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EDITED BY
Yen-Chiang Chang,
Dalian Maritime University, China

REVIEWED BY
Martin Visbeck,
Helmholtz Association of German Research Centres (HZ), Germany
Andrei Polejack,
Ministerio da Ciência, Tecnologia e Inovações, Brazil
Lorenzo Schiano Di Pepe,
University of Genoa, Italy

*CORRESPONDENCE
Fangli Qiao
qiaofl@fio.org.cn

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United Nations Decade of Ocean Science for Sustainable Development (2021-2030): From innovation of ocean science to science-based ocean governance

Song Guan[1,2], Fangyuan Qu[1,3,4] and Fangli Qiao[1,2,5,6]*

[1]First Institute of Oceanography, Ministry of Natural Resources, Qingdao, China, [2]United Nations Ocean Decade Collaborative Centre on Ocean-Climate Nexus and Coordination Amongst Decade Implementing Partners in People's Republic China (DCC-OCC), Qingdao, China, [3]Bohai Strait Ecological Channel Field Scientific Observation and Research Station, Ministry of Natural Resources, Qingdao, China, [4]Key Laboratory of Marine Eco-Environmental Science and Technology, Ministry of Natural Resources, Qingdao, China, [5]Laboratory for Regional Oceanography and Numerical Modeling, National Laboratory for Marine Science and Technology (Qingdao), Qingdao, China, [6]Key Laboratory of Marine Sciences and Numerical Modeling, Ministry of Natural Resources, Qingdao, China

United Nations Decade of Ocean Science for Sustainable Development (2021-2030) (hereafter the Ocean Decade) was officially launched at the beginning of 2021. This global initiative, which is designed and coordinated by the United Nations, aims to improve ocean governance at global, regional and national levels including supporting United Nations entities to fulfil their ocean-related mandates by means of providing innovative science-based solutions. Therefore, it will be of great significance to analyze and then have a deep and comprehensive understanding of the Ocean Decade with focus on its immediate and long-term influences to ocean governance. This paper introduces the background, Implementation Plan and recent main progress of the Ocean Decade, as well as China's contributions to the Ocean Decade and its national plan of implementing the Ocean Decade. Besides, this paper analyzes, evaluates and predicts what influences the Ocean Decade will bring to ocean governance at different levels in the future. Finally, this paper provides some suggestions for scientists, legal scholars and policy-makers on how to jointly build stronger science-policy interfaces under the framework of the Ocean Decade.

KEYWORDS

Ocean Decade, ocean governance, science-policy interface, China's national plan, science-based solution

1 Introduction

In 2016, the First World Ocean Assessment of the United Nations (UN) concluded that our civilization was nearly running out of time to start managing the ocean sustainably (Ryabinin et al., 2019; UNESCO-IOC, 2021). In 2017, the first Global Ocean Science Report, prepared by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO), pointed out that the investment into ocean science was less than 4% of the global funding of natural sciences, with very large variations among countries between 2009 and 2013 (UNESCO-IOC, 2017; Ryabinin et al., 2019). Besides, there was another conclusion that at the beginning of the third millennium, the ocean science was largely competent for diagnosing problems, while its ability to offer solutions of direct relevance to sustainable development still required a massive upgrade (UNESCO-IOC, 2021). Based on these alarming conclusions and the pressing needs of implementing the 2030 Sustainable Development Goals (SDGs) (Ryabinin et al., 2019), it was proclaimed on 5 December 2017 by the 72nd Session of the UN General Assembly that the United Nations Decade of Ocean Science for Sustainable Development (hereafter the Ocean Decade) would be implemented from 2021 to 2030 (UNGA, 2017, paragraph 292).

As guided by the United Nations Convention on the Law of the Sea (UNCLOS), the Ocean Decade aims to generate innovative solutions for more robust science-informed policies and stronger science-policy interfaces at global, regional, national and even local levels, leading to improved integrated ocean governance. Besides, the Ocean Decade will provide strong support for UN entities and other international organizations to fulfil their ocean-related mandates (UNESCO-IOC, 2021). The Ocean Decade is regarded as once-in-a-life opportunity to promote the sustainability of the ocean based on the innovation of ocean science. Lots of coastal states have announced their commitments of participation in and contribution to a successful implementation of the Ocean Decade. In fact, many countries have already established national committees to coordinate the Ocean Decade activities. Therefore, it will be of great significance to have a deep and comprehensive understanding of the Ocean Decade, and analyze its immediate and long-term influences to ocean governance from the legal science scholarship point of view. And based on this analysis, there will be conclusions on the possible approaches of improving ocean governance through catalyzing strong science-policy interfaces under the framework of the Ocean Decade.

2 Implementation plan of the ocean decade

The Implementation Plan (hereafter the IP) of the Ocean Decade was endorsed at the 75th United Nations General Assembly (UNGA) on the last day of 2020 (UNGA, 2020). The IP defines the framework of the Ocean Decade, including its rationales, vision, mission, challenges, expected outcomes, objectives, actions, governance and coordination structure, etc.

2.1 Drafting the IP

As mandated by the 72nd UNGA in the year of 2017, the IOC of UNESCO coordinated drafting the IP of the Ocean Decade (UNGA, 2017). The IOC established an Executive Planning Group (EPG) comprising 19 global leaders in ocean science in 2018 as the core team of preparing the IP, and had convened a series of global, thematic and regional planning meetings with over 1,900 participants from the scientific community, governments, UN entities, NGOs, private sectors and donors across ten ocean basins from June 2019 to May 2020. In late 2019, over 50 leading ocean institutions had contributed to the contents of the IP through providing written submissions. And later on, there were over 230 written submissions in response to the peer review of the zero draft of the IP in March and April 2020 (UNESCO-IOC, 2021). After that, a comprehensive review was made by the Member States of the IOC and members of UN-Oceans in June and July 2020. As an outcome of three-year preparation process, the IP was officially endorsed at the 75th UNGA in the last day of 2020. Now, six UN official languages versions of the IP are available on the website of the Ocean Decade (www.oceandecade.org).

