include implementing structural measures (spatial planning or engineered flood defences), using financial and fiscal instruments, bolstering community understanding and political support for safe development and building standards, and putting in place regulations that require local governments to engage with flood planning (IPCC, 2019). Flood zone mapping, land-use planning and flood zone building restrictions can build adaptive capacity to flood risk (IPCC, 2019). Taxes and subsidies that discourage, or do not encourage, undesirable activities (e.g. rebuilding in flood zones) are key instruments. Flood insurance can prove maladaptive by encouraging risky behaviours, though other measures, for example providing discounted insurance to those who undertake flood mitigation activities, can help counter this.

117. Nature-based solutions – including in combination with grey infrastructure – are attractive options for reducing the impacts of fluvial flooding in cities (IPCC, 2022).

118. Because many of these adaptation options, such as land-use planning and flood defences, operate on long time-horizons, decisions are often taken under uncertainty (IPCC, 2014) and the risk of maladaptation may arise where measures to reduce risk and vulnerability in the short term increase vulnerability in the long term (IPCC, 2014). A flood defence system that enables construction in a floodplain ahead of a large extreme event is one example. Planning of such measures therefore must be carefully considered, and their implementation may not automatically enhance adaptive capacity, strengthen resilience or reduce vulnerability.

4. Adaptation efforts, experiences and priorities identified in national reports

119. Measures for gathering, disseminating and assessing data related to run-off and river flooding feature in national plans as necessary to gaining a better understanding of and addressing related risks. Examples include studying or mapping flood risks, conducting flood vulnerability assessments, providing hydrological data for water resources management and engaging in research that addresses risks associated with run-off. Another knowledge-related measure being pursued involves the recovery of ancestral knowledge pertaining to water resources management.

120. As with other hazards, early warning systems were cited in national reports as key measures for adapting to flood risk, with Parties aiming to develop or improve such systems. Specific steps to improve early warning systems include developing a centralized database to process meteorological data and integrating indigenous knowledge into flood early warning systems. In addition to using these systems to warn of imminent flood risks, related measures also featured in national reports: educating the public on flood risk and emergency response, developing flood emergency response or recovery plans and engaging stakeholders in flood risk management.

121. Structural measures with respect to flood risk management included the upgrading or establishment of drainage systems and the construction or rehabilitation of dams, dykes and

storage tanks. Rainwater harvesting techniques that facilitate the infiltration of run-off water into the ground, such as terraces, diversion furrows and trenches, are also being considered. Structural nature-based solutions, such as promoting green infrastructure, conserving or reproducing ecosystem functions that help mitigate disaster risks, restoring peatlands to reduce downstream flood risk, creating riverside parks or restoring floodplains, 'giving space back to rivers' and combining nature-based solutions with traditional or technical solutions were also raised. Generally, the importance of designing, constructing and maintaining infrastructure considering run-off and flood risks was also noted.

122. Some countries reported on their use of policy and regulatory measures aimed at reducing the risk of flooding, such as land-use planning, restrictions and standards. Examples included developing flood risk standards governing the construction or rehabilitation of government funded or financed homes and properties, incorporating information on climate-related flood risks into dam safety guidelines, revising existing building standards to incorporate climate change considerations and using land-use restrictions to limit flood damage.

123. In some cases, adaptation measures prioritized by Parties that are not primarily targeted at reducing river flood risk are nonetheless expected to generate such risk reduction as an auxiliary benefit. This includes, for example, the expansion of agroforestry. The converse has also been highlighted; for example, ecosystem-based adaptation for integrated flood risk management is expected to increase water security and bolster agricultural productivity.

5. Observations, including information gaps

124. The adaptation measures prioritized by national and local governments in response to river flood risks reflect the combination of structural and non-structural measures outlined in scientific reports.

125. While Parties provided much information on flood-related risks, projections and measures, they did not always specify the type of flooding (river or otherwise) but rather mentioned flood events or risks in general. This makes it difficult to isolate information related to river flooding from that on, for example, inland or coastal flooding and determine the extent to which adaptation measures cited are intended to address a particular type of flood risk. Moreover, information specific to changes in run-off is scarce in national reports, particularly with regard to corresponding adaptation measures.

126. Beyond these information gaps, it is also unclear how well equipped Parties currently are to mitigate the risks of maladaptation to flood risks mentioned in para. 118 above. While they sometimes recognize explicitly the need to, for example, ensure that decisions related to infrastructure investment and design consider flood risk and other climate factors, the ways in which this is ensured are not outlined.

F. Increase in prevalence of drought and dryness

1. Global observations and projections of changes and impacts

127. Around half of the global population experiences severe water scarcity for at least one month per year owing to climatic and other factors (medium confidence) (IPCC, 2022). In some regions, including the Mediterranean, West Asia, parts of South America, much of Africa, and north-eastern Asia, the frequency and intensity of droughts have increased (IPCC, 2019) and are projected to increase, particularly in the Mediterranean and Southern Africa (IPCC, 2019). Droughts impact agriculture, water supply, energy production, water transportation, tourism, health, biodiversity and ecosystems (UNDRR, 2021). It is difficult to determine global trends owing to, inter alia, natural variability (droughts are a normal component of climate variability, and may be seasonal, multi-year or multi-decadal) and limitations of drought indices and precipitation data (UNDRR, 2021).

128. The IPCC expects that limiting global warming to 1.5 °C will substantially reduce the probability of extreme drought, precipitation deficits and risks to water availability in comparison with higher temperature increases (IPCC, 2018a). The risk of increased dryness

in the Mediterranean and Southern Africa is substantially higher at 2 °C than at 1.5 °C of warming (medium confidence) (IPCC, 2018a). Limiting warming to 1.5 °C may reduce the proportion of the global population exposed to a climate-induced increase in water stress by up to 50 per cent (with regional variability) compared with a 2 °C increase (IPCC, 2018a).

129. Assuming 'middle of the road' socioeconomic development (i.e. SSP2), it is projected that the dryland population vulnerable to water stress, drought and habitat degradation will reach 178 million people by 2050 at 1.5 °C of global warming, 220 million at 2 °C and 277 million at 3 °C (low confidence) (IPCC, 2019). Many cities are vulnerable to drought and water scarcity, including those in semi-arid or arid regions that rely on reservoirs or groundwater. At least 79 megacities have already suffered extensively (UNDRR, 2021). Low income countries – and particularly women, children, indigenous peoples and the elderly in those countries – are more impacted by water scarcity (IPCC, 2022).

130. It is likely that human influence has increased the chance of compound extreme events – where impacts are induced by a combination of events (IPCC, 2018a) – since the 1950s, including increases in the frequency of concurrent droughts and heatwaves at the global scale (IPCC, 2021). Heatwaves and droughts foster wildfires, and enhanced tree mortality has been attributed to heat and drought stress (IPCC, 2019). Moreover, heat and drought extremes have led to estimated national cereal crop losses of nearly 10 per cent in 1964–2007 and it is expected that climate change will reduce yields in areas already under heat and water stress (IPCC, 2019).

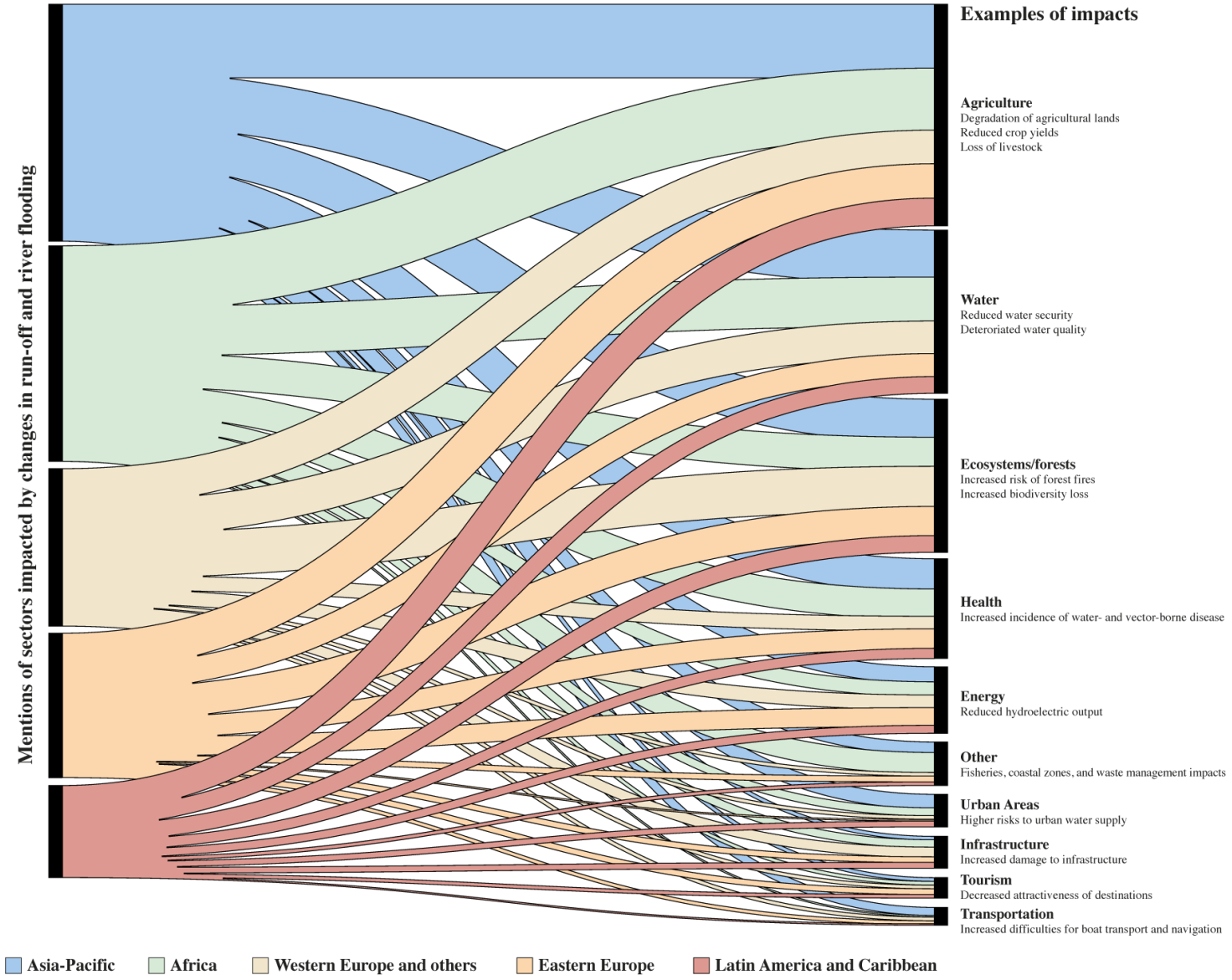
2. Observations and projections of drought and dryness in national reports

131. Many Parties identified drought and dryness as a significant risk. Of these, some described observed trends, including prolonged dry periods and more frequent and/or intense droughts, in some cases quantifying these in terms of annual rainfall, consecutive dry days or the percentage of drought events attributable to anthropogenic climate change. Moreover, some countries described especially severe, frequent or prolonged past drought events. In addition, about half of countries outlined projections of drought and dryness; some of these projections were quantified in terms of anticipated drought frequency, the percentage of the country that may be affected by persistent drought or drying trends, or changes in consecutive dry days indices. While most of the projections indicated future increases in droughts and dry spells, a few (six countries) indicated unchanged or decreasing trends. In many cases, however, countries expect these trends to manifest in only some parts of their territory.

132. Some countries identified sectors that will be especially impacted by droughts and dryness, including agriculture, water, health and forests (see figure 11). Agriculture is by far the sector the most highlighted as being affected, followed by the water sector and ecosystems.

Figure 11

Impacts of drought and dryness on various sectors identified by Parties



133. Countries estimated and reported the impacts of drought in a variety of ways, including as monetary losses, crop yield losses, land affected or lost, and the number of people who have experienced food insecurity or limited access to water. The impacts of droughts are largely indirect, affecting, for example, employment, international trade and global food prices, and not well documented or assessed. Estimates thus likely underestimate the costs and consequences of drought events (UNDRR, 2021).

3. Adaptation options identified in scientific assessments

134. Proactive measures designed to prepare communities for drought and mitigate drought risk are more efficient than reactive drought relief in limiting damage (high confidence) (IPCC, 2019). These protective measures include drought resilience policies, preparedness planning, early warning and monitoring, and improvements in water use efficiency, which help to foster sustainable land management and improve agricultural livelihoods (IPCC, 2019).

135. Many options involve reducing water demand, for example switching to drought-tolerant or low-water crop varieties, improving irrigation efficiency, reusing wastewater for irrigation, controlling leaks, implementing water-saving programmes and adopting water efficiency certifications (IPCC, 2014). Irrigation schemes are threatened by drought and can increase vulnerability; the viability of such systems should thus be carefully assessed (IPCC, 2014), Other options aim at increasing water supply, such as diversification of sources (spatially and by source type) (IPCC, 2014), including water harvesting (IPCC, 2014). Nature-based solutions, such as land regeneration, green belts and reforestation, can also provide adaptive responses (UNDRR, 2021). However, high rates of warming and drought may threaten the success of solutions such as peatland restoration and forest expansion (IPCC, 2022). Furthermore, contingency measures, such as crop insurance, can bolster resilience to drought events. Finally, financial instruments, for example drought funds, rebates and tax measures, can incentivize adaptation action across all these categories (UNDRR, 2021).

