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Partnership dialogues

Minimizing and addressing ocean acidification

Concept paper prepared by the secretariat

I. Introduction

1. The present concept paper on partnership dialogue 3 on the theme "Minimizing and addressing ocean acidification", prepared in response to General Assembly resolution 70/303, covers target 14.3 of the Sustainable Development Goals. The paper is based on inputs received from Member States, intergovernmental organizations, the United Nations system and other stakeholders.[1]

2. Ocean acidification is a threat to marine organisms, ecosystems, services and resources. It has potentially considerable ecological and socioeconomic consequences, adding to multiple stressors on ocean ecosystems, including other climate-driven changes, such as ocean warming, sea level rise and deoxygenation, and local pressures from pollution, overexploitation and habitat destruction.

3. One fourth of the carbon dioxide released into the atmosphere as a result of anthropogenic activities is absorbed by the ocean.[2] This vital service is not without consequence, however: when carbon dioxide enters the ocean, it changes the seawater chemistry, resulting in increased acidity. That change severely affects biological processes, with potentially profound socioeconomic impacts.

4. The long-term control of ocean acidification depends on a reduction in emissions of carbon dioxide into the atmosphere. In this regard, the ratification and effective implementation of the Paris Agreement will be instrumental. Even if

* A/CONF.230/1.

[1] Given the word limit, not all inputs have been included in their entirety, but they can be accessed at https://oceanconference.un.org/documents.

[2] Corinne Le Quéré and others, "Impact of climate change and variability on the global oceanic sink of CO_2", *Global Biogeochemical Cycles*, vol. 24, No. 4 (December 2010).

carbon dioxide emissions are reduced immediately, there will be lag time before the acidity levels of oceans normalize, in particular since more acidic surface ocean waters mix with deep water over a cycle that lasts hundreds of years. It is therefore critical to build the resilience of ocean ecosystems, and of the people who depend on them for their livelihoods, to the effects of ocean acidification and climate change.

II. Status and trends

5. Since the industrial revolution, some 375 billion tons of carbon have been emitted into the atmosphere by humans as carbon dioxide.[3] Globally averaged surface carbon dioxide reached new highs in 2015 at 400 parts per million, or 144 per cent of pre-industrial (before 1750) levels.[4] The increase in carbon dioxide from 2014 to 2015 was larger than that observed from 2013 to 2014 and that averaged over the past 10 years. The El Niño event in 2015 contributed to the increased growth rate through complex two-way interactions between climate change and the carbon cycle.[4]

6. The main sinks for carbon dioxide emissions emanating from fossil fuel combustion are the oceans and the terrestrial biosphere. Since the beginning of the industrial revolution, oceans have become 27 per cent more acidic,[5] and ocean acidity could increase by 150 per cent by 2050.[6] This would give marine ecosystems a very short amount of time for adaptation, as it would represent a rate of increase that is 100 times faster than that of any change in ocean acidity experienced over the past 20 million years.[6]

7. Ocean acidification affects calcifying organisms, such as corals, because their ability to build shell or skeletal material depends on the acidity of the water. As acidification intensifies, this problem will become more widespread and occur in wild, as well as in cultured, stocks. Ocean acidification also affects other marine biota, including by reducing their survival, development and growth rates. It therefore directly affects important components of the ocean food web, such as primary producers (plankton), coral reefs, shellfish and crustaceans; marine species that are important in capture fisheries and mariculture are also affected. Coral reefs in particular are very sensitive to ocean acidification, with 60 per cent currently threatened, a number that will rise to 90 per cent by 2030 and about 100 per cent by 2050.[7] Socioeconomic impacts include impacts on food security and the livelihoods of the fishing and aquaculture communities. Many such communities are especially vulnerable because they have fewer alternative livelihoods (see A/72/70, paras. 30-31).

8. In addition to acidification, most of the excess heat caused by increases in atmospheric greenhouse gases is absorbed by oceans, causing ocean warming and a loss of oxygen. The deep seabed and overlying waters are particularly vulnerable to the loss of oxygen. The most recent estimate indicates that the volume of water in

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[3] World Meteorological Organization, Greenhouse Gas Bulletin No. 8 (November 2012). http://www.wmo.int/pages/prog/arep/gaw/ghg/documents/GHG_Bulletin_No.8_en.pdf.

