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Oceans and the law of the sea

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Report of the Secretary-General**

Summary

In paragraph 358 of its resolution 73/124, the General Assembly decided that the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea would focus its discussions at its twentieth meeting on the theme "Ocean Science and the United Nations Decade of Ocean Science for Sustainable Development". The present report was prepared pursuant to paragraph 370 of resolution 73/124 with a view to facilitating discussions on the topic of focus. It is being submitted to the Assembly for its consideration at its seventy-fourth session and to the States parties to the United Nations Convention on the Law of the Sea, pursuant to article 319 of the Convention.

* A/74/50.

** The present report contains a summary of the most significant recent developments and selected parts of contributions by relevant agencies, programmes and bodies. Owing to word limits for reports mandated by the General Assembly, an advance, unedited version of the report, with comprehensive footnotes, is also available on the website of the Division for Ocean Affairs and the Law of the Sea at http://www.un.org/depts/los/general_assembly/general_assembly_reports.htm.

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I. Introduction

1. The oceans remain one of the least known areas of the planet. In the First Global Integrated Marine Assessment, it is noted that our understanding of the processes that are taking place in the oceans is currently not keeping up with the pace of the changes there.[1]

2. The General Assembly has consistently highlighted the importance of marine science[2] in eradicating poverty, contributing to food security, conserving the world's marine environment and resources, helping to understand, predict and respond to natural events and promoting the sustainable development of the oceans and seas. As confirmed in the 2030 Agenda for Sustainable Development, in particular Sustainable Development Goal 14, scientific knowledge, research capacity and the transfer of marine technology play an important role in sustainable development.

3. The United Nations Convention on the Law of the Sea, which contains the legal framework within which all activities in the oceans and seas must be carried out, in its preamble, includes the goal of promoting the equitable and efficient utilization of ocean resources, the conservation of living ocean resources and the study, protection and preservation of the marine environment. Ocean science plays a key role in that regard. Along with other instruments, including the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, the Convention requires that, among other things, the best available scientific evidence or information be used in adopting conservation and management measures.

4. In recognition of the critical importance of the role of ocean science, the General Assembly proclaimed the United Nations Decade of Ocean Science for Sustainable Development for the 10-year period beginning on 1 January 2021.[3] Most recently, the Assembly decided that the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea would focus its discussions at its twentieth meeting on the theme "Ocean Science and the United Nations Decade of Ocean Science for Sustainable Development". To facilitate the discussions, the present report provides an overview of ocean science and its role, gaps in information, knowledge and capacity among others, and ways to advance ocean science and fill existing gaps. It is beyond the scope of the present report to provide a comprehensive substantive assessment of scientific knowledge concerning the oceans.

5. The present report builds on the First Global Integrated Marine Assessment and the Global Ocean Science Report of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO),[4] together with other reports and scientific and technical publications, as well as the contributions submitted by States and relevant organizations and bodies upon the invitation of the Secretary-General.[5]

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[1] United Nations, *First Global Integrated Marine Assessment: World Ocean Assessment I* (Cambridge, United Kingdom of Great Britain and Northern Ireland, Cambridge University Press, 2017). For a summary of the first global integrated marine assessment, see A/70/112.

[2] The terms "ocean science" and "marine science" are used interchangeably in the present report.

[3] General Assembly resolution 72/73, para. 292, which followed on Intergovernmental Oceanographic Commission resolution XXIX-1.

[4] Intergovernmental Oceanographic Commission, United Nations Educational, Scientific and Cultural Organization (UNESCO), *Global Ocean Science Report: The Current Status of Ocean Science around the World* (Paris, 2017).

[5] The full text of the contributions is available on the website of the Division for Ocean Affairs and the Law of the Sea at www.un.org/depts/los/general_assembly/general_assembly_reports.htm.

II. Ocean science and its role

A. Scope and uses of ocean science

6. Ocean science is understood to encompass a range of disciplines relating to the study of the ocean, including the physical, biological, chemical, geological, hydrographic, health and social sciences, as well as the humanities, engineering and multidisciplinary research.

7. Ocean science is key to understanding such fundamental elements as the geology and geophysics of ocean basins, the physical processes at work in the oceans and seas, the input, distribution and impact of substances and energy input into the oceans, the occurrence and distribution of flora and fauna, the biological processes that regulate and sustain the productivity of ecosystems, the links between the ocean and atmosphere, including the effects of climate change and ocean acidification on the ocean, and the way in which all these elements interact. Scientific understanding is fundamental to the effective management of human activities that rely on and affect the oceans and seas. For example, ocean science plays a critical role in the fisheries management process, including for the adoption of conservation and management measures. It also has an important role to play in understanding the cumulative impacts of various activities taking place at sea and on land, including extractive activities, shipping, agriculture, coastal development and industrial production, as well as in designing appropriate management measures to ensure that tipping points are not reached. Ocean science also provides the supporting data needed to establish the baselines from which the outer limits of the various maritime zones are set out and to compile nautical charts for safe navigation. It is essential to predicting or forecasting, mitigating and guiding the adaptation of societies and infrastructure to natural and anthropogenic events and changes, in particular climate change. Furthermore, ocean science can promote a better understanding of the relationship between humans and the ocean and related socioeconomic aspects. Several contributions to the present report also indicate that ocean science has an important role to play in monitoring and surveillance activities.

8. Ocean science is of critical importance to decision makers and a wide range of sectors and users at the national, regional and global levels. At the global level, it can inform several processes, including the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects, the Review Conference on the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, the intergovernmental conference on an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, the processes under the United Nations Framework Convention on Climate Change and the 2030 Agenda for Sustainable Development.