4. Adaptation efforts, experiences and priorities identified in national reports

136. In their national reports, countries prioritized adaptation options to address drought and dryness. The options that address demand for water included transitioning to drought-tolerant or drought-resistant crops, installing water-efficient irrigation systems or optimizing irrigation systems, and halving water leakage rates. Options that address water supply included increasing rainwater harvesting, conducting assessments of water supply safety levels and drought risks, making provisions for additional water storage to buffer against prolonged drought, and preserving water catchments in areas facing increased drought risk. Some adaptation measures are broad and may address both supply and demand, including investing in drought-resilient water infrastructure and developing drought management plans and national water policies. Prioritized nature-based solutions included rehabilitating degraded lands and protecting forests from deforestation.

137. Countries aim to establish or improve climate monitoring and forecasting systems, early warning systems and meteorological forecasts, with the objective, among others, of reducing morbidity and mortality from extreme events. In many cases, these measures are not drought-specific, but aimed at addressing multiple climate-related hazards, including drought.

138. In addition to implementing these proactive measures to mitigate and reduce drought risk, some countries are preparing to better react to droughts and dry spells by, for example, developing drought contingency plans or drought management plans; integrating climate change related concerns (including in relation to drought) into emergency planning, training for health and emergency services personnel, and medical services; and providing crop insurance or compensation through schemes addressing damage caused by drought and other hazards.

139. Also highlighted in the national reports was the value of indigenous knowledge in adapting to droughts and water scarcity. In addition to general recognition of rich indigenous knowledge, plans to document indigenous knowledge and practices and use farmers'

indigenous knowledge and traditions to adapt to drought conditions were reported. Gender-responsive approaches, such as empowering women and mainstreaming gender in interventions addressing water scarcity and drought, were also mentioned.

140. A few countries reported regional or subregional initiatives dedicated to addressing drought and dryness. Examples included permanent subregional committees for drought control that invest in achieving food security in the face of drought and desertification, and regional capacity-building initiatives equipping stakeholders with tools for improving their drought emergency response and preparedness by producing new strategies for drought risk assessment and better monitoring drought risk.

141. A few countries documented spontaneous or autonomous adaptation actions being taken by individuals and communities domestically. These actions included fighting deforestation, using night grazing, migrating, selling more livestock than usual or selling non-productive assets, and limiting portion sizes during meals. Some of these may, however, be maladaptive and thereby increase vulnerability or reduce resilience to future climate change related shocks (see chap. VI below for further discussion of maladaptation).

5. Observations, including information gaps

142. In general, the adaptation options being prioritized and pursued by countries and cities are aligned with those identified in the scientific literature, including IPCC reports, with many Parties outlining proactive measures targeting both water supply and water demand.

143. Droughts are, however, "among the most complex and severe climate-related hazards encountered" (UNDRR, 2021, p.22). The information reported by countries in relation to drought in many ways reflects the difficulties that also constrain determinations of long-term global drought trends; many Parties did not provide projections of how drought and dryness will manifest within their countries, and those Parties that provided projections with confidence levels tended to cite low or moderate confidence in those projections. It is therefore difficult to gauge the extent to which adaptation actions being planned and implemented to address drought are calibrated to the level of future drought risk.

144. Moreover, while adaptation measures for drought and dryness are ubiquitous in national reports, the sectors most impacted by these hazards (agriculture and water resources) are also among those for which developing countries express the highest proportion of support needs (see chap. VI below). At the same time, many national reports highlighted significant – sometimes recurring – adverse effects of droughts on economies and populations that are already evident.

G. Sea level rise

1. Global observations and projections of changes and impacts

145. Global mean sea level is projected to rise by 0.26–0.77 m by 2100 relative to the 1986–2005 level for 1.5 °C warming, and by an additional 0.04–0.16 m for 2 °C warming. SLR will continue beyond 2100 even if warming is limited to 1.5 °C (IPCC, 2018a). Future warming, including at 1.5 °C or 2 °C, could trigger instability of the Greenland and Antarctic ice sheets (IPCC, 2018a). Risks increase disproportionately between 1 °C and 2 °C warming and become high above 3 °C owing to the potential for a large and irreversible SLR from ice sheet loss, including a possible near complete loss of the Greenland ice sheet over a millennium or more, contributing up to 7 m of global mean SLR (IPCC, 2014).

146. Warming amplifies the exposure of human and ecological systems located on small islands and in coastal areas and deltas to the risks associated with SLR, including saltwater intrusion, flooding and damage to infrastructure (IPCC, 2018a). Globally, millions of people may be at risk from SLR, and at 2 °C of warming, more than 90 per cent of coastlines may see SLR above 0.2 m (IPCC, 2018a) (see table 2). A slower rate of SLR reduces risks and enables more adaptation efforts to be made (IPCC, 2018a).

Table 2
Land and people exposed to sea level rise, assuming no protection or adaptation efforts

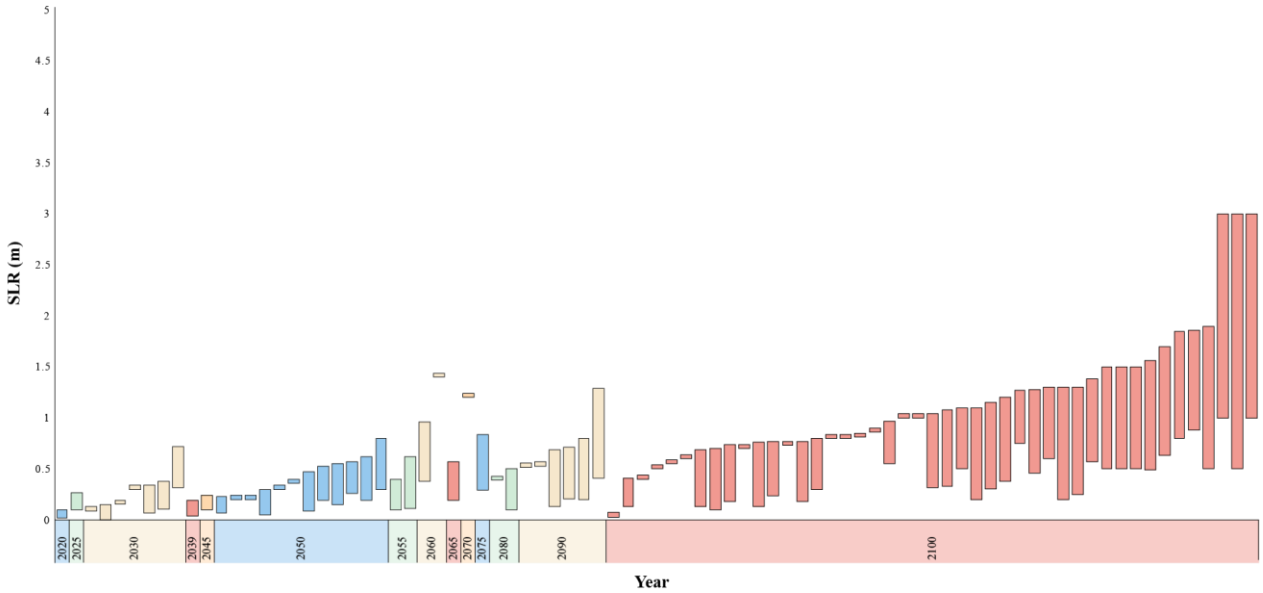
		Year	
Climate scenario	*Impact factor(50th percentile)*	*2050*	*2100*
1.5 °C	Temperature rise compared with 1850–1900 (°C)	1.71	1.60
	SLR compared with 1986–2005 (m)	0.20	0.40
	Land exposed (km^2)	574,000	620,000
	People exposed (millions)	127.9–139.0	102.7–153.5
2 °C	Temperature rise compared with 1850–1900 (°C)	1.76	2.03
	SLR compared with 1986–2005 (m)	0.20	0.46
	Land exposed (km^2)	575,000	637,000
	People exposed (millions)	128.1–139.2	105.5–158.1

Source: Adapted from IPCC (2018), p.234, table 3.3.

2. Assumptions about sea level rise in national reports

147. In their national reports, many Parties identified SLR as a key threat, describing its anticipated scope and both quantitative and qualitative consequences. Of these Parties, many also provided quantified information on observed or projected SLR. This included observed rates of SLR ranging from 1.0 to 8.2 mm/year; and observed absolute levels of SLR. In terms of projected SLR, countries provided anticipated absolute ranges of SLR for various time frames. Figure 12 summarizes those projections.

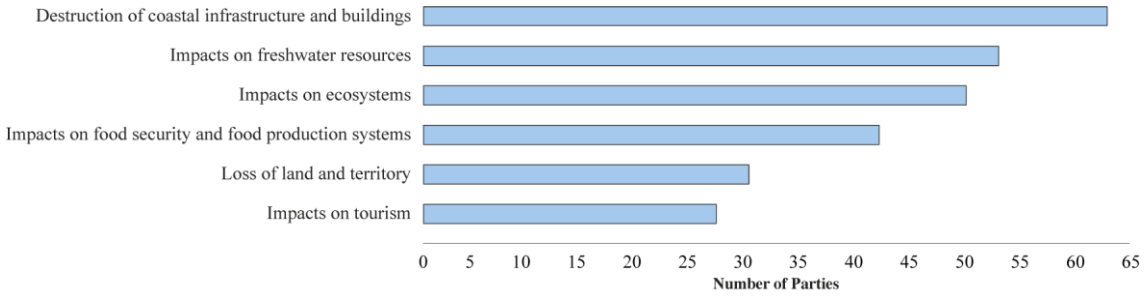
Figure 12
Sea level rise projected by Parties in national reports



148. In addition to the quantified observations and projections of SLR, Parties identified how SLR and impacts associated with it threaten various sectors and areas. They highlighted impacts on, for example, infrastructure, water resources, ecosystems, food production, land, tourism, culturally significant sites and buildings, health and energy production. Some indicated that impacts of SLR can lead to loss of habitability and associated displacement. Figure 13 captures the main impacts of SLR identified by Parties. In addition, some Parties

provided quantified assessments of impacts, including projected losses in food production or of amount of land, or the proportion of infrastructure threatened.

Figure 13
Impacts of sea level rise identified by Parties



3. Adaptation options identified in scientific assessments

149. While mitigation will reduce SLR and the need for adaptation (IPCC, 2018a), the IPCC considers that adaptation to SLR will be essential even at 1.5 °C warming (IPCC, 2018a).

150. Managing and restoring coastal habitats and ecosystems, including mangroves, seagrass beds, salt marshes and coral reefs, may reduce the impacts of SLR by protecting coasts and deltas, though with limitations (IPCC, 2018a). Integrated coastal zone management (IPCC, 2018a) and integration of coastal infrastructure with ecosystems offer further strategies. Maintaining sediment supply to coasts would support mangrove ecosystems and offer further protection (IPCC, 2018a).

151. Infrastructure construction and reinforcement, coastal defence construction and hardening, sea wall construction and enhanced floodwater management can also reduce the impacts of rising seas (IPCC, 2018a).

152. Other options include providing alternative livelihoods and food sources for coastal populations; adopting organized migration; and reducing impacts from tourism, fishing, coastal development, reduced sediment supply, and unsustainable aquaculture and agriculture (IPCC, 2018a).

153. Participatory decision-making and settlement designs that promote equity and sustainability can enhance synergistic outcomes between development and relocation (IPCC, 2018a). In addition to feasibility, cost and scalability, the implications of adaptation options on ecosystems should be assessed (IPCC, 2018a), as should feedback, such as the landward migration of wetlands and the adaptation of infrastructure (IPCC, 2018a).

154. There are few studies on the limits of adaptation to SLR. While some ecosystems (e.g. mangroves) may be able to move shoreward as sea levels increase, coastal development (e.g. coastal buildings, sea walls and agriculture) can interrupt these transitions (IPCC, 2018a).

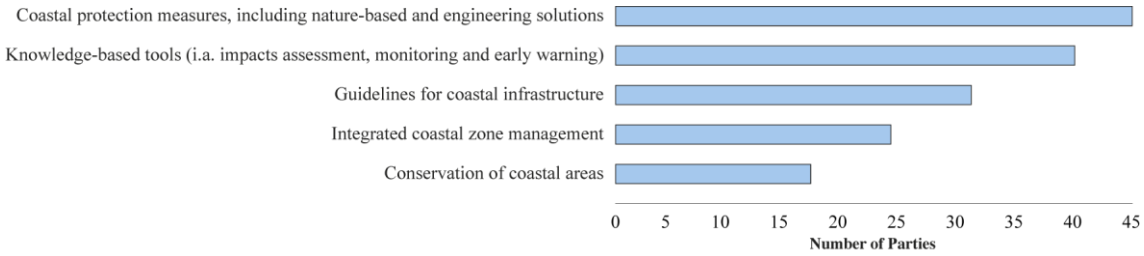
155. Adaptation to SLR is occurring, including through migration, ecosystem-based adaptation, infrastructure and defence construction, salt-tolerant food production, early warning systems, insurance and education. Planned and autonomous adaptation are widespread, but many countries are in the early stages or are not yet adapting. Adaptation is region- and subsector-specific, and is linked to non-climatic factors. Adaptation pathways assist long-term planning but are not used widely despite knowledge of long-term risks (IPCC, 2018a).

4. Adaptation efforts, experiences and priorities identified in national reports

156. In their national reports, many Parties described measures for protecting coastal and low-lying areas, including river deltas, and addressing SLR, erosion and saltwater intrusion. Approaches included assessing and monitoring impacts on and vulnerability of coasts, planning for coastal conservation, applying nature-based and engineering solutions for coastal restoration and protection, and developing standards, regulations and guidelines for construction and flood protection. Parties also described integrated coastal zone management

approaches. Some identified preventing loss of land as a major objective of adaptation strategies. See figure 14 for an overview of adaptation measures addressing SLR.