[4] World Meteorological Organization, Greenhouse Gas Bulletin No. 12 (October 2016).

[5] Ken Caldeira and Michael Wickett, "Oceanography: anthropogenic carbon and ocean pH", *Nature*, vol. 425, No. 6956 (September 2003), p. 365. https://www.nature.com/nature/journal/v425/n6956/.

[6] Secretariat of the Convention on Biological Diversity, *Scientific Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity*, Technical Series No. 46 (Montreal, 2009). https://www.cbd.int/doc/publications/cbd-ts-46-en.pdf.

[7] Lauretta Burke and others, *Reefs at Risk Revisited* (Washington, D.C., World Resources Institute, 2011). http://pdf.wri.org/reefs_at_risk_revisited.pdf.

the open ocean that is completely devoid of oxygen has quadrupled since 1960.[8] Many other areas experience a shortage of oxygen at dangerous levels, which has already been shown to significantly reduce the habitats of migratory fish species. Ocean acidification and ocean deoxygenation commonly occur together at a depth of 200 m to 1,000 m.[9] Increases in upwelling are bringing high-carbon dioxide,[10] low-oxygen waters into shallow waters,[11] where they can have a major impact on coastal fisheries and livelihoods.

9. Ocean acidification and deoxygenation must be observed and researched together with ocean warming, which is a master variable that affects oxygen limitation and response to acidification. The extra heat that oceans absorb owing to increased atmospheric levels of greenhouse gases also directly affects ecosystems. Fisheries are beginning to redistribute, for example by shifting away from the equator, while many coral reefs are experiencing major bleaching events. Habitat loss and the loss of ecosystem services directly affect hundreds of millions of reef-dependent people. Solutions must address all three problems (ocean acidification, loss of oxygen and ocean warming) in concert.[12] Although the surface ocean is changing the fastest, the uptake of heat and carbon dioxide from the atmosphere is also rapidly changing the temperature, the pH and the oxygenation of the deep oceans, with consequences for their ecosystems.[13]

III. Challenges and opportunities

10. Although ocean acidification is an observable and predictable consequence of increasing carbon dioxide emissions, the precise scope of its impact on the marine environment remains unclear. For example, many questions remain about the biological and biogeochemical consequences of acidification and the accurate determination of subcritical levels, or "tipping points", for global marine species, ecosystems and services. Most of the understanding of the biological impacts of ocean acidification is derived from studies of the responses of individual organisms.

11. Ocean basins and their ecosystems have evolved separately, meaning that their biological responses to changing pH levels, oxygen content and temperature are different. For example, the north-east Pacific is experiencing greater changes than the northern Atlantic, yet some organisms there may be more tolerant. There is, therefore, a need for information on impacts at the ecosystem level, which would include the interaction of multiple stressors, including those relating to climate change.

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[8] Sunke Schmidtko, Lothar Stramma and Martin Visbeck, "Decline in global oceanic oxygen content during the past five decades", *Nature*, vol. 542, No. 7642 (February 2017), pp. 335-339. http://www.nature.com/nature/journal/v542/n7642/index.html.

[9] Lisa Levin and Denise Breitburg, "Linking coasts and seas to address ocean deoxygenation", *Nature Climate Change*, vol. 5 (May 2015), pp. 401-403. http://www.nature.com/nclimate/journal/v5/n5/full/nclimate2595.html.

[10] W.J. Sydeman and others, "Climate change and wind intensification in coastal upwelling ecosystems", *Science*, vol. 345, No. 6192 (July 2014), pp. 77-80. http://science.sciencemag.org/content/345/6192/77.full.

[11] Richard Feely and others, "Evidence for upwelling of corrosive 'acidified' water onto the Continental Shelf", *Science*, vol. 320, No. 5882 (June 2008), pp. 1490-1492. http://science.sciencemag.org/content/320/5882/1490.