B. Ocean science for sustainable development, including its cross-cutting role in Sustainable Development Goal 14 and the 2030 Agenda for Sustainable Development

9. Managing human activities that rely on and affect the oceans and seas in a sustainable manner and in accordance with international law, including the United Nations Convention on the Law of the Sea and other relevant international instruments, requires informed decision-making. The role of science in furthering

sustainable development has long been recognized, including in the outcomes of major conferences on sustainable development, including Agenda 21, the Plan of Implementation of the World Summit on Sustainable Development and the outcome document of the United Nations Conference on Sustainable Development, entitled "The future we want". Ocean science is also essential to realizing Sustainable Development Goal 14, to conserve and sustainably use the oceans, seas and marine resources for sustainable development.

10. Ocean science cuts across Goal 14 and each of its interrelated targets. Indeed, in addition to target 14.a, to increase scientific knowledge, develop research capacity and transfer marine technology, several other targets of Goal 14 contain explicit references to the central role of science in their achievement, including through enhanced scientific cooperation at all levels, science-based management and reliance on the best scientific information available.

11. For example, ocean science has an important role to play in the achievement of target 14.4, to regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield, including through the collection of data to inform the development and implementation of science-based management plans.

12. Ocean science also supports the management of other anthropogenic pressures as called for in targets 14.1 (to prevent and significantly reduce marine pollution of all kinds by 2025), 14.2 (to sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts by 2020), 14.3 (to minimize and address the impacts of ocean acidification) and 14.5 (to conserve at least 10 per cent of coastal and marine areas by 2020). Scientific knowledge is also fundamental to the implementation of international law as reflected in the Convention, which is called for in target 14.c. The vital role of ocean science is further exemplified by the fact that more than 500 voluntary commitments registered in the context of the United Nations Conference to Support the Implementation of Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development, held in 2017, were directed at increasing scientific knowledge, building capacity and transferring technology.

13. Marine science also supports the development of the cross-sectoral and integrated solutions needed to achieve Goal 14 and the other related and mutually reinforcing Goals and targets of the 2030 Agenda for Sustainable Development.[6] Advances in scientific knowledge, as well as technological innovation, that are aimed at achieving one target may equally assist in achieving other targets and Goals. For example, in addition to contributing to the achievement of target 14.4, efforts to advance knowledge relating to the status of fish stocks may equally support the achievement of targets 14.6 and 14.7 and Goals 2, 6, 7, 8, 9, 11 and 12.

14. Much of the information needed to understand the ocean and ocean acidification is also needed to understand climate change. In this regard, efforts taken to strengthen the scientific knowledge base regarding changes in ocean temperature, sea level rise, salinity, carbon dioxide absorption, nutrient distribution and cycling and deoxygenation will also support the synergistic implementation of Goals 13 and 14 (see para. 21 below).

[6] See David Le Blanc, Clovis Freire and Marjo Vierros, "Mapping the linkages between oceans and other Sustainable Development Goals: a preliminary exploration", Department of Economic and Social Affairs working paper No. 149 (New York, 2017).

15. Ocean science also has a role to play in the achievement of gender equality and the empowerment of women and girls, as called for in Goal 5. For example, in 2017, female scientists accounted for 38 per cent of researchers in ocean science on average, some 10 percentage points higher than the global share of female researchers in that year (see para. 25 below).

III. Identifying gaps in knowledge and ocean science

A. Current state of knowledge and ocean science

16. Our knowledge of the ocean, including its physical structure, the state of its waters and its biota, and our understanding of the role that it plays in the planet's ecosystem, including the major ecosystem services that it provides, the ways that it functions and our relationship to it, have been enhanced considerably in the past 50 years. Steady progress has been made, for example, towards increasing our understanding of the essential links between the ocean and atmosphere, including the effects of climate change on the ocean, such as ocean warming, sea level rise, ocean acidification, shifts in ocean salinity and oxygen content, ocean stratification and changes in ocean circulation, as reflected in recent reports of the Intergovernmental Panel on Climate Change.

17. Much information has been generated to provide scientific data on the use of the ocean and its resources and to help to understand the impacts of such use. The Ocean Biogeographic Information System, which emanated from the decade-long Census of Marine Life, has recorded 55 million observations of more than 120,000 marine species. The process, under the Convention on Biological Diversity, relating to the identification of ecologically and biologically significant areas, has resulted in the description of 321 ecologically and biologically significant areas. Our understanding of the relationship between ocean health and human well-being, including the impacts of the increasing inputs of harmful material into the ocean, has markedly improved.[7] The First Global Integrated Marine Assessment provides a synthesis of scientific knowledge regarding the state of the marine environment, including socioeconomic aspects.

18. The Global Ocean Science Report indicated that ocean science was expanding in magnitude and scope, resulting in greater scientific output. Contributions to the present report provide examples of scientific activities being undertaken in the following areas: hydrography; the assessment of ocean change; the ocean-climate nexus; marine biodiversity and ecosystems, including deep-sea marine taxonomy; marine socioecological systems; the conservation and management of fish stocks and other marine living resources; and the environmental impact of various activities, such as shipping. This expansion results in part from an increase in investment in ocean science by States and private sources.

19. Ocean science relies on skilled individuals, ocean science institutions and marine laboratories that are specialized or work across a wide range of disciplines and on a broad array of equipment and technology (see sect. IV.B below).[4] A number of States have developed marine policies that encompass marine science and technology plans and strategies. Many States and relevant organizations have developed infrastructures relating to marine science and technology, such as oceanographic institutes, but they are at different levels of development.

[7] See summary of the first global integrated marine assessment, as contained in document A/70/112.

B. Gaps in knowledge and ocean science

20. Although our understanding of the oceans is improving, there remain considerable gaps and disparities in knowledge, which can hamper the ability of policymakers to make informed decisions. The First Global Integrated Marine Assessment noted that, in order for the role of the ocean in the Earth ecosystem to be comprehended fully, many areas still require further investigation. For example, there is a need to better understand ecosystem processes and functions and their implications for the conservation and restoration of ecosystems, ecological limits, tipping points, socioecological resilience and ecosystem services and their valuation. In particular, the effects of cumulative and socioeconomic impacts on biodiversity and ocean productivity are often not well understood.