Figure 14
Types of adaptation measures to sea level rise and associated impacts identified by Parties



5. Observations, including information gaps

157. The information presented above illustrates that in general terms, the SLR assumptions identified by countries in their national reports are consistent with the global projections of the IPCC. However, the national reports provide an unclear picture of the extent to which national adaptation efforts are specifically based on the projected levels of SLR. This is, in particular, due to variations in the timescales for SLR projections on the one hand, and adaptation planning on the other.

158. In terms of adaptation priorities, activities prioritized by countries corresponded to adaptation options for SLR-related impacts identified by the IPCC, with a clear collective preference for ecosystem-based adaptation, coastal protection engineering and integrated coastal zone management. The focus on providing alternative livelihoods for coastal populations or adopting migration as an adaptation approach is less pronounced in the adaptation priorities identified by Parties.

159. Both IPCC reports and the national reports of Parties emphasize the interconnected nature of the various impacts associated with SLR, and how coastal areas are often threatened by a combination of SLR and other impacts, such as strengthened storm surges, precipitation change and extreme events.

H. Changes in ocean chemistry

1. Global observations and projections of changes and impacts

160. The IPCC reports that increases in acidification, decreases in dissolved oxygen levels (deoxygenation), and changes in salinity are being measured for most oceans (IPCC 2021).

161. It is virtually certain that pH levels have decreased in the last 40 years (IPCC 2021), indicating increased ocean acidity. Surface pH levels have decreased by 0.003–0.026 per decade (IPCC 2021), which is unprecedented in the past 65 million years (IPCC, 2018a). The change in pH results mainly from the oceans absorbing 30 per cent of anthropogenic carbon dioxide emissions, but also, inter alia, coastal pollution (IPCC, 2018a).

162. Increased sea surface temperatures have reduced ocean oxygen levels by 2 per cent (IPCC 2021). These levels are also affected by acidification, SLR, changes in stratification, precipitation, winds and storms.

163. Human activity contributes to changes in regional salinity levels (IPCC 2021), which increase in some areas and decrease in others. In northern oceans, salinity decreases because of freshwater melting from sea ice, glaciers and ice sheets, whereas in lower latitudes, salinity increases because of higher sea surface temperatures and evaporation (IPCC, 2018a).

164. There is high confidence that ocean chemistry will continue to change during this century. Acidity is projected to increase by the end of the century, with pH levels decreasing by 0.16 ± 0.002 for SSP1–RCP 2.6 and 0.44 ± 0.005 for SSP5–RCP 8.5. Greater decreases are projected for polar oceans (IPCC 2021). Climate models project an additional 32–71 per

cent decrease in oxygen levels in the upper 600 m of the oceans by the end of the century (IPCC 2021). The contrast in regional salinity levels is expected to continue (IPCC 2021).

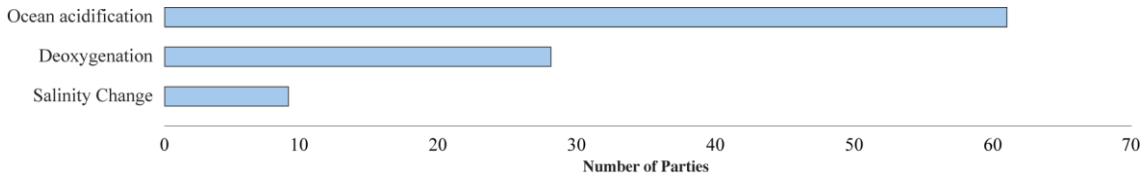
165. The IPCC reports with high confidence that at 1.5 °C warming, acidification will impact the calcification, growth, development, survival and abundance of many marine species, from algae and corals to fish. These impacts are projected to be greater at 2 °C warming (IPCC, 2018a). Fisheries and aquaculture are highly vulnerable to acidification (IPCC, 2014), which impacts marine communities, species, ecosystems and food webs. (IPCC, 2018a).

166. Deoxygenation combined with local pollution has resulted in more than 700 coastal regions becoming hypoxic, with dissolved oxygen levels of less than 2 mg/litre (IPCC 2021). Deoxygenation affects marine organism behaviour, increases marine organism mortality, and displaces oxygen-dependent organisms, including fish and invertebrates. Such impacts are virtually certain to increase with higher temperatures, but the exact impacts of 1.5 °C versus 2 °C warming are not fully understood (IPCC, 2018a).

2. Observations and projections of ocean chemistry in national reports

167. Some Parties reported on the impacts of climate change on ocean chemistry in their national reports. The numbers reporting changes in ocean acidification, deoxygenation and salinity are shown in figure 15.

Figure 15
Observed changes in ocean chemistry identified by Parties

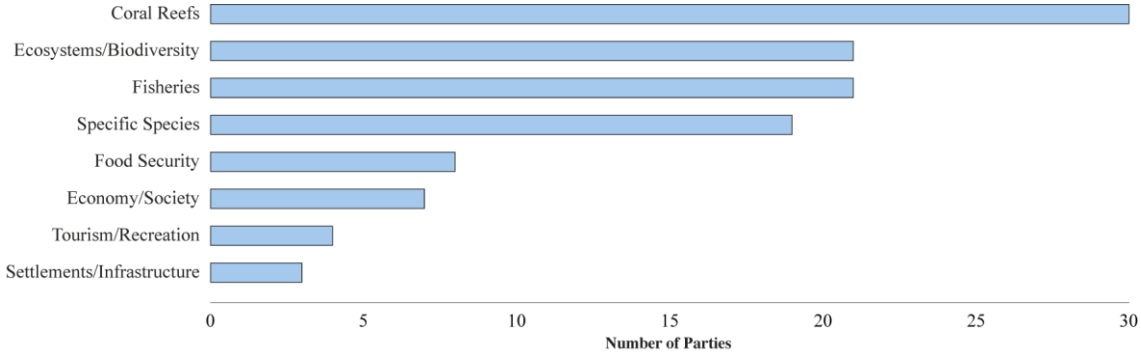


168. While some Parties noted the impacts of changing ocean chemistry, only a few reported a measured change in acidity (a decrease in pH of 0.1). Another indicator of ocean acidification is aragonite saturation. This metric is correlated with acidity but is a more precise measure of the availability of calcium and carbonate ions for calcification (i.e. the process through which corals and other species produce their shells) (Mongin et al., 2016). A few SIDS reported observed decreases in aragonite saturation levels (lower levels are more harmful to marine species that calcify) and provided projections of when the saturation levels would become stressed.

169. A few countries projected changes in ocean chemistry, including reduced pH levels over this century (e.g. a decrease in pH of 0.33 by 2100, and higher increases in acidity in high latitudes in comparison to subtropical waters) and 2–3 per cent increase in ocean salinity. No projections of future deoxygenation were reported.

170. Some Parties described the biological or societal impacts of changes in ocean chemistry (see figure 16). Most of these discussed the effects of increased ocean acidification. Such impacts were often considered together with other climate change impacts, in particular SLR and changes in coastal storms. This illustrates how ocean chemistry change and its effects are closely related to other ocean-related climate impacts. Among the impacts specifically connected with ocean chemistry change, Parties highlighted deoxygenation, which harms marine biomass, and increased salinity, which reduces chlorophyll formation and marine ecosystem health and harms fish and shellfish in lagoons and estuaries.

Figure 16
Biological and societal impacts of ocean chemistry change identified by Parties



171. The impacts of ocean acidification on coral reefs was mentioned by most Parties who described impacts of ocean chemistry change, closely followed by the impacts of changes in ocean chemistry on marine ecosystems or biodiversity, and fisheries. Some Parties mentioned specific species such as crustaceans, molluscs and pelagic fish (e.g. tuna). The few Parties describing societal impacts mentioned food security more than other concerns but also mentioned tourism and settlements.

3. Adaptation options identified in scientific assessments

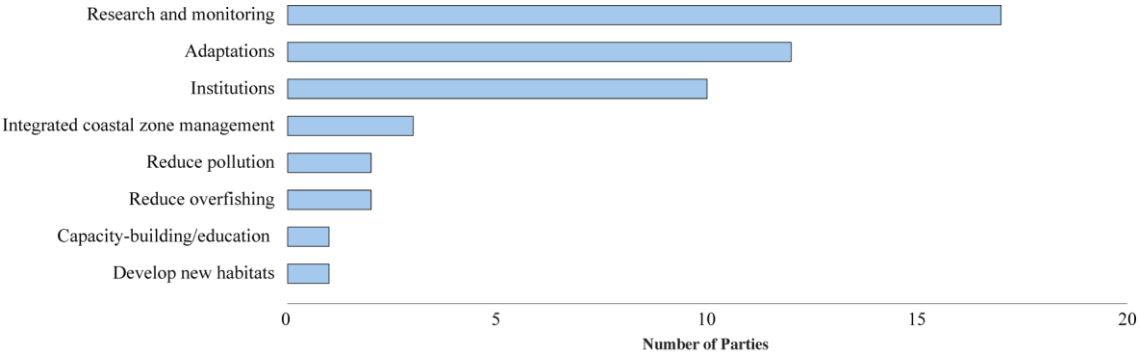
172. The IPCC states that active ocean geoengineering to offset adverse changes in ocean chemistry could be harmful to marine ecosystems (IPCC, 2014). In contrast to such direct interventions, the IPCC described how reducing other stresses such as overfishing can help improve the capacity of coastal ecosystems to buffer climate impacts (IPCC, 2014) The IPCC also concluded that reducing coastal pollution, which will limit anthropogenic sources of organic carbon in benthic areas, should limit deoxygenation in coastal waters and lower the number of hypoxic areas (IPCC, 2018a).

173. The IPCC also mentions ecosystem-based management, which addresses all human interactions with ecosystems, the ecosystem approach, which integrates conservation and sustainable development into ecosystem management, and adaptive management, which monitors and makes adjustments on the basis of changed conditions, as strategies to be followed to adapt to climate change impacts on the oceans (IPCC, 2014).

4. Adaptation efforts, experiences and priorities identified in national reports

174. Some Parties reported on measures they are taking regarding ocean chemistry change. The Parties described their efforts in conducting research and monitoring, creating and participating in institutions, implementing adaptation actions, and supporting education on ocean chemistry changes and impacts (see figure 17).

Figure 17
Adaptation options for ocean chemistry change identified by Parties



175. More Parties described their support of research and monitoring of changes in and impacts of ocean chemistry than any other effort. Some are measuring changes in chemistry (e.g. pH levels), while others are researching and monitoring the biological impacts of

changes in ocean chemistry. Most of the monitoring and research is being done on acidification.

176. The institutional efforts involve participating in the work of international research organizations such as the Pacific Partnership on Ocean Acidification, the Pacific Coast Collaborative and the Biological Impacts of Ocean Acidification. Parties also mentioned working with international institutions that are addressing adaptation to ocean impacts such as the Secretariat of the Pacific Regional Environment Programme.

177. Measures directly addressing the impacts of ocean chemistry change included creating institutions to address climate risks to oceans, for example, developing a climate change policy framework and an ocean implementation plan; introducing integrated coastal zone management; taking specific steps to limit marine pollution; protecting and developing habitats; and relocating fisheries.

5. Observations, including information gaps

178. While some Parties discussed observed or projected changes in ocean chemistry, a much smaller number quantified the changes or described specific observed impacts of such changes on the marine environment or on society.

179. It is notable that while the IPCC highlights the reduction of other stresses to marine areas vulnerable to changes in ocean chemistry, such as pollution and overfishing, few Parties that discussed measures being taken on ocean chemistry described taking on such adaptations. A few Parties mentioned steps being taken to reduce other stresses on the marine environment but no Parties mentioned approaches such as ecosystem-based management, ecosystem management or adaptive management.

I. Changes in ocean circulation and temperature

1. Global observations and projections of changes and impacts

180. The temperature of the upper ocean (0–700 m) has increased (IPCC. 2018a). The ocean surface warmed in 1950–2016 by 0.11, 0.07 and 0.05 °C per decade in the Indian, Atlantic and Pacific Oceans, respectively, with the greatest changes being observed at high latitudes (IPCC, 2018a). The 0–2,000 m layer reached a new record temperature in 2019, and warming is expected to accelerate (WMO, 2021).

181. The impacts of increased ocean temperature include:

(a) Thermal expansion, which increases SLR (WMO, 2021; IPCC, 2018a);

(b) Marine heatwaves (WMO, 2021; IPCC, 2018a);

(c) Extreme events such as strong storms, flooding and ENSO (IPCC, 2018a, p.205 and 222);

(d) Coral reef damage (IPBES, 2019; IPCC, 2018a): at 1.5 °C warming, about 70–90 per cent of reefs might degrade, and at 2 °C warming, this figure may reach 99 percent (IPCC, 2018a). Corals provide resources to over 500 million people and are worth USD 5 billion annually (IPCC, 2014). Coral reef degradation impacts tourism (IPCC, 2014) and the availability of fish and invertebrates (IPCC, 2014);

(e) Changes in species ranges (IPCC, 2018a), for example, the poleward expansion of temperate fish species (IPCC, 2014). Limiting warming to 1.5 °C decreases the risk of extinction and catch declines (IPCC, 2018a);

(f) Reduced polar summer sea ice (IPCC, 2018a);

(g) Changes in timing of phytoplankton blooms (IPCC, 2014);

(h) Decreased oxygen solubility (IPCC, 2018a).

182. Regarding ocean circulation, upwelling-favourable winds have intensified in the California, Benguela and Humboldt current upwelling systems, but weakened in the Iberian system and remained neutral in the Canary system (IPCC, 2018a). AMOC has likely

weakened, but limited evidence links this weakening to anthropogenic warming (IPCC, 2018a).