[12] Denise Breitburg and others, "And on top of all that ... coping with ocean acidification in the midst of many stressors", *Oceanography: Emerging Themes in Ocean Acidification Science*, vol. 28, No. 2 (June 2015), pp. 48-61.

[13] Lisa Levin and Nadine Le Bris, "The deep ocean under climate change", *Science*, vol. 350, No. 6262 (November 2015), pp. 766-768. http://science.sciencemag.org/content/350/6262/766/tab-pdf.

12. Whereas trends for open-ocean pH are well known, data are lacking in many locations, especially coastal regions, where natural variability can be large.[14] Thus, in many cases, the direction of change is known, but uncertainty remains about the timing and rate of change and its magnitude and spatial pattern. This calls for a better understanding of the system-level impacts of ocean acidification.

13. In that regard, it is important to develop indicators for the impact of ocean acidification in addition to the top-level indicator for target 14.3 of the Sustainable Development Goals, "Average marine acidity (pH) measured at agreed suite of representative sampling stations". For example, aragonite saturation state is arguably a more ecologically relevant measurement than marine acidity, while three-dimensional mapping of the distribution of sensitive species in ocean space may be as crucial as the measurement of acidity itself. Particularly valuable indicator systems are tropical coral reefs, cold-water coral ecosystems, polar seas and carbonate plankton-based trophic chains. Developing a proper indicator framework for target 14.3 could improve the tracking of progress and the implementation of actions. This could, as far as possible, encompass water quality parameters (for example, aragonite saturation and pH), physiological parameters (such as calcification, skeletal density and growth of indicator species) and ecosystem parameters (for example, benthic composition and production/erosion rates). The development and implementation of indicators would require enhanced scientific cooperation.

14. Governments and academia are the primary drivers of ocean acidification monitoring and research, but the private sector, with its great reach and technical capacity, should be more engaged. Global ocean acidification monitoring is too great a challenge to be achieved without the engagement of all sectors. Significant opportunities exist in the form of enhanced collaboration among countries; scientific programmes on ocean acidification; relevant intergovernmental bodies, such as regional fisheries management organizations and arrangements and regional seas conventions and action plans; academia; and civil society in conducting research to achieve an understanding of the impacts of and the risks associated with climate change and ocean acidification.

15. An example of an innovative idea to foster the engagement of the private sector is the $2 million Wendy Schmidt Ocean Health XPRIZE, a competition for developing breakthrough ocean pH sensors to improve the understanding of ocean acidification. A number of the competing teams are now commercially producing state-of-the-art pH sensors, some of which are being deployed globally and on Argo floats in the southern hemisphere. The opportunity exists to use these technologies to fully monitor the status of ocean acidification changes across the world's oceans, from the deep sea to the coast, and in lakes and rivers. Nevertheless, the complete implementation of such a global monitoring system remains a challenge.

16. There is also a need to improve the understanding of the social and economic impacts of ocean acidification, in particular to produce improved damage estimates, which can be used to support climate policy decisions, including mitigation and adaptation planning.

17. An analysis of the implications of ocean acidification for the implementation of the 2030 Agenda for Sustainable Development is warranted to identify those goals and targets to which ocean acidification is likely to pose additional challenges.

[14] Intergovernmental Panel on Climate Change, *Climate Change 2013: The Physical Science Basis — Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Thomas F. Stocker and others, eds. (Cambridge and New York, Cambridge University Press, 2013). http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf.

The analysis could also identify how the implementation of the 2030 Agenda can address ocean acidification by reducing carbon dioxide emissions, enhancing ecosystem resilience to ocean acidification, locally mitigating its impacts or otherwise reducing economic and social vulnerability. In addition, such an analysis could be used to explore the establishment of further targets at the global level, as appropriate.

18. Climate change mitigation measures will play a crucial role in slowing ocean acidification and minimizing its impacts. The two issues of ocean acidification and climate change (Sustainable Development Goal 13) therefore need to be considered in an integrated manner. In that regard, an opportunity to address ocean acidification is to consider it within the process of the United Nations Framework Convention on Climate Change and in the context of the commitments made under the Paris Agreement, including by supporting access to climate finance to address the impacts of climate change on the ocean and its resources, noting the need for simplified access and the special circumstances of small island developing States.