21. Additional information is needed in order to better understand the ocean-climate nexus, including sea temperature, sea level rise, salinity distribution, carbon dioxide absorption and nutrient distribution and cycling.[7] The special report of the Intergovernmental Panel on Climate Change, on the ocean and cryosphere in a changing climate, is expected to be published in September 2019.

22. Further information is also needed on marine biodiversity, including the number and distribution of marine species and the health and reproductive success of populations, as well as marine taxonomy, including deep-sea taxonomy, in particular relating to the species and habitats that have been scientifically identified as threatened, declining or otherwise in need of special attention or protection.[7]

23. Additional examples of specific knowledge gaps can be found in recent reports of the Secretary-General on oceans and the law of the sea and on sustainable fisheries, as well as in the background information for the United Nations Conference to Support the Implementation of Sustainable Development Goal 14, held in 2017. The examples relate to anthropogenic underwater noise and its impacts on the marine environment and marine species (see A/73/68); some marine ecosystems and processes; pollution, including its impact on the life cycle and the impacts of marine debris, plastics and microplastics, heavy metals and other hazardous substances; understanding species and the diversity of marine resources, including the status of some highly migratory fish stocks and straddling fish stocks, discrete high sea stocks and non-target, associated and dependent species; integrated coastal zone management; and the effectiveness and impact of conservation measures, including with regard to their socioeconomic benefits and how marine and land-based human activities alter their effectiveness.

24. The level of knowledge concerning the socioeconomic aspects of the oceans, including the gender dimension, remains limited owing to insufficient studies thus far. There are also widespread gaps in the skills needed to assess the ocean with regard to, for example, the integration of environmental, social and economic aspects.[7]

25. Our level of knowledge of various parts of the ocean varies considerably. Recent calculations show that only 18 per cent of information on ocean depths is available and a much lower percentage is covered at the level of accuracy expected, given the current state of technology. Knowledge of deep waters and the seabed in areas beyond national jurisdiction, including the interaction between the physical structures and the biota in those areas, is limited.[7] Of the four main ocean basins, the least is known about the Arctic Ocean and the Indian Ocean. Parts of the Atlantic Ocean and the Pacific Ocean in the Northern Hemisphere have been more thoroughly studied than those in the Southern Hemisphere. The North Atlantic and its adjacent seas are the most studied areas, but major gaps also remain there.[7] Moreover, disparities in scientific capacity, in particular in developing countries, contribute to the uneven distribution of scientific knowledge (see sect. IV.E below). Female participation in

ocean science, which also remains insufficient, ranges from 4 per cent to more than 62 per cent across the various categories of ocean science.

26. An ambitious programme of action in ocean science is required to close the knowledge gaps.[7] Enhanced international and interdisciplinary scientific collaboration, paired with capacity-building and technology transfer, is also needed. The acquisition of sufficient credible scientific data and information requires major investment. Government funding for ocean science remains modest overall, however, and faces sustainability-related challenges in a number of countries.[4] In many cases, there is a lack of national ocean research policies, scientific advisory mechanisms and oceanographic institutes.

IV. Advancing ocean science and addressing related gaps

A. Role of the United Nations Convention on the Law of the Sea and its implementing agreements in advancing ocean science

27. The key role of ocean science is recognized in Part XIII of the Convention, which sets out a comprehensive legal framework for marine scientific research.[8] In addition to the specific rules laid down in Part XIII for the conduct of marine scientific research in the various maritime zones, including with regard to consent for marine scientific research undertaken within national jurisdictions, it is reaffirmed that States and competent international organizations have the right to conduct marine scientific research and should promote and facilitate its development and conduct; that such research should be conducted exclusively for peaceful purposes; that it should be conducted using appropriate scientific methods and means compatible with the Convention; that it should not unjustifiably interfere with other legitimate uses of the sea that are compatible with the Convention and should be duly respected in the course of such uses; that it should be conducted in compliance with all relevant regulations adopted in conformity with the Convention, including those relating to the protection and preservation of the marine environment; and that it should not constitute the legal basis for any claim to any part of the marine environment or its resources. Further set out in Part XIII is the obligation to promote international cooperation in marine scientific research, to create favourable conditions for the conduct of such research and to make available by publication and dissemination knowledge resulting from marine scientific research and promote the flow of scientific data and information and the transfer of knowledge. Part XIII also addresses scientific research and installations or equipment, as well as responsibility and liability. While some States have adopted measures of a legislative, regulatory or policy-related nature to implement Part XIII, such measures do not seem to be widespread.[9]

28. Part XIV of the Convention provides for the development and transfer of marine technology (see sect. IV.B below). Other provisions of relevance to ocean science, some of which have contributed to the advancement of ocean science in an indirect manner, can be found throughout the Convention. For example, in article 76 thereof and annex II thereto, there is mention of an obligation of coastal States wishing to delineate their continental shelves beyond 200 nautical miles from the territorial sea baselines to submit scientific information on the limits of the continental shelf beyond

[8] Although the term “marine scientific research” is not defined in the Convention, in article 251 thereof it is stated that States should seek to promote, through competent international organizations, the establishment of general criteria and guidelines to assist States in ascertaining the nature and implications of marine scientific research.

[9] See www.un.org/Depts/los/LEGISLATIONANDTREATIES/regionslist.htm.