183. General Circulation Models project a strengthening of the Benguela, Canary and Humboldt systems (IPCC, 2018a). It is very likely AMOC will weaken, with best estimates being 11 per cent under RCP 2.6 and 34 per cent under RCP 8.5. No evidence indicates AMOC weakening will be significantly different for 1.5 °C versus 2 °C of warming (IPCC, 2018a). Changes in circulation can impact marine ecosystems by connecting regions and facilitating the circulation of species and disease agents. Risks are projected to be greater than they currently are at 1.5 °C and 2 °C. Weakening of AMOC is projected to be highly disruptive (IPCC, 2018a).

2. Assumptions about ocean circulation and temperature in national reports

184. Some Parties reported observed increases in sea surface temperature, which they expressed as:

(a) Absolute figures (e.g. 1 °C of warming of surrounding oceans in the last 100 years);

(b) Changes per decade within a specific time frame (e.g. 0.34 °C per decade in 1982–2019; a range of 0.1–0.15 °C per decade);

(c) An annual rate (e.g. an increase of 0.04–0.05 °C per year since the beginning of the 1980s).

185. Few parties also reported sea surface temperature change observations for particular islands, in parts of key ocean currents in territorial waters, and in specific water bodies. Further, they reported on temperatures observed during certain events; for example, sea surface temperature of 3–5 °C above normal was reported to have occurred during the 1998 ENSO event.

186. Many Parties indicated they expect sea surface temperature to increase further. Some Parties reported specific projections based on model simulations, for example:

(a) An increase of 0.6–0.8 °C by 2035, 1.2–2.7 °C by 2100, 1.6–1.8 °C by 2080 and 2.3 °C by 2100 in the Pacific region;

(b) An increase of 0.8–3 °C by 2080 in the Caribbean Sea;

(c) An increase of 4 °C in 2081–2100 from the 1985–2005 level;

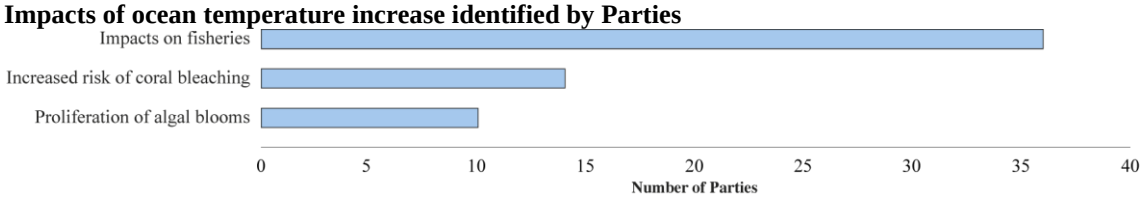
(d) An increase of about 1 °C in winter in the next 50 years, and of 3–4 °C in the south, subject to uncertainties due to natural variability and reference periods, in the Barents Sea.

187. Some Parties described potential changes in key ocean currents, including a tropicalization of the equatorial heating zone of the Benguela Current, while acknowledging uncertainties due to secular dynamics and recent phenomena such as the Benguela Niño.

188. Many Parties described how changes in ocean temperature and circulation impact natural and human systems (see figure 18). Sea surface temperature change is expected to have impacts on, in particular, fisheries, coral reefs and coastal ecosystems. Ocean circulation change, while described in fewer of the reports, is considered to have impacts on reefs and on fish species and stocks, and to increase salinity and sedimentation. The impacts of changes in sea surface temperature and ocean circulation are connected with other ocean-related risks, in particular SLR (see chap. IV.G above) and ocean acidification (see chap. IV.H above).

Figure 18

Impacts of ocean temperature increase identified by Parties



189. Several Parties described how ocean temperature increases will impact fisheries; namely, they will threaten the production of fish and shellfish by causing migration and loss of supporting ecosystems. Such developments threaten food security, coastal livelihoods, health, GDP and government revenue.

190. Parties reported on past mass coral bleaching events, which sometimes caused a near-complete loss of individual reefs and which affected fish abundance. Ocean temperature increase is considered to increase the risk of coral bleaching, which is projected to trigger losses of biodiversity, fish stocks (including highly migratory tuna), coastal defences and tourism income. A greater incidence of ENSO is expected to increase the risk of coral bleaching and associated impacts on biodiversity and fisheries.

191. Sea surface temperature increase is expected to trigger algal blooms, which can damage corals and harm fish, and increase the risk of food poisoning in humans owing to contamination of fish and other marine resources. Sea surface temperature change also causes stronger marine heatwaves, as well as damage to ecosystems (e.g. seagrass beds, mangroves) and other vegetation, thus undermining coastal protection, increasing the risk of appearance of novel diseases and parasites, and threatening seaweed production.

192. The anticipated impacts of ocean circulation change include higher coastal salinity and disruption of upwelling, with consequent impacts on fisheries and marine ecosystems, including outcrop pulses of the planktonic system in, for example, the Benguela Current.

3. Adaptation options identified in scientific assessments

193. Ocean temperature and circulation changes are associated with other ocean-related climate hazards. Therefore, the review for this report identified few adaptation options aimed specifically at addressing ocean temperature and circulation changes in the literature. Rather, options for adapting to other ocean-related hazards will also facilitate adaptation to the consequences of ocean temperature and circulation changes.

4. Adaptation efforts, experiences and priorities identified in national reports

194. Several Parties identified changes in sea surface temperature and ocean circulation as key ocean-related hazards and indicated the general need to adapt to higher water temperatures along with other coastal risks. However, given the interconnected nature of marine hazards, they reported few adaptation options that directly assess the impacts of changing ocean temperature and circulation, with the exception of efforts to develop models and enhance monitoring of sea surface temperature and ocean circulation. Overall, adaptation measures to enhance the resilience of fisheries, coral reefs and marine ecosystems help address the impacts of ocean temperature and circulation change. Chapters IV.G and IV.H above provide more information on such measures.

195. As measures to enhance the resilience of ocean ecosystems and resources, Parties highlighted the following measures:

(a) To protect fisheries from ocean-related climate hazards, Parties have focused research and development on changing fish stocks and productivity, aquaculture and sustainable fish farming techniques, diversification of coastal livelihoods, capacity-building, sustainable management, habitat protection (e.g. implementing marine protected areas and restoring habitats and mangroves), financial instruments (e.g. insurance), and monitoring, control and surveillance (including traceability of fishing activities);

(b) Actions to protect coral reefs include artificial reef projects and policies to protect coral reefs, which also have the benefit of helping local fish stocks recover;

(c) Some Parties described investments in the ocean and the 'blue economy' and efforts to protect marine and coastal ecosystems, with a focus on coral reef, seagrass and mangrove restoration and conservation. Marine monitoring and surveillance systems and programmes were also considered important.

5. Observations, including information gaps

196. While the risks of ocean temperature and circulation change are well documented in scientific publications and national reports, they cannot be isolated from other ocean-related climate risks, in particular SLR and ocean acidification. These three risks have many shared impacts, and similar adaptation options can help address them. Nexus-based approaches to adaptation in coastal and ocean systems are likely to be the most effective.

197. The adaptation efforts identified by Parties are generally consistent with the types of impacts identified in scientific reports; for both, the focus is on the adaptation of fisheries and coral reefs and related efforts to protect marine ecosystems against ocean-related climate risks.

198. The information provided by Parties on their adaptation efforts generally does not indicate whether or which long-term assumptions about ocean temperature rise inform the articulation of adaptation efforts.

J. Decrease in sea ice

1. Global observations and projections of changes and impacts

199. According to the IPCC, the annual Arctic sea ice extent decreased over 1979–2012, very likely at a rate of 3.5 to 4.1 per cent (0.45 to 0.51 million km^2) per decade (IPCC, 2018a). The probability of a sea ice-free Arctic Ocean during summer is substantially lower at 1.5 °C global warming than at 2 °C. With 1.5 °C warming, the IPCC projects one sea ice-free Arctic summer per century, but this likelihood increases to at least one per decade with 2 °C global warming (IPCC, 2018a).

200. In the Antarctic, sea ice shows regionally contrasting trends, such as a strong decrease in coverage near the Antarctic peninsula and the Bellingshausen and Amundsen seas, but an increase in the western Ross Sea. The IPCC describes an observed long-term increase in overall sea ice coverage in the Southern Ocean, although with comparably low coverage from September 2016 onward (IPCC, 2018a). The limited amount of data on Antarctic sea ice precludes firm conclusions about southern hemisphere sea ice losses (IPCC, 2018a).

201. Sea ice change can impact regional ecosystems, habitats, fisheries and industry in the following ways:

(a) In terms of ecosystems, photosynthetic communities (e.g. macroalgae, phytoplankton and microalgae) dwelling under sea ice are changing (IPCC, 2018a), and large-scale changes to the food web are occurring;

(b) In terms of habitats, sea ice loss in the Antarctic threatens the habitats of krill, with ramifications for seabirds and whales (low-medium confidence) (IPCC, 2018a). The losses of sea ice at 1.5 °C and 2 °C of warming will result in habitat losses for seals, polar bears, whales, seabirds and other marine life (IPCC, 2018a). Many species and ecosystems have a limited ability to adapt to warming of 2.6 °C or more, particularly in the Arctic (IPCC, 2018a);

(c) In terms of fisheries, there is strong agreement and robust evidence that photosynthetic species will change because of ice retreat and changes in temperature and radiation, and this is very likely to benefit the productivity of fisheries in the northern hemisphere spring bloom system (IPCC, 2018a). As ice retreats, mixing of the water column increases, and phototrophs have increased access to seasonally high levels of solar radiation. There is evidence that this is already happening for some fisheries in the northern hemisphere, such as the Bering Sea, although these positive impacts on the productivity of fisheries may be short-lived (IPCC, 2018a);

(d) In terms of industry, reduced Arctic sea ice opens shipping and commercial corridors (IPCC, 2018a).

2. Observations and projections of sea ice in national reports

202. Since the risk of decreasing sea ice is geographically limited and given the sparse land coverage of the southern polar regions, mainly countries in the northern hemisphere have considered the issue of sea ice in their national reports. They have observed major downward trends in sea ice extent, sea ice thickness, duration of coastal ice cover and level of 'first year' ice. Quantified observations of sea ice include:

(a) In the Arctic Ocean, a 65 per cent decline in ice thickness in 1975–2012; reductions in average annual area of 3.5–4.1 per cent (0.45–0.51 million km^2) per decade and in summer minimum sea ice (permanent ice) of 9.4–13.6 per cent (0.73–1.07 million km^2) per decade in 1979–2012; and record low minimum ice extent in 2012 and maximum ice extent in 2016;

(b) In the Baltic Sea, a reduction in maximum ice cover from 420,000 km^2 to 400,000 km^2 in the past 50 years;

(c) In the Sea of Okhotsk, a long-term decline in sea ice in 1971–2016.

203. Parties provided projections about sea ice levels, including that rapid reductions in summer Arctic sea ice is likely to continue, that the Arctic Ocean might be ice-free in the summer by mid-century or as early as the late 2030s, and that sea ice in the Sea of Okhotsk in January to April might decrease by 75 per cent by 2100.

204. Parties identified how sea ice change will impact various domains, as follows (see figure 19):

(a) Impacts on infrastructure, such as damage due to loss of protective sea ice and increased wave erosion, and loss of ice roads used for transport;

(b) Impacts on communities and livelihoods of indigenous peoples, including risks to food and water security, loss of traditional knowledge, logistical difficulties and the possible need to relocate;

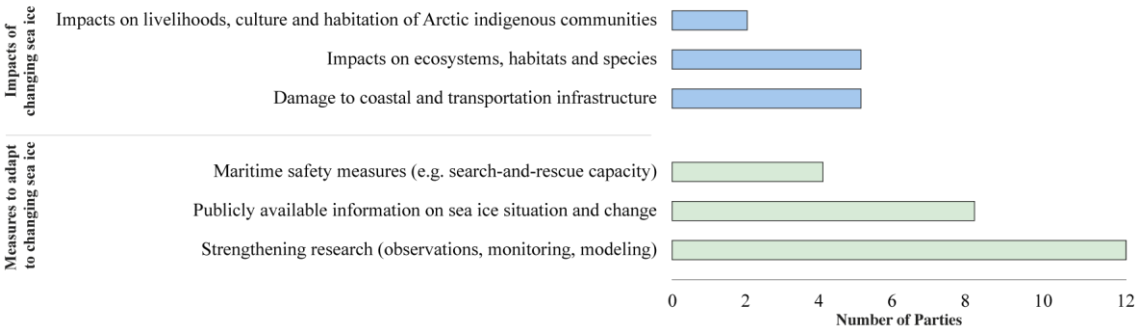
(c) Impacts on ecosystems, such as changes in food webs, diets and predator–prey relationships; and changes in migration patterns of fish and other species, in particular northward, with changes in competition, predation, disease and parasite prevalence;

(d) Impacts on habitats, such as habitat loss, including the loss of alternative habitats, in particular for species that depend on sea ice (e.g. algae, seabirds, seals and polar bears);

(e) Impacts on economic activities, such as changing access to fisheries and extractive activities (oil, gas and mining);

(f) Impacts on tourism, for example enhanced access by ships to some locations and reduced cold weather tourism.