19. In response to climate change, many States have initiated programmes for energy production from new and renewable resources (Sustainable Development Goal 7). By reducing carbon dioxide emissions, an increased use of renewables would also address the impacts of ocean acidification. The oceans, a relatively unexploited source of energy, can be used to produce renewable energy through their waves and tidal force, thereby contributing to sustainable development. Innovation and technological change can also provide new opportunities for economies to develop technologies, such as wind energy and solar energy, that produce less carbon dioxide while increasing their economic benefit (see A/67/79 and Corr.1).

20. Building the resilience of ecological and socioeconomic systems could also contribute to minimizing the impacts of ocean acidification, by minimizing the impact of other anthropogenic stressors. For example, the effective implementation of the United Nations Convention on the Law of the Sea and other relevant legal instruments aimed at limiting marine pollution and curtailing overfishing would have a positive effect on the ability of marine ecosystems to adapt to acidifying conditions (see A/68/71). Another way to build resilience is by maximizing the likelihood of the survival of marine species through, for example, the conservation of coastal and marine areas to create refuges for important biodiversity.

21. Other opportunities to minimize and address the impact of ocean acidification exist through:

(a) Science, by fostering joint experiments and research opportunities involving scientists from developing and developed countries and by supporting the dissemination of experimental results in highly visible publications;

(b) Capacity-building, by creating training and mentorship programmes linking young researchers from developing countries to established experts in the field of ocean acidification and by encouraging industry to support research facilities in developing countries;

(c) Communication, by finding new ways to reach out to broader audiences, such as through a targeted international communication campaign on ocean acidification, and by strengthening communication that addresses the needs of different stakeholders, including policymakers, environmental planners and managers and the private sector, which can support and enable action across sectors.

IV. Existing partnerships

22. Strategic partnerships between United Nations and universities and research institutes are essential to effectively identify and address research and knowledge gaps, which still exist in areas highly vulnerable to ocean acidification, and to facilitate the implementation of target 14.3.

23. Government and academic researchers are the main actors, with positive examples of successful networks and integrated projects. Government agencies typically sponsor long-term monitoring programmes, and many academics contribute through in-depth, focused projects. Several national and multinational research projects on ocean acidification have emerged in recent years, including the National Oceanic and Atmospheric Administration ocean acidification programme of the United States of America, the ocean acidification programme of the United Kingdom of Great Britain and Northern Ireland, the Pacific Partnership on Ocean Acidification of New Zealand, the European Project on Ocean Acidification and monitoring by the North Pacific Marine Science Organization, the International Council for the Exploration of the Sea and the Pacific Islands Global Ocean Observing System.

24. Some international coordination platforms have been established to promote, facilitate and communicate about global activities. For example, the Ocean Acidification International Coordination Centre, under the auspices of the International Atomic Energy Agency (IAEA), was announced at the United Nations Conference on Sustainable Development and began its work early in 2013; the Framework for Ocean Observing was developed by the Global Ocean Observing System and the International Ocean Carbon Coordination Project, led by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization;[15] and the International Alliance to Combat Ocean Acidification, a newly formed international network of organizations and Governments (including those of Chile, France and provinces and states in Canada, Nigeria and the United States) built to address ocean acidification and other threats from changing ocean conditions. The World Meteorological Organization and IAEA jointly organize an annual meeting on carbon dioxide, other greenhouse gases and related measurement techniques, and the nineteenth such meeting will include a session on observations of greenhouse gases in oceans.

25. Building on the work of the Framework for Ocean Observing, the Global Ocean Acidification Observing Network was created in 2012 to expand coverage of ocean acidification measurements to areas where there are currently little or no data, provide a global understanding of ocean acidification conditions and ecosystem response and inform modelling efforts and, ultimately, policy development. The Network has more than 350 members from 66 countries and organizations and works closely with the Intergovernmental Oceanographic Commission, the Ocean Acidification International Coordination Centre and other relevant bodies. Since its launch, it has contributed significantly to advancing ocean acidification-monitoring worldwide by engaging scientists from low-income countries and providing training and guidance. The Network includes a data portal, which centralizes all existing and quality-controlled ocean acidification-observing data and would contribute to the implementation of and reporting on target 14.3.