200 nautical miles to the Commission on the Limits of the Continental Shelf. The acquisition of data in that context has improved the spatial coverage and resolution of primarily bathymetric and seismic data on continental margins and has contributed to a better geoscientific understanding of those areas. Similarly, activities relating to exploration for mineral resources in the Area, in accordance with Part XI of the Convention and the Agreement relating to the implementation of Part XI of the Convention, have contributed to the acquisition and dissemination of important data on deep-sea ecosystems.

29. The Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks also requires the promotion and conduct of scientific research and the development of appropriate technology in support of fishery conservation and management and, to that end, includes a number of provisions for the collection and provision of information and cooperation in scientific research as well as standard requirements for the collection and sharing of data.

B. Technology and data infrastructure

30. Innovation in technology relating to ocean science is critical to increasing knowledge of the oceans and seas. Ocean science projects have stimulated technological advancements, which have, in turn, accelerated the pace of development of scientific knowledge of the ocean.

31. The application of advanced technology to ocean science and the development of new technology, including satellites and remote-sensing techniques, airborne laser scanning, autonomous underwater vehicles and remotely operated vehicles, floats and sensors and new measurement devices and techniques, such as multibeam sonars, have enhanced the range of technical options available to improve our knowledge of the ocean, in particular in remote or difficult-to-access environments, such as the polar regions, the deep ocean floor and mangroves.

32. Remote sensing and satellite imagery can provide very detailed and accurate information on essential oceanic variables. For example, satellite imagery has been used to track fragile or threatened ecosystems or habitats in real time and for the early warning of events, such as algal blooms. Earth-observing satellites represent some of the most valued components of the international Global Ocean Observing System and the Global Climate Observing System.

33. In the future, scientific monitoring and reliable telecommunications cable systems could integrate ocean sensors into undersea telecommunication cables, with the potential to provide near global coverage at a fraction of the cost of single-purpose, science-only systems. Airborne laser scanning and the mathematical derivation of the seabed topography from satellite imagery have enhanced the range of technical options available to complete our image of the oceans. Environmental DNA is being explored as a way to assess biodiversity and track invasive species, harmful algal blooms, aquaculture pathogens, migratory species, larval dispersal and endangered populations cost-effectively. Hydrophones have also been used to understand the acoustic landscape of species of priority conservation or commercial interest and to assist in monitoring and surveillance. New technology includes acoustic monitoring for the tracking of salmon and geometric and biomolecular techniques for the identification of species. Technology is under development to avert, minimize and address loss and damage from slow-onset events, non-economic losses and the irreversible impacts of climate change.

34. Notwithstanding the importance of emerging technology and the application of older technology for ocean science purposes, research vessels continue to be an essential component of ocean research infrastructure. While evolving science needs, cost pressures and newer technology, such as autonomous underwater vehicles and remotely operated vehicles, have changed the ocean science infrastructure, they have not lessened reliance on well-equipped ships, as research vessels are fundamental to deploying and recovering new observing technology and exploring the vast areas of the ocean that were observed poorly until now.

35. Challenges and gaps remain, however. Sustained investment is essential to developing the required technology and continuously improving the existing technology. Higher-resolution observation in the upper ocean, the rapid delivery of data for weather forecasts and the extension of the observing system into the deep ocean are also needed, along with observations of additional parameters, in order to incorporate more Earth-system processes, such as chemical and biological ones. Efforts are under way to address some of the challenges and gaps. For example, the World Meteorological Organization (WMO) is working with partners to incorporate new technology, including satellites, autonomous vehicles and sensors, into the Global Ocean Observing System in order to address key existing gaps in observations. The Intergovernmental Oceanographic Commission, WMO and the International Telecommunication Union have established a joint task force to try to integrate bottom pressure, temperature, and acceleration sensors into cables. In 2018, the Executive Council of the Intergovernmental Oceanographic Commission approved the measurement of new biogeochemical parameters on Argo floats to increase knowledge of the large-scale evolution of the ocean's biogeochemistry and the associated impacts on marine ecosystems.

36. Other challenges include the need for continuing assistance to ensure that developing countries can fully benefit from ocean science technology and data (see also sect. IV.E below). The implementation of Parts XIII and XIV of the Convention requires strengthening, taking into account the Criteria and Guidelines on the Transfer of Marine Technology of the Intergovernmental Oceanographic Commission (see A/58/65/Add.1).

37. Questions of a legal nature, in particular concerning the application of the legal framework set out in Part XIII of the Convention (see sect. IV.A above), have arisen with regard to the use of new technology, such as floats and gliders, and methods of collecting data, such as the Voluntary Observing Ship scheme of WMO, and require further consideration.[10]

38. Another challenge that requires consideration is the way in which data collected are accessed, collated, shared and transformed into information. Technological developments and improvements have led to the production of new kinds of data at an accelerated rate, in an unprecedented amount and over larger spatial areas. While the International Oceanographic Data and Information Exchange programme of the Intergovernmental Oceanographic Commission has developed a global network of nearly 100 oceanographic data centres and hundreds of online data and information services and products, it is becoming increasingly difficult to extract and process data and information as a result of differences in, among other things, language, interface, technology and format. The adoption and implementation of internationally accepted

[10] See Intergovernmental Oceanographic Commission resolution XX-6 and the final report of the technical workshop "Enhancing ocean observations and research, and the free exchange of data, to foster services for the safety of life and property" of the World Meteorological Organization, Geneva, 5–6 February 2019. Available at https://ane4bf-datap1.s3-eu-west-1.amazonaws.com/wmocms/s3fs-public/event/related_docs/Ocean_Safe-Final-Report-Final-Rev2.pdf?rMjPwGRpEbMblOxZH7ouJekS8KlFSg6P.

standards and best practices for the management and exchange of data, and the adoption and implementation of data policies that support open access, therefore require further consideration.