Figure 19
Impacts and adaptation options related to sea ice change identified by Parties



3. Adaptation efforts, experiences and priorities identified in national reports

205. The adaptation activities targeted specifically at the response to sea ice loss (see figure 19) included strengthening efforts to observe, monitor and model sea ice levels in order to develop well-informed adaptation strategies. Some countries have developed institutional arrangements to provide up-to-date public information on sea ice, in particular to benefit maritime activities. In addition, various measures are considered to reduce the risks resulting from changing sea ice, for example:

(a) Research activities, in particular:

(i) Monitoring of sea ice through aircraft, satellite, buoy, coastal station and ship-based observations, as well as systematic sea ice surveys;

(ii) Modelling to represent sea ice dynamics and regional impacts;

(iii) Programmes to study the impacts of sea ice loss on Arctic ecosystems and social systems;

(b) Public information, including preparing data sets, advancing real-time monitoring tools, and providing daily or weekly updates on sea ice;

(c) Maritime safety measures, including enhanced search-and-rescue capacity and oil-spill response.

206. In addition, some countries identified efforts to strengthen the regulation of protected areas and fisheries, including through the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, which seeks to ensure the sustainability of future fishing enabled by diminishing sea ice in the region.

V. Recognition of adaptation efforts of developing country Parties

207. The Paris Agreement stipulated that adaptation efforts of developing countries shall be recognized in accordance with modalities to be adopted by the CMA (Article 7, para. 3), and that the global stocktake shall undertake such recognition (Article 7, para. 14(a)). This chapter highlights key information related to recognition of efforts, including:

(a) Relevant work under the Convention;

(b) The ways in which countries expressed information related to recognition of efforts in their national reports;

(c) Domestic investments and expenditure on adaptation by developing countries;

(d) Adaptation actions identified by developing countries to be undertaken independently of international support;

(e) South-South cooperation.

A. Work related to recognition of efforts under the Convention

208. The COP, in decision 1/CP.21, requested the AC and the LEG to develop, for adoption by the CMA, modalities to recognize adaptation efforts of developing countries.[27] These modalities were captured in decision 11/CMA.1, in which the CMA, inter alia:

(a) Requested the secretariat to include, in this synthesis report, information on adaptation efforts of developing countries to facilitate recognition;[28]

(b) Decided to recognize adaptation efforts of developing country Parties during the high-level events of the global stocktake, and requested the secretariat to prepare a summary of that event drawing on, inter alia, this synthesis report;[29]

(c) Decided to use existing events, including the NAP Expo and the Adaptation Forum, to showcase the adaptation efforts of developing countries;[30]

(d) Requested the secretariat, under the guidance of the AC and the LEG and in collaboration with stakeholders, to prepare a synthesis report every two years on specific themes, focusing on lessons learned and good practices by developing countries in the context of recognizing their adaptation efforts.[31] The first such synthesis report, on addressing hazards, was published in 2021.[32] The second report, due to be published in 2022, will focus on assessing and meeting the costs of adaptation.

209. Further information on the work by the AC and the LEG related to the recognition of efforts is available in their synthesis reports.[33]

B. Recognition of efforts expressed in the national reports

210. A few developing country Parties explicitly identified in their national reports information they considered relevant to recognition of adaptation efforts. They focused on national adaptation efforts for the purpose of recognition, such as:

(a) Mainstreaming adaptation in existing institutional frameworks and regulations (e.g. national development processes and priorities);

(b) Developing and implementing climate change laws that consider adaptation, including multilevel and sectoral adaptation policies and plans;

(c) Establishing a new national climate change cabinet;

(d) Reporting on national expenditure on adaptation;

(e) Mainstreaming disaster risk management in sectoral adaptation efforts;

(f) Undertaking the process to formulate and implement NAPs as well as other earlier initiatives such as national adaptation programmes of action;

(g) Preparing national reports to the UNFCCC, including NCs, adaptation communications and adaptation components of NDCs.

211. A few Parties in their national reports acknowledged, in the context of recognition of efforts, that Parties' adaptation efforts contribute to the achievement of the global goal on adaptation.

212. For the explicit purpose of recognition of efforts, a few Parties highlighted adaptation actions that have been implemented across sectors. These included:

[27] Decision 1/CP.21, para. 41.
[28] Decision 11/CMA.1, para. 9.
[29] Decision 11/CMA.1, para. 10–11.
[30] Decision 11/CMA.1, para. 12.
[31] Decision 11/CMA.1, para. 13.
[32] Available at https://unfccc.int/documents/267818.
[33] To be made available at https://unfccc.int/topics/global-stocktake/information-portal.

(a) Actions in the agriculture and food security sector, including diversifying agricultural, livestock and fish production; improving drought-tolerant seeds; enhancing soil management and irrigation infrastructure; adopting climate-smart agricultural practices, improving industrial and artisanal fish landing sites; and making efforts to strengthen sectoral investments and access to technology;

(b) Actions in the biodiversity and forestry sectors, including improving sustainable forest management, livelihoods (such that they can withstand climate change impacts), and the sustainable conservation and restoration of ecosystems. Conservation and plantation of mangrove and other coastal forests, sand dune fixation and construction of coastal defence structures to mitigate the impacts of coastal erosion, inundation and saline intrusion were reported as successful adaptation actions by some Parties;

(c) Actions in the freshwater resource sector, including improved water management, rainwater harvesting and drainage systems, and advocacy campaigns on water conservation;

(d) Actions in the transportation, urban development, housing, waste management and health sectors.

213. Furthermore, Parties described their efforts to raise awareness of the importance of adaptation and identified the recognition of adaptation efforts as a national priority. They highlighted the importance of information and knowledge on current and expected climate vulnerabilities, impacts across sectors and capacity. In terms of information and knowledge generation, Parties mentioned efforts such as developing climate vulnerability assessments and scenarios for multiple risks across priority sectors and improving early warning and climate information systems, including monitoring and surveillance. Knowledge and information dissemination through best practices on applying vulnerability and impact assessments and implementing adaptation measures was also mentioned. Parties recognized the ways in which adaptation efforts were already building capacity and training various stakeholders on climate change risks, scenarios, disaster risk management and adaptation actions; developing or integrating climate change science programmes in higher education curricula; and providing training for women to enhance their capacity to adapt to climate change.

C. Domestic adaptation investments highlighted by developing countries

214. In their national reports, a few developing country Parties described how their adaptation actions have been or will be largely financed from domestic sources. Domestic financial resources were typically directed towards poverty alleviation, disease control and health risk management, urban development, flood risk reduction. and enhancement of river and ecosystem management.

215. In the context of limited availability of domestic adaptation finance, some Parties described their resource mobilization strategies for identifying and prioritizing finance sources and incentivizing domestic investments in adaptation, while other Parties mentioned already established funds that can be mobilized to support adaptation efforts (e.g. National Environment Fund, Angola; Environmental Management Fund, Myanmar; Ecological Fund Office, Nigeria).

216. Some Parties reported that their efforts are limited by insufficient domestic finance given growing adaptation needs, and highlighted their reliance on international finance sources.

D. Adaptation to be undertaken independently of international support

217. Based on the quantitative data on investment requirements for adaptation, developing countries' estimates for required adaptation funding range from USD 98 million to USD 100 billion per Party by 2030. The Parties that communicated information on estimated adaptation funding also provided information on domestic financial resources for adaptation (also termed as unconditional contribution), which ranged from USD 26 million to USD 7

billion per Party. Among those Parties, domestic resources account for an average of USD 1.54 billion (27 per cent) of total estimated investment requirements in adaptation.

218. Many Parties distinguished their priority sectors (see figure 20) and a few identified associated adaptation measures as unconditional and conditional. Unconditional adaptation measures are planned to be undertaken using domestic financial resources. Half of all identified unconditional adaptation measures are aimed at addressing food production and security, key economic sectors and services (e.g. infrastructure, waste, tourism) and freshwater resources. The unconditional measures are focused on:

(a) Enhancing research on climate change risks, impacts and vulnerabilities in areas such as agriculture, fisheries, settlements, coastal and marine areas, water resources and health. These efforts include mapping risks of flooding and coastal erosion, and developing climate models and projections;

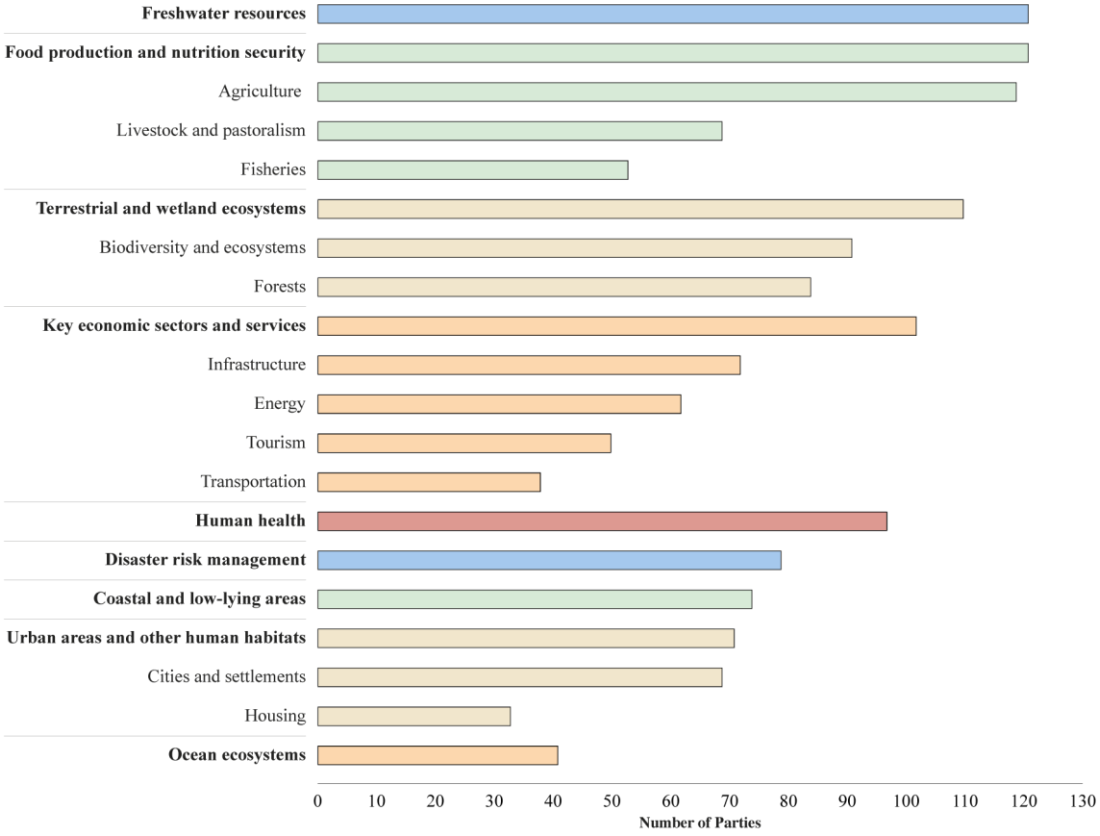
(b) Improving or developing policies, regulations, laws and mechanisms for adaptation and disaster risk reduction in various sectors, including on the basis of best scientific information available;

(c) Strengthening multilevel finance, technology and institutional capacities;

(d) Mainstreaming adaptation considerations in sectoral plans and strategies, and improving regulatory frameworks for disaster risk reduction.

219. Regarding capacity-building, Parties reported improving capacity of the national financial system for international finance cooperation and strengthening institutional and technical capacities of multilevel actors and citizens in the implementation of adaptation measures for health, settlements, agriculture, coastal resources and water together with improving the national capacity for disaster risk reduction and contingency planning.

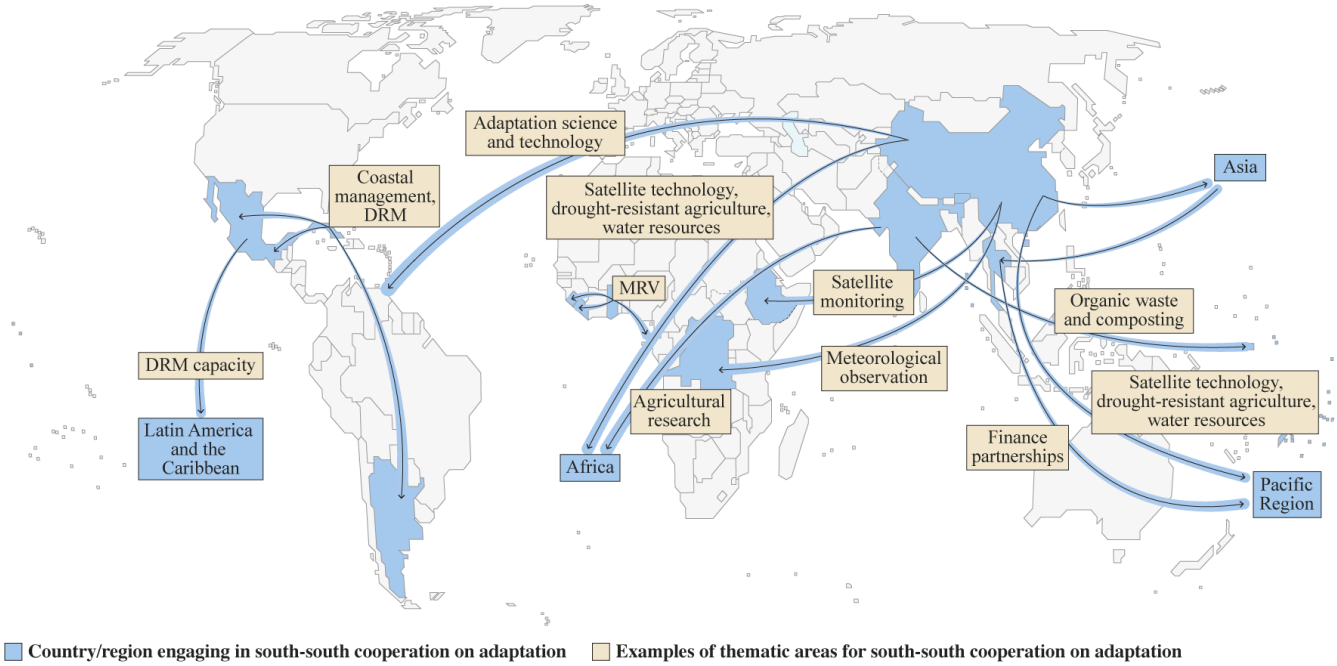
Figure 20
Adaptation priority areas identified by developing country Parties



E. South-South cooperation

220. Some Parties reported on efforts related to South-South cooperation in their national reports (see figure 21 for an overview). In terms of priority areas of South-South cooperation, Parties highlighted, inter alia, scientific and technical cooperation, technology transfer, capacity-building for adaptation planning and implementation, and financial resources for adaptation actions.