26. The Deep Ocean Observing Strategy, a programme within the Global Ocean Observing System, is being developed to expand and integrate ocean acidification

[15] J. A. Newton and others, "Global ocean acidification observing network: requirements and governance plan", 2nd edition (Ocean Acidification International Coordination Centre, 2015). Available from www.iaea.org/ocean-acidification/act7/GOA-ON%202nd%20edition%20final.pdf.

measurements in the deep ocean, that is, at below 200 m. This can inform deep-sea scientists of needs and opportunities, including that of collaborating with or building the capacity of small island/large-ocean developing States that have large areas of deep sea and are considering or already have the active use of deep water for energy, mining or fishing. In addition, the Deep Ocean Stewardship Initiative brings together deep-ocean scientists, representatives of industry, regulators and policy experts and is able to address the intersection of climate-related ocean changes, including acidification, with societal uses of the oceans.

27. With regard to the impact of ocean acidification on ecosystems, an example of partnership is the Global Coral Reef Monitoring Network of the International Coral Reef Initiative, which works to strengthen the provision of best available scientific information on and communication of the status and trends of coral reef ecosystems, to assist in their conservation and management. The main activity of the Network is the preparation of global reports and of regional periodic assessments of the status, trends and outlook with regard to coral reefs. Initiatives such as the special report on climate change of the Intergovernmental Panel on Climate Change, and its reports on the oceans and the cryosphere, are also expected to increase knowledge of the impact of specific and combined effects of changes in climate-related variables (such as warming, acidification, oxygen loss and dust inputs) on productivity, species distribution and exclusion, habitat compression and food webs.

28. In a global policy making context, the General Assembly has addressed issues relating to ocean acidification in its resolutions on oceans and the law of the sea, urging States to make significant efforts to tackle the causes of ocean acidification, further study and minimize its impacts and enhance cooperation at all levels, including the sharing of relevant information and the development of worldwide capacity to measure it. The outcome document of the resumed 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, held in May 2016, calls for the strengthening of efforts to study and address the adverse impacts of climate change and ocean acidification and to explore ways to incorporate the consideration of those impacts into decision-making processes relating to the adoption of conservation and management measures. In 2013, at the fourteenth meeting of the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea, discussions were focused on the impacts of ocean acidification on the marine environment (see A/68/159); at the eighteenth meeting of the process, to be held from 15 to 19 May 2017, discussions will be focused on the effects of climate change on oceans and the issues of cooperation, coordination and partnerships (see A/AC.259/L.18 and A/72/70).

29. Work under the Convention on Biological Diversity has resulted in a scientific synthesis of the impacts of ocean acidification on marine and coastal biodiversity and guidance in how to enhance the resilience of ecosystems through a range of management measures.[16] In particular, the voluntary specific workplan on biodiversity in cold-water areas within the jurisdictional scope of the Convention, which was adopted by the Conference of the Parties in its decision XIII/11, includes actions focused on better understanding, avoiding, minimizing and mitigating the combined and cumulative effects of multiple stressors, including ocean acidification, on biodiversity in cold-water areas.

[16] See Secretariat of the Convention on Biological Diversity, *An Updated Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity*, Technical Series No. 75 (Montreal, 2014). Available from www.cbd.int/doc/publications/cbd-ts-75-en.pdf.

30. Partnerships to address the socioeconomic impacts of ocean acidification have been promoted by international organizations. For example, the Food and Agriculture Organization of the United Nations, together with partners, has taken stock of the available knowledge on the impacts of climate change on the fisheries and aquaculture sector and their consequences for food security. In addition to flagship publications summarizing relevant information,[17] field projects have been developed in Africa, Asia, Latin America and the Caribbean to assess the vulnerability of coastal communities relying on fisheries and aquaculture resources, identify suitable adaptation options and strengthen institutional and local capacities to foster adaptation. Wherever relevant, ocean acidification is addressed as one of the stressors affecting the coastal resources that sustain fisheries and aquaculture.