39. In that regard, the Intergovernmental Oceanographic Commission is developing the Ocean Data and Information System to integrate existing data exchange systems using common data exchange formats and protocols in order to facilitate access to the vast amounts of ocean knowledge. Other online platforms have also been established to facilitate information-sharing and scientific collaboration, for example on marine biodiversity and deep-sea ecosystems. The International Commission for the Conservation of Atlantic Tunas is exploring new ways to communicate and present the results of the collection of complex data to a broad range of stakeholders and is supporting research initiatives and projects to introduce emerging technology and modelling approaches, such as satellite and acoustic tags and advanced analytical models. The International Hydrographic Organization has supported the enhanced application of new technology through the definition of harmonized procedures, the adaptation of quality standards and the coordination of capacity-building, training and education. The International Atomic Energy Agency is developing and sharing new analytical methods and reference materials.

C. Strengthening the integration of the traditional knowledge of indigenous peoples and local communities into ocean science

40. Indigenous and local knowledge systems embody distinct and diverse understandings and values, which enrich and expand the knowledge base for decision-making. In recent decades, there has been increased recognition of the important role of such knowledge systems in addressing contemporary sustainability challenges, including with regard to enhancing understanding of the health and role of the ocean and the stressors on its ecosystems, since many cultures have built broad traditional knowledge of the ocean. Women, who are frequently the primary holders of local and indigenous knowledge concerning natural resources, play a central role in the transmission, preservation and elaboration of such knowledge.

41. Efforts to understand and better integrate the wealth of traditional knowledge held by indigenous peoples and local communities regarding the oceans are under way in several global forums and processes, including with regard to the conservation and sustainable use of marine biological diversity, climate change assessment and adaptation, disaster risk reduction and sustainable development.

42. At the regional level, efforts to incorporate the traditional knowledge of indigenous and local communities are also under way within regional fisheries management organizations, including through the participation of traditional knowledge holders in research, training and outreach programmes and, more generally, with regard to the conduct of ocean science and natural resource management.

43. While work has advanced with regard to the integration of traditional knowledge into efforts to understand marine ecosystems and sustainably use the oceans and their resources, there are opportunities to build on existing mechanisms, tools and procedures for fostering effective collaboration among such systems. Inclusive multi-stakeholder dialogues and knowledge exchange platforms at all levels are required, as are efforts towards the co-production of knowledge, including training and capacity-building initiatives to facilitate such collaborative efforts among scientists, traditional knowledge holders and policymakers.

D. Strengthening the science-policy interface

44. Strengthening the science-policy interface to ensure that relevant data are collected, analysed and communicated to policymakers and ultimately incorporated into policy is critical to the sustainable development of the oceans and their resources. A number of global, regional and national processes and initiatives contribute to the goal of strengthening the interface.

45. For example, scientific assessments and syntheses are continuously being prepared to provide policymakers with up-to-date knowledge on various issues. A notable example is the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects, through which a review is conducted of the state of the marine environment, including socioeconomic aspects, on a continual and systematic basis by providing regular assessments at the global and supraregional levels and an integrated view of environmental, economic and social aspects. The assessments prepared in the context of the Regular Process are intended to support informed decision-making and thus contribute to managing human activities in a sustainable manner. In that regard, apart from the second world ocean assessment, a major outcome of the second cycle (2016–2020) of the Regular Process was the support provided to other ocean-related intergovernmental processes, including through the technical abstracts of the First Global Integrated Marine Assessment on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction; the impacts of climate change and related changes on the atmosphere and the ocean; and the Sustainable Development Goals. The First Global Integrated Marine Assessment provided the necessary baselines against which trends and gaps can be identified in the context of the second cycle of the Regular Process.

46. Other recent assessments that have been, or are being, undertaken include the upcoming special report of the Intergovernmental Panel on Climate Change on the ocean and cryosphere in a changing climate; a global assessment of biodiversity and ecosystem services, including a chapter on the open ocean, to be released in 2019 by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; the scientific syntheses and global biodiversity outlooks of the secretariat of the Convention on Biological Diversity; the publication *The State of World Fisheries and Aquaculture* of the Food and Agriculture Organization of the United Nations (FAO); the global environmental outlooks of the United Nations Environment Programme; and regional assessments of the marine environment by regional seas programmes and conventions, regional fisheries management organizations or in the context of various large marine ecosystem transboundary diagnostic analyses. It will be important to ensure compatibility and synergies between assessments at the global and regional levels and that the assessments support one another. Reports or assessments on the state of the marine environment or of the environment at the national level have also been undertaken.

47. Tools and methodologies are also being developed for measurements, evaluations and modelling in order to facilitate the interoperability of data and assist in the development of regulations or the implementation of various instruments. For example, the Intergovernmental Oceanographic Commission has developed a methodology to measure blue carbon storage in order to assist in national efforts and reporting in the light of the potential of blue carbon ecosystems as a nature-based solution to be applied to the nationally determined contributions under the Paris Agreement adopted under the United Nations Framework Convention on Climate Change. Under the Coupled Model Intercomparison Project of the World Climate Research Programme, WMO is coordinating the models used by the Intergovernmental Panel on Climate Change and the United Nations Framework

Convention on Climate Change in support of climate model diagnosis, validation, intercomparison, documentation and data access. Scientific advice from the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection has been crucial to the development of the amendments to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (the London Convention), and the 1996 Protocol thereto (the London Protocol) on sequestration of carbon in subseabed geological formations and on marine geoengineering. Efforts are currently under way to implement the global indicator framework for the follow-up and review of the Sustainable Development Goals and their targets, including with regard to methodological development.