Figure 21
Overview of South-South cooperation efforts identified by Parties



Note: DRM refers to disaster risk management and MRV refers to monitoring, reporting and verification.

221. Parties highlighted various South-South cooperation efforts they considered successful; for example:

(a) Implementing training courses in the assessment of climate change impacts, risks and vulnerabilities, and cross-sectoral adaptation measures;

(b) Developing early warning systems and meteorological observation hardware;

(c) Introducing new scientific fields and technologies;

(d) Donating satellites for monitoring climate change;

(e) Developing climate models and scenarios;

(f) Supporting development and implementation of adaptation policies;

(g) Establishing a capacity-building centre for disaster risk reduction and adaptation to strengthen capacity for disaster risk and vulnerability studies and to promote adaptation measures;

(h) Creating the Framework of Technical and Institutional Cooperation on Environment in Africa to improve African countries' capacities for addressing climate change;

(i) Creating the Collaboration Platform on Climate Change and Green Growth to enhance evidence-based decisions and investments and improve climate finance tracking;

(j) Establishing knowledge networks to strengthen cooperation on measurement, reporting and verification.

222. A few Parties called for a greater effort in strengthening South-South cooperation in the field of capacity-building for climate risk management and adaptation.

223. Parties also documented their increasing commitment to providing financial resources through South-South cooperation for adaptation goals. A few reported on adaptation measures funded through South-South cooperation, such as the construction of a climate-resilient waste management facility, agricultural crop diversification and improvement of irrigation, sustainable management of water resources and ecosystems, control of desertification, coastal and marine management, and gender-responsive communication.

224. A few Parties mentioned that through their support of South-South cooperation they strive to increase global and regional capacities to reduce the impacts of climate change and achieve more ambitious adaptation goals in line with national development priorities.

VI. Adequacy and effectiveness of adaptation and support, and the status of adaptation support needs

A. Adequacy and effectiveness of adaptation

1. Related work under and outside the Convention

225. Article 7, paragraph 14(c), of the Paris Agreement stipulates that the global stocktake will review the adequacy and effectiveness of adaptation and support provided for adaptation.

226. The COP requested the AC and the LEG, in collaboration with the SCF and other relevant institutions, to develop methodologies, and make recommendations for consideration and adoption by the CMA at its first session, on reviewing the adequacy and effectiveness of adaptation and support.[34] In response, the AC and the LEG gathered information through desk reviews, from submissions and at events on the margins of United Nations Climate Change Conferences to identify possible methodologies, validating them through outreach to Parties and stakeholders, and selecting options for recommending to the CMA.[35] The work was challenging, and the AC and the LEG suggested that additional work was needed.

227. Noting the constraints encountered by the AC and the LEG, including the knowledge gaps that constrained efforts to address the original mandate, the CMA invited Parties, academia and other relevant stakeholders to undertake further technical work, building on the work of the AC and the LEG, in collaboration with the SCF, and taking into consideration ongoing relevant work under and outside the Convention, on developing methodologies for reviewing the adequacy and effectiveness of adaptation and support.[36] In the same decision, the CMA also invited the AC and the LEG, in collaboration with the SCF, and relevant experts to contribute to this technical work by continuing to compile existing methodologies for reviewing the adequacy and effectiveness of adaptation and support.[37]As at March 2022, this work under the Convention is ongoing.

228. Other work can also shed light on the adequacy and effectiveness of adaptation, and associated challenges. The 2021 UNEP *Adaptation Gap Report*, for example, offers insights into global progress on adaptation planning and implementation. Noting the lack of consensus on definitions and approaches surrounding adequacy and effectiveness, the report assesses the adequacy and effectiveness of adaptation planning indirectly by examining criteria such as comprehensiveness, inclusiveness, implementability, integration, and monitoring and evaluation. It states that, while progress is being made in most of these areas, "significant gaps remain" in, for example, subnational planning and monitoring and evaluation, and "the ultimate test" of the adequacy and effectiveness of adaptation planning "will be whether these plans are implemented and, in turn, whether this implementation reduces risk and vulnerability and bolsters resilience and adaptive capacity" (UNEP, 2021, p.25). Similarly, looking at adaptation projects funded through multilateral funds under the Convention and the Paris Agreement and by bilateral donors, the report finds slow but steady growth in implementation yet limited data on how effectively actions reduce climate risk. It points to the imperative of scaling up implementation, particularly in developing countries, to avoid falling behind with climate risk management. Finally, the report suggests that the adaptation finance gap in 2021 was larger than in 2020, and is widening, and finds an urgent need to increase public adaptation finance. The adequacy and effectiveness of support for adaptation is explored in more detail in chapter VI.BB below.

[34] Decision 1/CP.21, para. 45(b).
[35] See FCCC/SB/2017/2/Add.1−FCCC/SBI/2017/14/Add.1.
[36] Decision 11/CMA.1, para. 34.
[37] Decision 11/CMA.1, para. 35.

229. The Working Group II contribution to the Sixth Assessment Report of the IPCC also concluded that, while a range of effective and feasible adaptation options exist to reduce vulnerability, and adaptation planning and implementation have been progressing across all regions and sectors, thereby generating multiple benefits, this progress is unevenly distributed and there are observed adaptation gaps (IPCC, 2022). These gaps exist between current levels of adaptation and those needed to respond to impacts and reduce climate risks. Furthermore, the IPCC suggests that this gap will continue to grow at current rates of planning and implementation. So far, no studies have systematically assessed the adequacy and effectiveness of adaptation at a global scale, and there is negligible evidence that existing adaptation responses are adequate to reduce climate risk (high confidence) (IPCC, 2022). The effectiveness of adaptation in reducing climate risks is also projected to decrease as warming increases (IPCC, 2022). However, the IPCC also emphasised the key role that fostering enabling conditions plays in accelerating adaptation progress that can assist in overcoming some of the barriers and limits to adaptation (IPCC, 2022).

230. These initial efforts have provided insights into the adequacy and effectiveness of adaptation. However, the indirect nature of assessments, along with the significant methodological work still needed, makes it difficult to produce a conclusive finding on the state of adequacy and effectiveness of adaptation. This section therefore does not aim at a comprehensive assessment of the adequacy and effectiveness of adaptation efforts made to date. Rather, it extracts information from Parties' national reports that can shed light on the extent to which adaptation action is taking place, is effective (i.e. successful at strengthening resilience, enhancing adaptive capacity and reducing vulnerability over time) and is adequate (i.e. sufficient in relation to identified needs).

2. Information on adequacy and effectiveness of adaptation in national reports

231. In their national reports, many Parties described domestic progress in both planning and implementing adaptation actions. This progress has been made at different levels – regional, national, local and community – and by different actors – governments, indigenous peoples, the private sector, youth, non-governmental organizations and more. Moreover, progress in identifying and implementing adaptation actions has been made across sectors and in response to various hazards, as described in chapter IV above.

232. Beyond describing specific measures and programmes that have been implemented, Parties also sometimes alluded, in general terms, to successes in their adaptation efforts or in preparedness to current and future risks as a result of implemented adaptation actions. A few Parties also outlined results achieved, mentioning the effectiveness of their actions, such as:

(a) Reduced mortality from high temperatures despite higher frequency, intensity and duration of heatwaves;

(b) Reduced area affected by forest fires despite an increase in fire risk indices;

(c) High percentage of new homes built in line with government advice on flood risk;

(d) Increased public awareness on the importance of biodiversity;

(e) Increased use of online awareness-raising tools;

(f) Relocation of families living in flood-prone areas or areas contaminated by floodwater.

233. In general, however, Parties stopped short of illustrating the extent to which adaptation actions implemented are adequate or effective under different climate change scenarios and time-horizons. One possible contributor to the dearth of such information is the difficulty of designing and implementing monitoring and evaluation systems for adaptation. According to the 2021 edition of the UNEP *Adaptation Gap Report*, only about a quarter of countries have dedicated adaptation monitoring and evaluation systems in place, which "limits opportunities for learning and revising adaptation planning to make it more adequate and effective" (UNEP, 2021, p. 24). Indeed, in the national reports, while references to monitoring and evaluation are common, and quantified targets and indicators are increasing, monitoring and evaluation is an area that continues to represent a challenge for

both developed and developing countries. Parties highlighted, for example, the lack of (1) systematic monitoring or evaluation of the effects of adaptation actions in terms of reducing impacts, vulnerability and risks; (2) monitoring and evaluation systems for adaptation; and (3) comprehensive and robust metrics and indicators. They also highlighted that the measurement of adaptation is complex and is less developed conceptually and practically than the measurement of mitigation. At the same time, adaptation monitoring and evaluation is seen as critical for effective and efficient implementation of adaptation; several Parties indicated plans to introduce or strengthen related capacities and systems.

234. In addition to the challenges associated with monitoring and evaluation, Parties described in their national reports other challenges, barriers and gaps that stand in the way of adaptation action and thus constrain the adequacy and effectiveness of adaptation (see table 3 for examples). Many of these stem from outstanding support needs (see chap. VI.B below for more details) but other types of challenges were also elucidated.

Table 3
Challenges, barriers and gaps linked to adaptation, as described in Parties' national reports

Type of challenge, barrier or gap	*Examples*
Institutional	- Lack of or weak institutional infrastructure and frameworks - Insufficient coordination of sectors and/or levels of government - High staff turnover
Knowledge and capacity	- Insufficient sector-specific training - Gaps in knowledge on climate change and adaptation - Limited knowledge-sharing among stakeholders - Insufficient public awareness - Insufficient technological capacity and knowledge - Lack of specialized skills for advanced or scalable technologies - Lack of local government capacity to implement adaptation - Gaps in methodologies related to applying specific adaptation measures - Insufficient uptake and application of traditional knowledge
Data and information	- Lack of long-term reliable and up-to-date data - Insufficient data on specific areas, such as climate impacts on health and well-being through a gender perspective, or climate-induced migration - Inadequate systems for data collection, management, reporting and verification - Lack of research on applicable policy measures - Limited access to, or insufficient quality and quantity of, necessary or basic adaptation-related information - Poor dissemination and application of scientific findings related to climate change impacts
Policy	- Weak mainstreaming of adaptation in national and sectoral plans and policies - Lack of related legislation - Insufficient addressing of climate change impacts in sectoral policies and legislation
Resources	- Lack of human and financial resources for research and monitoring - Lack of long-term predictable and adequate financing

235. The risk of maladaptation is another important consideration related to the adequacy and effectiveness of adaptation action. The IPCC defines maladaptation as "[a]ctions that may lead to increased risk of adverse climate-related outcomes, including via increased GHG emissions, increased vulnerability to climate change, or diminished welfare, now or in the future" and notes that it "is usually an unintended consequence" (IPCC, 2018a, p.553). The

contribution of Working Group II to the Sixth Assessment Report of the IPCC found increased evidence of maladaptation across regions and sectors (IPCC, 2022). Some Parties are considering the potential of maladaptation and how it might be avoided. A subset of these have already documented cases of maladaptive actions occurring within their borders, such as:

(a) The overuse of groundwater for irrigation;

(b) Irrigated farming or winter cropping on or near riverbeds, causing soil erosion and riverbed siltation;

(c) The excessive destruction of vegetation in rangelands due to pastoralists switching from animal breeding to selling fuelwood during drought years;

(d) Deforestation for charcoal and firewood production, which accelerates soil erosion and surface run-off (and emits GHGs);

(e) The selling of livestock by farmers to supplement their incomes, which reduces long-term adaptive capacity;

(f) Riprap armouring intended to protect shorelines exacerbating erosion.

236. Measures highlighted in national reports to help reduce the risks of maladaptation include encouraging cross-sectoral coordination; applying a climate lens to sectoral strategies and policies; promoting education and public awareness programmes, along with public access to information and participation; and fostering strong science, technology and innovation linkages among scientists, local communities and other stakeholders. Avoiding maladaptation can be challenging, however, particularly when support needs (covered in chapter VI.B below), gaps (such as the lack of basic data or quantitative studies) and uncertainties (in climate models and emissions trajectories) persist. The potential for maladaptation makes it clear that the implementation of adaptation does not necessarily translate into increased adaptive capacity, strengthened resilience or reduced vulnerability, and thus complicates the path towards adequate and effective adaptation. To reduce maladaptation, it is important to anticipate potential unintended consequences that may arise from adaptation programmes or projects.