31. The International Organization for Migration, and the Ocean and Climate Platform, an international ocean and climate think tank that comprises more than 70 organizations established with the support of the Intergovernmental Oceanographic Commission, have worked together to address the challenge that climate change poses to oceans and the degradation of marine ecosystems in terms of its impact on human migration. In addition, the Intergovernmental Oceanographic Commission is working with the Ocean and Climate Initiatives Alliance foster specific action and solutions and to bring together existing initiatives on issues relating to climate and oceans.

32. Partnerships aimed at ameliorating the impacts of ocean acidification include the International Blue Carbon Initiative, which is coordinated by the Intergovernmental Oceanographic Commission, Conservation International and the International Union for Conservation of Nature and works to protect and conserve coastal blue carbon ecosystems through scientific capacity-building activities, and the International Partnership for Blue Carbon, which focuses on awareness-raising, the exchange of knowledge and accelerating practical action.

V. Possible areas for new partnerships

33. It should be a high priority for all Member States to enhance close collaboration among countries, international organizations (including regional fisheries management organizations and arrangements), regional seas conventions and action plans, scientific organizations, academia and civil society in conducting research to achieve an understanding of the impacts of and risks associated with climate change and ocean acidification (see A/CONF.210/2016/5). Partnerships need to be ambitious enough to make meaningful progress in helping coastal communities and ecosystems to adapt and build resilience to ocean acidification and climate change.

34. Some of the most pressing emerging areas for possible new partnerships are related to strengthening the science of ocean acidification. This includes supporting the establishment and operation of a global ocean observation and monitoring system, emphasizing in particular integrated observation and monitoring in ocean physics, geobiochemistry, biology and ecosystems, and monitoring climate change and its impacts comprehensively. In that regard, it is important to strengthen existing ocean acidification monitoring and forecasting, including by geographically and institutionally building on and expanding the Global Ocean Acidification Observing Network and regional ocean acidification networks, such as the Latin American Ocean Acidification Network and the Ocean Acidification-Africa

[17] Food and Agriculture Organization of the United Nations, "Global strategies and knowledge on climate change and fisheries and aquaculture" (2016). http://www.fao.org/fi/static-media/ClimateChange/FAOFisheriesandAquacultureClimateChangePublications.pdf.

Network. Modelling and forecasting partnerships could be aimed at improving the accuracy of projections regarding the timing of and the rate of change in climate change and ocean acidification and magnitude and spatial patterns at a finer spatial resolution. Partnerships relating to ocean acidification data could encourage open access to data and research, including promoting means of managing and disseminating data and information. There is also a gap in formal partnerships addressing ocean acidification in the deep ocean and on the high seas. In that regard, partnerships to establish deep ocean-focused ocean acidification programmes could be established or become a subgroup within existing alliances, such as the Deep Ocean Observing Strategy within the Global Ocean Observing System. Partnerships with industry could lead to improvements in ocean observation of climate change, ocean acidification and changes in marine biodiversity and provide possible sustained funding for ocean observation and monitoring programmes.

35. The assessment of the impact of ocean acidification on marine ecosystems is another area for new and strengthened partnerships. This includes partnerships to assess the role of the ocean in critical processes, such as carbon dioxide absorption and the water cycle of the earth system; increase knowledge of how the proportion of the carbon dioxide absorbed by the ocean will change in the future and its consequences for ocean acidification, including climate system feedbacks; conduct research on the impacts of oceans' complex changes on marine ecosystems, in particular marine habitats, spawning sites and feeding grounds; conduct constant monitoring, surveying and impact assessments of the consequences of climate change with regard to oceans, including sea level rise; take active counter-policy measures to narrow the affected areas and the scope of ocean acidification; support integrated vulnerability assessments focused on ecosystems and associated services, including evaluating the direct effects of ocean acidification on fish populations and increasing knowledge of the food webs that support them; develop a "low-cost" methodology to measure the impacts of climate change and ocean acidification on marine biodiversity and ecosystems; understand and address the cumulative impacts of ocean acidification and other stressors, including deoxygenation, increased temperature, pollution, sea level rise, reduced sea-ice cover, coastal erosion and overfishing; assess the vulnerability of sentinel marine species that have economic, social and cultural importance; and invest in case studies to provide a more in-depth understanding of the vulnerability of key resources to ocean acidification.