48. In some cases, the science-policy interface is strengthened through the institutionalization of scientific committees as a formal part of institutional arrangements, while, in other cases, advice is provided by external partners. For example, the Standing Committee of Research and Statistics of the International Commission for the Conservation of Atlantic Tunas provides scientific advice to the Commission. The North-East Atlantic Fisheries Commission receives scientific advice from the International Council for the Exploration of the Sea, in particular on fisheries resources management. The Commission for the Protection of the Marine Environment of the North-East Atlantic and the North-East Atlantic Fisheries Commission have benefited from the advice of the International Council for the Exploration of the Sea on the identification of ecologically and biologically significant areas in the north-east Atlantic and in relation to deep-sea sharks, rays and chimaeras. The International Maritime Organization has been relying on the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (see para. 47 above).

49. Conferences, workshops, forums and projects have also strengthened the science-policy interface. For example, the informal consultations of States parties to the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, held in 2018, were focused on the theme “Science-policy interface”. A multi-stakeholder dialogue and capacity-building partnership event was held under the auspices of the Regular Process in January 2019 to, among other things, bring various actors together to explore ways to strengthen the science-policy interface (see also sect. IV.E below) and identify a number of required actions. Other activities highlighted in the contributions include capacity-building activities carried out within the framework of the Sustainable Ocean Initiative of the secretariat of the Convention on Biological Diversity to bridge ocean science and policy in support of cross-sectoral conservation and the sustainable use of marine and coastal biodiversity. The United Nations Conference on Trade and Development is strengthening the capacity of policymakers to understand climate change impacts on coastal transport infrastructure, in particular seaports and airports, and take appropriate adaptation response measures. The United Nations Environment Assembly has held science-policy forums, while the European Commission is organizing “science meets policy” workshops and conferences on bridging gaps.

E. Strengthening capacity to carry out research in ocean science

50. Ocean science depends on skilled human resources, technical and institutional infrastructure, financial support and international cooperation, among others. As indicated in the Global Ocean Science Report, human resources that drive ocean science are concentrated in certain countries and vary worldwide by age and gender. Illustrative of the disparity in ocean science expertise among regions and genders is

the composition of the Pool of Experts of the Regular Process. National ocean research policies and scientific advisory mechanisms that could define a pathway to support the development of the necessary capacity are mostly missing. Gaps in human and institutional capacity and a lack of resources still hamper developing countries from taking full advantage of ocean science. The importance of developing human and institutional capacity relating to ocean science cannot, therefore, be overstated.

51. Contributions to the present report emphasize the importance of strengthening capacity to carry out research in ocean science, benefit from adequate infrastructure and technology to conduct observations, and collect, store, collate and analyse data. The need to strengthen the capacity to assess capabilities in ocean science and capacity-building needs is also highlighted. Previous reports of the Secretary-General on oceans and the law of the sea also provided an overview of the needs of States with regard to ocean science capacity and of a number of capacity-building programmes and projects[11] to strengthen that capacity. Such information is also available in the capacity-building inventory under the Regular Process.[12]

52. The Convention mandates the development of the marine scientific and technological capacity of States, in particular developing States. In that regard, the implementation of Part XIV of the Convention is particularly critical, including the establishment of national and regional marine scientific and technological centres. Also relevant is target 14.a of the Sustainable Development Goals, to increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.

53. Means for strengthening ocean science capacity include raising public awareness and increasing ocean literacy; holding workshops, seminars and trainings, such as the Division for Ocean Affairs and the Law of the Sea-Intergovernmental Oceanographic Commission training programme on the conduct of marine scientific research under the Convention; developing or strengthening forums for multi-stakeholder and/or interdisciplinary or multidisciplinary collaboration; sharing data, knowledge and the results of research; enhancing local emergency action capabilities for integrated multi-hazard warning systems through public education and developing the knowledge, tools and capabilities to observe the global ocean; and developing manuals, standards, procedures and methodologies. Public-private partnerships also have a role to play in strengthening the capacity to conduct and benefit from research in ocean science.

54. At the multi-stakeholder dialogue, an analysis of the capacity-building needs to be prioritized was also identified as an important initial step towards the strengthening of capacities in ocean science, as was the need for enhanced North-South, South-South and triangular cooperation. Scientific priorities may determine the relative proportion of institutions specializing in a field, the share of funding that is invested in ocean science, the number and type of research publications published and how data are managed and can be obtained.[4]

55. The General Assembly has established a technology bank to, among other things, strengthen the science, technology and innovation capacities of least developed countries. The Capacity Development Strategy of the Intergovernmental Oceanographic Commission is focused on, among other things, the development of

[11] See, for example, A/46/722, A/47/512 and A/65/69.

[12] Available at www.un.org/regularprocess/content/inventory.

human resources. In addition, the Intergovernmental Oceanographic Commission has launched an ocean literacy framework. Efforts to strengthen the capacity of policymakers and enhance the science-policy interface are also under way in a number of organizations (see sect. IV.D above). The assessments prepared in the context of the Regular Process contribute to strengthening capacity and filling gaps, including at the national level. Efforts are also under way to improve access to, and understanding of, existing data, including through support provided to global, regional and national data centres for the effective and efficient management and exchange of ocean data and to promote open access to the data.

56. Ocean science relies on sustained funding. Ensuring financial support for ocean science capacity-building, which is an important factor in strengthening the capacity of developing countries to conduct research in ocean science, including by exploring and encouraging alternative funding models, remains a challenge. During the multi-stakeholder dialogue, it was proposed that guidance could be developed on how to carry out capacity-building analyses, including by mapping funding issues and through the effective use of resources.

F. United Nations Decade of Ocean Science for Sustainable Development

57. The United Nations Decade of Ocean Science for Sustainable Development is a 10-year global framework designed to foster scientific research and bolster technological innovation towards a healthier, more sustainable ocean. It is anticipated that it will address knowledge gaps through integrated research, enable action at all levels, including by catalysing investments in ocean science and stimulating the research agenda at the national level, and build capacities by, among other things, improving ocean literacy. Ultimately, the Decade should ensure that ocean science can fully support countries in creating improved conditions for the sustainable development of the ocean.