237. A few mentioned possible limits to adaptation, including physical, economic, technological, institutional, and social and cultural limits. These Parties highlighted that the possibility of running up against limits to adaptation is directly related to global mitigation ambition. Indeed, the IPCC has concluded with high confidence that, with increasing global warming, additional human and natural systems will reach adaptation limits (IPCC, 2022). Further, the IPCC found that 'soft' limits to some human adaptation efforts have already been reached but can be overcome by addressing the underlying constraints, and that 'hard' limits in some ecosystems have also been reached (IPCC, 2022). Looking ahead to different warming scenarios, the IPCC projects that above 1.5 °C of global warming, some ecosystems will reach hard limits, thereby causing ecosystem-based adaptation measures to lose their effectiveness, and limited freshwater resources will pose hard limits for SIDS and regions that depend on glacial and snow melt; 2 °C of warming can see soft limits reached for multiple staple crops, especially in tropical regions; and 3 °C of warming can lead to soft limits being reached for some water management measures in various regions, as well as hard limits for these measures being reached in parts of Europe (IPCC, 2022). These findings suggest that limits to adaptation will likely be a growing concern moving forward, particularly when juxtaposed against the suggestion that full implementation of current NDCs will lead to an emission level in 2030 that is higher than the well below 2 °C scenarios of the IPCC.[38]

[38] As found in the "Synthesis report on the overall effect of Parties' NDCs and overall progress made by Parties towards the implementation of their NDCs, including the information referred to in Article 13, paragraph 7(b), of the Paris Agreement", available at https://unfccc.int/sites/default/files/resource/GST_SR_23c_30Mar.pdf .

B. Adequacy and effectiveness of support for adaptation

238. The draft work by the AC and the LEG suggests that the effectiveness of adaptation support relates to the process of delivering and receiving support (covering aspects such as country ownership, enabling environments, and whether support reaches the most vulnerable).[39] Consistent with generic definitions of the term, effectiveness may also encompass the degree to which support generates desired results. In contrast, the adequacy of adaptation support relates to whether support provided meets globally agreed finance targets or provisions agreed under the UNFCCC or whether it meets needs determined at the country or global level.[40]

239. Various processes under the UNFCCC have shed light on the effectiveness of support provided under the Convention and the Paris Agreement. These relate, but are not specific, to adaptation and include:

(a) **Regular reviews of the Financial Mechanism**, which take place every four years,[41] and look at, among other things, dimensions of effectiveness. The sixth and most recent review concluded in 2017 and was based in part on the expert input of the SCF. The SCF examined five dimensions under "delivery and effectiveness of financial resources", namely, (1) accessibility, (2) timeliness and rate of disbursement, (3) country ownership of programmes and projects, (4) sustainability of programmes and projects, and (5) enabling environments.[42] While the SCF concluded that notable efforts and progress have been made in relation to these aspects of effectiveness, significant gaps and challenges remain, including with respect to accessibility (e.g. lack of developing country capacity to devise strategies for using available climate finance and for attracting climate-friendly investments; complexity of the global climate finance architecture creating complications in navigating the requirements of and differences between funds) and the financial sustainability of project activities after projects conclude;

(b) **Regular independent reviews of the effectiveness of implementation of the CTCN** (the implementation arm of the Technology Mechanism), which take place every four years.[43] The second review took place in 2021. On the effectiveness of CTCN technical assistance, the report prepared for the review[44] concluded that, although the overall satisfaction of nationally designated entities and beneficiaries with the assistance is mixed, requests are largely well addressed in terms of mobilizing appropriate resources, and the number of technical assistance response plans and geographical coverage of assistance are in range of their corresponding targets. Enduring barriers to the effective implementation of the CTCN include limited financial resources, challenges with resource mobilization, and nationally determined entities lacking the resources to engage with the CTCN despite its provision of capacity-building support. More than half of technical assistance requests focus on mitigation, while less than a quarter focus on adaptation;

(c) **Regular comprehensive reviews of the implementation of the framework for capacity-building in developing countries established under decision 2/CP.7**, of which the fourth and most recent was concluded in 2019. A synthesis report prepared by the secretariat in advance of this review, drawing on the views of Parties and observer organizations, noted continual progress in implementing the capacity-building framework, including in relation to the implementation of national adaptation action.[45] Nonetheless, associated gaps and challenges remain, including overarching challenges such as retaining capacity and challenges specific to adaptation such as undertaking vulnerability and adaptation assessments.[46]

[39] See AC and LEG document AC-LEG/INFO/3, annex.
[40] See AC and LEG document AC-LEG/INFO/3, annex.
[41] Decision 3/CP.4.
[42] FCCC/CP/2017/9, annex II.
[43] Decisions 2/CP.17, annex VII, para. 20, and 14/CP.23, para. 10.
[44] FCCC/CP/2021/3.
[45] FCCC/SBI/2019/INF/17, para. 15.
[46] FCCC/SBI/2019/INF/17, paras. 21–22.

240. Several resources shed light on the adequacy of support provided for adaptation, suggesting that this support is not yet adequate when compared with current needs. For example:

(a) The 2020 Biennial Assessment of and Overview of Climate Finance Flows found that, on average, USD 30 billion was invested in adaptation from public sources in 2017 and 2018.[47] Moreover, support for mitigation continues to be greater than that for adaptation, with the latter constituting between 20 and 25 per cent of committed concessional finance across all sources and moving little since the previous assessment, though this figure is complicated by finance flows that contribute to adaptation and mitigation simultaneously;

(b) In recent CMA decisions (2021), Parties to the Paris Agreement noted with concern that the current provision of climate finance for adaptation remains insufficient to respond to worsening climate change impacts and developing country Parties,[48] and urged developed country Parties to urgently and significantly scale up their provision of climate finance, technology transfer and capacity-building for adaptation so as to respond to the needs of developing country Parties;[49]

(c) The 2021 edition of the UNEP *Adaptation Gap Report* concluded that the adaptation finance gap is large and widening (see chap. VI.A above).

241. In addition, the wide range of support needs reported by Parties in relation to adaptation testifies to the urgency of scaling up financial, technological and capacity-building support. These needs are explored in detail in the following two sections.

1. Information on adaptation support needs in other reports

242. Adaptation support needs are expressed by Parties in various national reports, including adaptation communications, NDCs, NAPs and NCs. To date, such needs have been synthesized in particular in the first report on the determination of the needs of developing country Parties prepared by the SCF,[50] and related information is captured in the synthesis report on the information identified in decision 19/CMA.1, paragraph 36(d)prepared by the secretariat.[51]

243. The first report on the determination of the needs of developing country Parties provides an overview of, inter alia, needs for finance for adaptation, with information on both the qualitative and the quantitative (i.e. costed) needs identified by developing country Parties. The report is based on a review of 563 documents, including nine types of national reports submitted by developing countries to the UNFCCC,[52] as well as reports by regional and global organizations. The report provides an overview of the finance needs of developing country Parties; approaches for determining needs; tools and methodologies for determining and prioritizing needs; and opportunities, challenges and gaps in determining needs. For each of these themes, adaptation-related information is identified. A focused consideration of adaptation and resilience is provided in chapter 2.3.2 and information on costing adaptation needs in chapter 5.3.1 of the report. More specifically, in terms of adaptation support needs, the report presents information on:

(a) Thematic distribution of support needs between mitigation and adaptation;[53]

(b) Adaptation support needs identified in national reports;[54]

[47] https://unfccc.int/sites/default/files/resource/54307_1%20-%20UNFCCC%20BA%202020%20-%20-Report%20-%20V4.pdf

[48] Decision 1/CMA.3, para. 14.

[49] Decision 1/CMA.3, para. 15.

[50] https://unfccc.int/sites/default/files/resource/54307_2%20-%20UNFCCC%20First%20NDR%20-technical%20report%20-%20web%20%28004%29.pdf

[51] Available at https://unfccc.int/sites/default/files/resource/GST_SR_23d_MOI.pdf

[52] Adaptation communications, biennial update reports, low-emission development strategies, national adaptation programmes of action, NAPs, NCs, NDCs, technology action plans and technology needs assessments.

[53] Executive summary, paras. 17 and 22; main report, para. 36.

[54] Executive summary, table 1 and figure 2.1; main report, table 2.1 and figure 2.3(a).

(c) Regional distribution of adaptation support needs;[55]

(d) Types of information reported in relation to loss and damage;[56]

(e) Distribution of adaptation support needs identified in national reports by sector or area, with agriculture, water, disaster prevention and preparedness, coastal zone management and health identified as key sectors. Information is also included on specific adaptation support needs in the agriculture and water sectors;[57]

(f) Estimated costs of adaptation and resilience in regional and global reports, impacts to GDP, and investments needed to enhance the resilience of infrastructure and coastal protection;[58]

(g) Regional differences in the proportion of adaptation support needs as part of total needs;[59]

(h) Adaptation support needs identified by the LDCs and SIDS;[60]

(i) Methodologies and approaches for identifying adaptation costs and needs;[61]

(j) Costing adaptation needs;[62]

(k) Challenges in determining needs, including data gaps;[63]

(l) Enhancing the determination of costs and needs;[64]

(m) Sources of information on total investment needs in developing countries, including on adaptation;[65]

(n) The global costs of adaptation, in quantitative terms, based on reports and estimates of various organizations, notably the 2016 UNEP *Adaptation Gap Report*, the 2019 World Bank report *Lifelines: The Resilient Infrastructure Opportunity*, the 2015 UNEP *Africa Adaptation Gap Report*, Global Commission on Adaptation estimates, International Monetary Fund *Fiscal Monitor* October 2020 and African Development Bank estimates;[66]

244. The synthesis report on the information identified in decision 19/CMA.1, paragraph 36(d) provides information on adaptation support needs in terms of finance, technology development and transfer, and capacity-building. It focuses, in particular, on:

(a) Information on needs for adaptation finance, based on the needs determination report described in paragraph 243 above, with a focus on:

(i) The needs expressed by developing countries in national reports (see figure 12.2 and table 2);

(ii) The thematic distribution of costed needs (see paras. 102, 103 and 107);

(iii) The distribution of needs across adaptation priority sectors, in particular agriculture and water resources (see paras. 115–117 and figure 12.2);

(iv) The potential needs related to averting, minimizing and addressing loss and damage (see para. 105);

(v) The regional distribution of needs (see para. 108);

[55] Main report, paras. 43 and 51, table 2.3 and figure 2.3(b).
[56] Executive summary, paras. 20 and 62; main report, paras. 45, 138, 148(b) and 170.
[57] Executive summary, paras. 28–30 and figure 3.2; main report, paras. 29 and 56–58, and figure 2.3(e).
[58] Executive summary, paras. 35–36 and figure 5; main report, para. 31 and figure 2.6.
[59] Main report, paras. 43 and 45.
[60] Main report, paras. 47–48.
[61] Executive summary, paras. 48–50 and 53; main report, paras. 148–154, 164 and 178–190, and boxes 3.3, 3.4, 4.1, 4.4, 4.7 and 4.8.
[62] Main report, paras. 225–229, 232 and 234.
[63] Executive summary, paras. 59(b) and 62; main report, paras. 210(b) and 213.
[64] Executive summary, para. 71(g) and (l).
[65] Main report, table 2.4.
[66] Main report, paras. 75–80 and figure 2.7.

(vi) The adaptation support needs of the LDCs and SIDS (see paras. 109–110);

(vii) The estimated needs related to adaptation and resilience in regional and global reports (see para. 122-123);

(b) Information on needs for technology development and transfer for adaptation, based in particular on biennial update reports and technology action plans, with a focus on:

(i) The technology needs in specific adaptation priority sectors, reflected in paragraphs 189–195 and figures 25–27. The most common priority sectors in this context were agriculture, water resources, and infrastructure and settlements, including in coastal zones. Figure 25 provides an overview of the most common adaptation priority sectors where technology is needed. The synthesis report also provides information on specific technology needs for adaptation in agriculture, water resources, and infrastructure and settlements;

(ii) The estimated budget requirements for adaptation identified by Parties in their technology action plans, with the total cumulative budget requests amounting to USD 4.4 billion, and the highest budgets identified for the agriculture, forestry and land use, as well as water resources sectors (see paras. 198 and 200, table 5 and figure 28);

(iii) The economic and financial barriers to technologies for adaptation, which include lack of policy, legal, regulatory, institutional, organizational and human capacity. As key enablers, the synthesis report highlighted increased financial resources and/or enhanced financial arrangements, enhanced institutional capacity, and the establishment of information and awareness-raising programmes (see paras. 206–209 above and figure 30);

(c) Information on capacity-building needs of developing country Parties, based in particular on NDCs, biennial update reports and NCs (see paras. 250–253), with a focus on:

(i) The capacity-building needs for formulation and implementation of NAPs and other plans and programmes; forecasting, risk mapping and ‘climate proofing’; addressing loss and damage; and monitoring and evaluation of adaptation efforts;

(ii) The capacity-building needs for vulnerability assessments (e.g. legal and regulatory frameworks and institutional capacity, databases on impacts, human resources, climate models, scenarios, projections, impact mapping, monitoring, remote sensing and geographic information systems); and the need to build capacity for assessing social impacts and developing socioeconomic scenarios;

(iii) The capacity-building needs for adaptation in specific sectors, in particular agriculture, coastal zones, disaster risk management, fisheries, forestry, health and water.

2. Cross-sectoral adaptation needs

245. To complement the information outlined in the SCF’s first report on the determination of the needs of developing country Parties and the synthesis report on the information identified in decision 19/CMA.1, paragraph 36(d) prepared by the secretariat, table 4 provides a detailed overview of the activities in specific priority sectors that Parties identified in their national reports as areas in need of finance, technology and/or capacity-building support for adaptation efforts.