36. There is also a need to increase the understanding of and address the vulnerability of specific ecosystems (such as coral reefs and fragile ecosystems of the polar regions) to multiple stressors and to promote ecosystem-based and holistic approaches to natural resources management, adaptation and mitigation so as to address the multiplicity of drivers affecting oceans and coastal areas. In this regard, it is important to build on existing partnerships, including by strengthening the Global Coral Reef Monitoring Network at the global, regional and national levels, including by enhancing data and reporting services and establishing regional networks and nodes.

37. Addressing ocean acidification also requires new partnerships to assess its social and economic impacts, including on the livelihoods and food security of communities that depend on marine ecosystems. New partnerships are needed to explore ways to incorporate into decision-making the processes relating to the adoption of conservation and management measures, in line with the precautionary approach, consideration of the adverse impacts of climate change and ocean acidification, and the uncertainties regarding such impacts on fisheries and fish stocks, including in relation to migration patterns, productivity and the vulnerabilities of individual species to changes in marine ecosystems. These

partnerships could work to identify options for reducing such risks, promoting the health and resilience of marine ecosystems, sharing information and identifying and sharing best practices in this regard (see A/CONF.210/2016/5).

38. There is also a need to assess the social and economic impacts of efforts to address ocean acidification. For example, new partnerships could assess the potential environmental and socioeconomic impacts of marine geoengineering approaches on the marine environment, in accordance with relevant legal and policy instruments.

39. In terms of adaptation to ocean acidification, partnerships could strengthen early warning systems and promote ecosystem-based approaches to adaption. This may include reducing other local stress factors, such as land-based pollution; creating marine protected areas, blue carbon mitigation efforts and grey-green infrastructure; and incorporating ocean acidification into ecosystem-based and coastal zone management plans to increase the resilience of coastal ecosystems and communities. Partnerships could strengthen the dialogue between natural scientists and socioeconomists on identifying vulnerabilities and possibilities for adaptation, where relevant, and on drawing on successful partnerships and lessons learned from other domains, such as climate change. Partnerships could also increase the application of scientific results to improve marine economies.[18]

40. In relation to mitigation, new partnerships are needed to work towards reducing the emissions of greenhouse gases by the maritime and fisheries sectors. Partnerships could also explore the use of ecosystem-based approaches to mitigation, grey-green infrastructure and blue carbon ecosystems, and incorporate ocean acidification into ecosystem-based and coastal zone management plans to increase the resilience of coastal ecosystems and communities.

41. Partnerships could also be established to promote relevant policies and capacity-building, to address ocean acidification. This includes partnerships to encourage consideration of vulnerability to ocean acidification in national adaptation plans; enhance the technical capacity development of vulnerable countries through the establishment of regional training centres, to increase cooperation among States on ocean-climate research and multidisciplinary observation;[19] and develop tools for integrated decision-making, taking into consideration the impacts of ocean acidification and climate change on marine biodiversity and ecosystems.

VI. Guiding questions for the dialogue

42. The following are proposed questions to guide discussions at the partnership dialogue:

- How can the measurement of ocean acidification at the national, regional and global levels be improved?
- What adaptive measures can be taken to improve the sustainability of resources and the ecosystems that they rely on in the face of stress from ocean acidification?

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[18] One possibility is a strategic alliance with the Global Partnership for Climate Change, Fisheries and Aquaculture, a voluntary partnership of governmental, non-governmental and civil society organizations sharing a concern for better recognition of the sector in global climate change policy development and action and recognizing the need for coordinated action.

[19] See General Assembly resolution 69/15, para. 58 (f).

- What effective mitigation and adaptation measures currently exist, and what new ones can be put in place?
- How will partnerships help communities and ecosystems to minimize and address the impacts of ocean acidification in a meaningful way?