58. Having proclaimed the Decade, the General Assembly called upon the Intergovernmental Oceanographic Commission to prepare an implementation plan for the Decade in consultation with Member States, specialized agencies, funds, programmes and bodies of the United Nations, as well as other intergovernmental organizations, non-governmental organizations and relevant stakeholders. UN-Oceans and its participants were invited to collaborate with the Commission on the Decade (see Assembly resolution 72/73, paras. 292 and 295). The implementation plan is scheduled to be presented to the Assembly in 2020.

59. A preparatory phase currently under way is aimed at developing and agreeing on a governance arrangement for the planning phase and the Decade; outlining the form and structure of the Decade; engaging and consulting with relevant communities; developing a resource-mobilization plan; communicating the purpose and expected results; and drafting an implementation plan.

60. In that context, a road map, including proposals for governance arrangements, as well as a guiding framework to further develop the concept, objectives, outcomes and modalities for the Decade's implementation and engagement strategy, was prepared[13] and taken note of by the Executive Council of the Intergovernmental Oceanographic Commission. Two overarching goals for the Decade are proposed in the road map, namely to generate the scientific knowledge, underpinning

[13] United Nations Educational, Scientific and Cultural Organization, Intergovernmental Oceanographic Commission, "Revised road map for the United Nations Decade of Ocean Science for Sustainable Development" (IOC/EC-LI/2 annex 3).

infrastructure and partnerships needed for the sustainable development of the ocean and to provide ocean science, data and information to inform policies for a well-functioning ocean in support of all the Sustainable Development Goals.

61. Six strategic objectives and a number of societal outcomes are identified in the road map, and a number of research and development priority areas are defined therein in order to achieve the following outcomes: a comprehensive digital atlas of the ocean; a comprehensive ocean-observing system for all major basins; a quantitative understanding of ocean ecosystems and their functioning; a data and information portal; an integrated multi-hazard warning system; ocean in Earth-system observation, research and prediction, supported by social and human sciences and economic valuation; and capacity-building, accelerated technology transfer, training and education and ocean literacy.

62. The high-priority research and development areas will be adapted to the scientific priorities identified during regional consultation workshops, to be conducted in 2019 and 2020 as part of the preparatory process. Two global planning meetings will also be held during this period. The first meeting, to be held from 13 to 15 May 2019, will address the status of ocean research in the light of the Decade's objectives. It will also provide an opportunity to further develop the high-priority research and development areas and address cross-cutting issues, such as capacity development, financing and ocean literacy.

63. In a number of contributions to the present report, reference is made to current and proposed national, regional and global activities contributing to the goals, objectives and outcomes of the Decade, and suggestions are provided for related possible initiatives, ideas, proposals and perspectives. They include identifying gaps in capacity-building in the field of the law of the sea and determining appropriate means of reducing such gaps in developing countries; enhancing collaboration between the maritime education institutes of developing countries and those of developed countries; encouraging cooperation between developing and developed countries on the implementation of international commitments; assisting developing countries in the assessment of marine pollution risks and the establishment of management tools for the prevention of marine pollution; and aligning the emerging priorities of the Decade with activities at the national level.

64. The need to address the following aspects was also noted: data, including data access, compatibility and innovative technology; ocean observation, including seabed mapping and space-based observations; integrated multi-hazard warning systems; underwater noise; Arctic research; sea level rise and ocean acidification; abandoned, lost or otherwise discarded fishing gear; the land-sea interface; the protection of coastal zones from natural disasters; the management of marine resources; the governance of fisheries; the science-policy interface; and the promotion of an enabling environment for governance, innovative financing and capacity-building. In addition, the need to mobilize interdisciplinary and transformative actions towards the achievement of the Sustainable Development Goals was noted. Lastly, the need for stronger promotion of the Decade at the national level, coordinated by the national commission of UNESCO and relevant bodies, was highlighted.

65. The importance of aligning the Decade not only with the 2030 Agenda but also with a number of other multilateral frameworks and initiatives was also stressed. In that regard, synergies with the Regular Process (see sect. IV.D above) are notable. The activities to be developed within the framework of the Decade can complement and support the Regular Process. They will provide a coordinated framework for formulating research questions, conducting collaborative research, collecting and disseminating data and building technical capacity, all of which are essential building blocks for the conduct of robust integrated marine assessments. In turn, the trends

that will be evaluated in the second Global Integrated Marine Assessment and the gaps identified could inform the Decade. Another clear pathway for synergies lies in capacity-building, which is crucial to both the Decade and the Regular Process.

66. In their contributions, a number of global and regional intergovernmental organizations noted the synergies between their workplans and activities and the high-priority areas proposed for the Decade. It was noted that the Decade could provide an opportunity to meet the needs of States for scientific evidence and support the implementation of nationally determined contributions, national adaptation plans, long-term strategies and global stocktaking in the context of the United Nations Framework Convention on Climate Change.

67. The Intergovernmental Oceanographic Commission noted that, without additional resources, the secretariat may not be in a position to deliver an implementation plan for the Decade that fully reflects the needs of all States. To date, three States have made financial contributions to support planning activities for the Decade.

G. Promoting international cooperation and coordination

68. Advancing science to improve knowledge of the ocean requires international cooperation and coordination. In particular, challenges in applying a holistic approach to understanding and addressing the cumulative impacts of anthropogenic pressures require multidisciplinary and transdisciplinary research on oceans and cross-sectoral cooperation. Enhancing such cooperation and coordination will enable all States to engage in ocean research and ultimately increase scientific output and impact.[4]

69. The integrative nature of the 2030 Agenda, which requires strengthening interdisciplinary cooperation and coordination, provides opportunities to identify critical research priorities through a more coordinated international research agenda. The Decade will likely assist in that regard. In addition, the Regular Process could play a major role to that end, including by strengthening the science-policy interface.