Table 4
Areas of finance, technology and capacity-building needs in adaptation priority sectors

Adaptation priority sector	*Areas of finance needs*	*Areas of technology needs*	*Areas of capacity-building needs*
Agriculture	- Irrigation equipment - Fodder and seed production - Genetic diversity - Pest management - Mixed farming - Climate-smart agriculture - Agricultural projects - Agricultural information - Fertilizer purchase - Women's empowerment	- Climate-friendly irrigation - Soil, livestock, land-use and pest management - Crop diversification - Water-efficient planting - Farm organization	- Design, construction and maintenance of irrigation systems - Identification of vulnerable areas - Pest monitoring - Training and evaluation - Risk management tools - Awareness-raising campaigns - Subsidy arrangements
Water	- Water infrastructure - Sanitation - Drought - Local riverbank development - Drinking water supply systems - Irrigation facilities and maintenance - Water conservation - Integrated watershed management - Water resources	- Catchment management - Sanitation - Water management - Elaboration of watershed water balances - Regulation of aquifers - Impact evaluation - Flood management - Water treatment - Sea water desalinization	- Ecological water resources planning and engineering - Water resilience - Risk and project management - Hydro-climatic modelling - Water treatment - Regulation review - Vulnerability assessment - Research on transboundary water systems - Early warning systems - Monitoring
Disaster risk reduction	- Early warning systems - Disaster risk reduction and management - Infrastructure - Flood management	- Early warning systems - Risk management - Information technology for monitoring and evaluation	- Risk analysis, mapping and management - Evacuation strategies - Early warning systems - Action plans and coordination - Monitoring and evaluation
Coastal zone management	- Coastal modelling and erosion prevention - Canal opening	- Sustainable management - Infrastructure	- Research on and monitoring of SLR - Surface water management

	- Coastal zone protection - Coastal management - Restoration of coastal vegetation		- Mapping and forecasting - Early warning systems
Health	- Waterborne disease prevention - Sanitation - Health care		- Health training - Health information systems - Early warning systems - Disease monitoring/surveillance systems - Equipment
Education	- Technical skills - Youth and gender mainstreaming	- Awareness-raising - Training	- Training - Multilevel awareness-raising - Research - Environmental education
Biodiversity and forestry	- Sustainable forest management - Regeneration and conservation - Management of biodiversity - Reforestation of mangroves	- Conservation ecology - Forestry management tools - Area protection and REDD+ - Bush biomass - Agroforestry interventions - Soil fertilization	- Training - Domestic framework
Energy	- Renewable energy	- Renewable energy - Technology transfer - Access to energy for vulnerable people - Biomass alternatives for domestic use	- Renewable energy - Institutional strengthening - Local capacity for energy technologies
Institutions	- Technology transfer - Policymaking - Human and institutional capacity	- Climate policy and methods - Early warning systems - Monitoring and evaluation - Risk analysis - Institutional framework - Innovation policy design	- Legal and financial frameworks - Training - Needs assessment - Data collection - Policy design and implementation - Development of institutions and coordination among them - Leadership - Research and feasibility studies

			- Monitoring and evaluation

VII. Equity, fairness and ambition

A. Equity, fairness and adaptation

246. Several Parties highlighted considerations of equity in the context of adaptation, thereby emphasizing the importance of equity, historical responsibility and equitable access to sustainable development. Equitable transfer for financing for adaptation was identified as a key aspect in this context. Public participation and stakeholder consultation in decision-making, encompassing application of the human rights-based approach in developing adaptation solutions, were identified as means of enhancing equity. The rights of indigenous peoples and/or local communities were emphasized by some Parties as an important consideration in adaptation planning and implementation. Similarly, some Parties recognized the importance of and need for dialogue and inclusive participation of indigenous peoples in decision-making and policymaking processes for climate adaptation.

247. Considerations of equity were often focused on integrating intergenerational- and gender-based perspectives or approaches into adaptation measures, including by considering gender aspects in the design of efforts in all sectors and by applying a gender-based analysis in the development of climate policies.

248. Some Parties highlighted the importance of inclusive measures that leave no one behind and benefit the most vulnerable and most impacted people, such as youth, children, women, the elderly, indigenous peoples, persons with disabilities, persons with chronic diseases, environmental migrants, low-income persons, and people in rural and remote communities.

249. Equity was also expressed by Parties' highlighting of the importance of the contribution of indigenous and local peoples to the development and implementation of adaptation measures, and the design of adaptation efforts to benefit indigenous peoples and local communities. Specifically, several Parties highlighted in their national reports the importance of indigenous knowledge holders in informing current and future adaptation responses.

250. Parties emphasized that adaptation efforts should be inclusive, both socially and territorially, and should reduce existing inequalities, in particular those faced by minority groups. Aligning the development agenda with climate goals was identified as a potential enabler of inclusive growth.

251. Fairness is an integral aspect of the mitigation components of NDCs. For adaptation components, some Parties referred to fairness in general terms by stating that their adaptation contributions are fair, while a few Parties stressed the importance of incorporating just transition together with social and climate justice into their adaptation actions. A few Parties raised concerns about insufficient national and multilateral financial support for adaptation. Developing a new financial instrument for adaptation and supporting capacity-building in developing countries were mentioned as measures to enhance the fairness of adaptation contributions.

B. Understanding adaptation ambition set out in national reports

252. Many Parties described in their national reports their understanding of ambition in the context of adaptation. They outlined factors that determine their adaptation ambition, what they understand as constituting their adaptation ambition, and how they have increased the ambition of their adaptation efforts since their first NDCs. Several Parties identified adaptation and resilience as their priority ambitions, and some emphasized the importance of treating adaptation ambition as equally important as mitigation.

C. Determinants of adaptation ambition identified by Parties

253. Adaptation ambition, according to the national reports, is determined by a range of factors. One such factor is the current level of mitigation ambition, which is likely to lead to an increase of 2.7 °C by the end of the century[67] and cause significant climate change-related impacts. Against this background, some countries have highlighted that they must prioritize adaptation in order to cope with the anticipated impacts of climate change. Adaptation ambition is also considered in connection with national circumstances. Countries with a high level of vulnerability and/or a low adaptive capacity consider that such circumstances imply that they must make ambitious adaptation efforts.

254. In some cases, adaptation ambition is described as being constrained by low capacities, development challenges and the effects of the COVID-19 pandemic, among other factors. Considerations of common but differentiated responsibilities and respective capacities, equity and justice were also seen as determinants of adaptation ambition. The need for financial, capacity-building and technology support in order to increase adaptation ambition was mentioned by some Parties. Some noted that adaptation ambition can be increased through fostering synergy between inclusive consultation and social inclusion.

C. How adaptation ambition is articulated by Parties

255. Parties see that their adaptation ambition is illustrated, inter alia, by including adaptation components in their NDCs, submitting an adaptation communication and a NAP, and outlining in their national reports how their national efforts contribute to the global goal on adaptation. At the national level, countries described their ambitions to increase adaptive capacity; build resilience and follow ambitious adaptation pathways; decrease the vulnerability of populations and territories; outline or mainstream national climate change adaptation strategies and sectoral measures, including those geared towards reaching specific contributions identified in the national reports; and undertake economic diversification and adaptation efforts with mitigation co-benefits to address synergies. Several countries highlighted how their adaptation ambition is focused on sustainable and efficient use of natural resources, including through efforts to conserve and sustainably manage specific local and regional terrestrial and oceanic ecosystems and forests.

256. Many Parties connected their adaptation ambition with sustainable development in various ways. In general terms, Parties see a mutually reinforcing relationship between adaptation and sustainable development, with better alignment of adaptation efforts with the SDGs being seen as a way of enhancing adaptation, including by outlining a shared national vision for climate resilience and development. On the one hand, adaptation ambition is seen as being enhanced by prioritizing sustainable development, integrating adaptation into development planning, achieving a climate-resilient economy, implementing the 2030 Agenda for Sustainable Development and the SDGs, reducing poverty and addressing the challenges of the COVID-19 pandemic. On the other hand, many countries' adaptation ambition involves actions that contribute to sustainable development and the SDGs, to more inclusive and resilient growth, to a more inclusive, climate-resilient economy, and to a vision of improved quality of life for all. As part of their adaptation ambition, some countries highlighted their aspirations to reach middle income nation status by 2030, and how adaptation efforts are designed to help that transition.

D. How Parties have enhanced their adaptation ambition since their first nationally determined contributions

257. In their national reports, in particular in their NDCs, countries described how their adaptation efforts have become more ambitious since their first NDCs. As such, developing an adaptation component of an NDC, prioritizing and developing adaptation measures with corresponding targets and indicators to increase adaptive capacity and/or climate resilience

[67] See FCCC/PA/CMA/2021/8/Rev.1.

of various priority sectors, and mainstreaming adaptation in national policies and programmes were mentioned as contributions to the national and global level of adaptation ambition. Examples of this enhanced adaptation ambition include the articulation of more comprehensive efforts through, inter alia, the inclusion of additional sectors, targets, measures, strategies and policies, as well as expansion of the territorial coverage of actions. Ambition has also been enhanced by identifying more targeted actions, outlining actions that benefit from adaptation–mitigation synergies, aligning targets closely with the SDGs, defining quantitative targets and indicators to increase adaptive capacity and/or the climate resilience of various priority sectors, and enhancing the ability to track and understand the effects of adaptation.

Annex

Adaptation-related questions provided by the Chairs of the subsidiary bodies for the global stocktake

A. Adaptation-related questions for the information collection and preparation component of the global stocktake[1]

1. What are the observed and projected changes in the global climate system and biosphere?

2. What are the global levels of climate risks, observed and potential impacts and vulnerability of human and ecological systems caused by climate change and at what temporal scales (Articles 7.9(c), 13.8 and para 36(b))?

3. What is the state of adaptation efforts, support, experience and priorities based on i.e. the information referred to in Article 7, paragraphs 2, 10, 11 and 14, of the Paris Agreement, and the reports referred to in Article 13.8 of the Paris Agreement (para 36(c), taking into account the best available science, gender perspectives, traditional knowledge, knowledge of indigenous peoples, and local knowledge systems?

4. What are the support needs of developing country Parties (11/CMA.1, para 31) and to what extent has progress been made towards assessing the support needs of developing country Parties (Articles 7.2 and 7.10)?

5. To what extent has progress been made towards enhancing the adequacy and effectiveness of adaptation and support provided for adaptation (Articles 7.14(c))?

6. What is the overall progress made in achieving the global goal on adaptation stated in Article 7.1, how do national adaptation efforts contribute to this goal (11/CMA.1, paragraph 14) including by contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2 (Article 7.1)? What work on methodologies, including metrics, will be needed to better understand that progress and what is further needed?

7. How can Parties increase the ability to adapt to the adverse impacts of climate change and foster climate resilience and low GHG emissions development, in a manner that does not threaten food production, consistent with the goal set out in Article 2.1 (b)?

8. To what extent do adaptation efforts of Parties ensure an adequate adaptation response according to the temperature limits identified by the Paris Agreement?

B. Adaptation-related questions for the technical assessment component of the global stocktake[2]

1. What is the collective progress in terms of the current implementation of, and ambition in, adaptation actions towards achieving the goals defined in Articles 2.1(b)[3] and 7.1[4] of the Paris Agreement?

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[1] Guiding questions for the information collection and preparation component are available at https://unfccc.int/sites/default/files/resource/REV_Non-paper_on_Preparing_for_GST1_forSBs_15Sept.pdf.

[2] Guiding questions for the technical assessment component are available at https://unfccc.int/sites/default/files/resource/Draft%20GST1_TA%20Guiding%20Questions.pdf.

[3] Article 2.1(b) of the Paris Agreement: "Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production."

[4] Article 7.1 of the Paris Agreement: "Parties hereby establish the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change,

2. What efforts are being undertaken to plan, implement and accelerate adaptation action towards achieving the goals defined in Articles 2.1 (b) and 7.1 of the Paris Agreement and with a view to recognizing the adaptation efforts of developing country Parties, what efforts have been undertaken by these Parties towards achieving these goals?

3. How adequate and effective are the current adaptation efforts and the support provided for adaptation towards achieving the goals defined in Articles 2.1(b) and 7.1 of the Paris Agreement?[5]

4. How can the implementation of adaptation action towards achieving the goals defined in Articles 2.1(b) and 7.1 of the Paris Agreement be enhanced, taking into account the adaptation communication referred to in [Article 7] paragraph 10 of the Paris Agreement?[6]

5. In order to achieve the goals defined in Articles 2.1(b) and 7.1 of the Paris Agreement:

(a) What further action is required?

(b) What are the barriers and challenges, and how can they be overcome at national, regional and international levels?

(c) What are the opportunities, good practices, lessons learned and success stories?

with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2."

[5] Article 7.14 (c) of the Paris Agreement.

[6] Article 7.14 (b) of the Paris Agreement; Decision 11/CMA.1, paragraph 9.

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Abbreviations and acronyms

AC	Adaptation Committee
AMOC	Atlantic meridional overturning circulation
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
COP	Conference of the Parties
COVID-19	coronavirus disease 2019
CTCN	Climate Technology Centre and Network
ENSO	El Niño/Southern Oscillation
GDP	gross domestic product
GHG	greenhouse gas
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
LDC	least developed country
LEG	Least Developed Countries Expert Group
NAP	national adaptation plan
NC	national communication
NDC	nationally determined contribution
RCP	Representative Concentration Pathway (of the Intergovernmental Panel on Climate Change)
REDD+	reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks (decision 1/CP.16, para. 70)
SCF	Standing Committee on Finance
SDG	Sustainable Development Goal
SIDS	small island developing State(s)
SRES	Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios
SSP	Shared Socioeconomic Pathway
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
WMO	World Meteorological Organization