70. Bilateral and multilateral cooperation, including North-South, South-South and triangular cooperation, are under way in a number of areas, such as seabed mapping, deep-sea exploration, oceanographic observation, ocean innovation and data-related cooperation and exchange. Other matters addressed through cooperative initiatives include ocean acidification, ocean and climate change, deoxygenation, eutrophication and nutrients, marine plastics and the conservation and sustainable use of marine biological diversity, as well as, more generally, oceanographic observation. The initiatives include Global Climate Observing Systems and Global Ocean Observing Systems.

71. Strategic partnerships, including among international organizations and between such organizations and their stakeholders, including the scientific community and academia, are an important interdisciplinary and cross-sectoral collaborative tool. For example, the International Council for the Exploration of the Sea has entered into cooperation agreements with other international organizations, including FAO and the Intergovernmental Oceanographic Commission, that have related objectives. The International Hydrographic Organization has initiated a campaign to crowdsource bathymetry data from the most diverse range of contributors possible in order to store and freely provide all depth data contributed through governmental, commercial, academic and private bodies. The Commission is collaborating with Xiamen University to educate and build expertise in deoxygenation. Regional seas organizations and regional fisheries management organizations are sharing information increasingly, including through such platforms as the Global Dialogue with Regional Seas Organizations and Regional Fisheries

Bodies on Accelerating Progress Towards the Aichi Biodiversity Targets and Sustainable Development Goals, of the Sustainable Ocean Initiative.

72. Scientific collaboration to promote the integrated and cross-sectoral management of human activities that rely on and affect the oceans and seas is supported by various organizations and bodies of the United Nations system, including through inter-agency cooperation. For example, the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection serves as a mechanism for coordination and collaboration regarding the provision of scientific advice to the United Nations system. UN-Oceans, an inter-agency mechanism that currently comprises 28 members and seeks to strengthen and promote the coordination and coherence of United Nations system activities on coastal and ocean issues, is facilitating contributions from its members to the Decade and the second cycle of the Regular Process.

73. The scaling up of interdisciplinary and cross-sectoral cooperative efforts and the identification of synergies among existing initiatives could contribute significantly to advancing ocean science while addressing resource constraints.

V. Conclusions

74. Ocean science plays an important and cross-cutting role in the achievement of the 2030 Agenda. It encompasses a wide range of disciplines, some of which are at more advanced stages than others, with social sciences currently lagging behind. Ocean science is a critical underpinning for addressing complex global sustainability challenges, such as eradicating poverty; ensuring food security and nutrition; supporting the sustainable ocean-based economy; protecting and preserving the marine environment; understanding, predicting and responding to natural events; and mitigating and adapting to climate change. The important and cross-cutting role of ocean science in supporting the achievement of Sustainable Development Goal 14 and each of its interrelated targets is reflected in target 14.a. Ocean science also contributes to the achievement of other Sustainable Development Goals.

75. Gaps and disparities in knowledge remain. While our knowledge of the oceans has improved in the past 50 years, our current understanding of ocean processes is not adequate and has not kept pace with changes in the oceans. Advancing ocean science globally and filling gaps in knowledge present a number of challenges, including insufficient funding and competition for funds; limited human, institutional, technological and infrastructural capacity in some regions, in particular developing countries; and a lack of national policies or regulatory frameworks to promote ocean science, as well as challenges regarding data acquisition, analysis, management and dissemination.

76. Opportunities exist to advance ocean science and address challenges and related gaps, as well as to narrow and close various other gaps. It is imperative to continue to increase awareness of the provisions of the Convention and its implementing agreements, as well as those of other legal instruments that complement the Convention, and to address any challenges in the implementation of the legal framework. It is also critical to further develop technology and infrastructure and to acquire, process, disseminate and publicize the necessary data in a coherent manner. Further actions to advance ocean science include the adoption and implementation of internationally accepted standards and best practices for the management and exchange of data and the adoption and implementation of data policies that support open access. Continuing to expand the corpus of information and knowledge available by incorporating other sources, such as the traditional knowledge held by indigenous peoples and local communities, will also be important to supporting decision-making.

It is paramount to further increase efforts to ensure that science is responsive to the needs of policymakers and other stakeholders and to strengthen the science-policy interface for informed decision-making. In that regard, consideration could be given, in the context of the Regular Process, to the development of a comprehensive strategy during a third cycle in order to reach policymakers more effectively.

77. There is an essential need to build ocean science capacity. It will be important to develop a coherent programme for capacity-building in order to conduct marine assessments, in particular integrated assessments. Further awareness-raising and the enhancement of ocean literacy worldwide, the expansion of training activities and other measures to develop the requisite capacities, as well as the development and transfer of marine technology, are indispensable. Establishing national reporting mechanisms for ocean science capacity, productivity and performance are necessary first steps for the identification of capacity-building gaps, needs and opportunities.

78. Multidisciplinary and transdisciplinary research and cross-sectoral cooperation are needed. Continuously strengthening multidisciplinary and cross-sectoral multi-stakeholder cooperation and coordination at all levels is essential to addressing capacity and other gaps in ocean science. Existing mechanisms, initiatives and partnerships can be further built upon in that regard. Ensuring adequate and sustainable funding by, among other things, exploring alternative funding models, including joint ocean science projects and expeditions to reduce the costs of field expeditions, is key to the success of such endeavours.

79. The General Assembly has a role to play in the advancement of ocean science. As the global body with a comprehensive, cross-sectoral overview of oceans and the law of the sea, the Assembly can spearhead the required changes. Under the overall oversight of the Assembly and with support from all relevant stakeholders, the Decade that it has proclaimed for the period 2021–2030 has the potential to universally foster the momentum and action necessary to advance ocean science significantly for the benefit of the ocean and society within the framework provided by the Convention.