2.2 How to implement the ocean decade?

Before discussing the approaches of implementing the Ocean Decade, it is important to understand its targets. According to the IP, the vision of the Ocean Decade is "***the science we need for the ocean we want***", and the mission of the Ocean Decade is to "***catalyze transformative ocean science solutions for sustainable development, connecting people and ocean***". The "ocean we want" is defined through setting up seven expected outcomes in the IP, which include ***a clean ocean*** *where sources of pollution are identified and reduced or removed,* ***a healthy and resilient ocean*** *where marine ecosystems are understood, protected, restored and managed,* ***a productive ocean*** *supporting sustainable food supply and a sustainable ocean economy,* ***a predicted ocean*** *where society understands and can respond to changing ocean conditions,* ***a safe ocean*** *where life and livelihoods are protected from ocean-related hazards,* ***an accessible ocean*** *with open and equitable access to data, information and technology and innovation,* and ***an inspiring and engaging ocean*** *where society understands and values the ocean in relation to human well-being and sustainable development.* As the IP mentioned, the seven expected outcomes describe not only the desired state of the ocean, but also the desired state of human society's use of, and interaction with, the ocean.

In addition, it is important to understand the operational framework of the implementation of the Ocean Decade. The IP provides ten Challenges which are the most immediate and pressing needs for achieving the seven Outcomes of the Ocean Decade. Challenge 1 is to understand and beat marine pollution. Challenge 2 is to protect and restore ecosystems and biodiversity. Challenge 3 is to sustainably feed the global population. Challenge 4 is to develop a sustainable and equitable ocean economy. Challenge 5 is to unlock ocean-based solutions to climate change. Challenge 6 is to increase community resilience to ocean hazards. Challenge 7 is to expand the global ocean observing system. Challenge 8 is to create a digital representation of the ocean. Challenge 9 is to build capacity and share knowledge and technology for all. Challenge 10 is to change humanity's relationship with the ocean. In order to resolve the ten Challenges, the IP designs Actions which are tangible initiatives and endeavours. Actions will be implemented in different scales including Programmes, Projects, Activities and Contributions, which are supposed to be proposed and implemented by a wide range of proponents including research institutes, governments, international organizations, UN entities, business and industry, foundations, individuals and so on. Besides, the Actions are suggested to be implemented through the process of three Objectives involving identifying knowledge that is required for sustainable development, generating knowledge, and then utilizing the knowledge to deploy solutions for sustainable development.

2.3 How to govern and coordinate the ocean decade?

An effective and inclusive intergovernmental process is needed to guide and report on the progress of the Ocean Decade. This process will be built on a set of centralized and decentralized structures, taking into account the relevant provisions of UNCLOS with respect to marine scientific research (UNESCO-IOC, 2021).

According to paragraph 303 of the UNGA Resolution 74/19, the IOC will regularly consult with, and report to, UN Member States on the implementation progress of the Ocean Decade. Besides the UNGA and IOC Governing Bodies, the Decade Advisory Board (DAB), which is mandated to provide strategic advices during the implementation of the Ocean Decade, will also play the key role in the governance framework.

The Decade Coordination Unit (DCU), which locates in the headquarters of the IOC Secretariat in Paris, will take the responsibilities as the primary coordination office for the implementation of Ocean Decade Actions. In addition, series of Decade Coordination Offices (DCOs) and Decade Collaborative Centers (DCCs) will be established globally focusing on thematic or regional issues and working closely with DCU. In this system, all DCOs and DCCs will act as decentralized DCU to coordinate, monitor and evaluate the implementation of the endorsed Decade Actions in their respective domains. And National Decade Committees (NDCs) are encouraged to be established to facilitate engagement in, and coordinate actions of, the Ocean Decade at national level.

2.4 What are special points of the ocean decade?

Comparing with other global initiatives on ocean science, the Ocean Decade has some unique features, which also explains why we need to pay high attention to the Ocean Decade from the perspectives of ocean laws and governance.

On one hand, the Ocean Decade is a comprehensive global initiative covering all disciplines of ocean science. Before that, there were several global initiatives relating to one or several disciplines of ocean science. For example, the International Decade of Ocean Exploration was successfully implemented in 1971-1980 with focus on promoting ocean exploration (UNESCO-IOC, 2021), and the Global Ocean Observing System (GOOS) is currently being implemented with the objective of enhancing capability of ocean observation. In addition, the scope of ocean science covered by the Ocean Decade is quite broad. It encompasses natural and social science disciplines, local and indigenous knowledge. It also includes the science-policy and science-innovation interfaces, as well as technology and infrastructure (UNESCO-IOC, 2021). Multidisciplinary research is regarded as the key approach to generate solutions for ocean sustainable development. Being more inclusive is one of the foci of the Ocean Decade. Ocean laws and governance are regarded as integral parts of the Ocean Decade, and will be of great importance for the successful implementation of the Ocean Decade.

On another hand, the Ocean Decade aims to catalyze more robust science-informed policies and build stronger science-policy interfaces at global, regional, national and even local levels, leading to improved integrated ocean management (UNESCO-IOC, 2021). The process of science to inform policies is not naturally fluent and remains challenging because of the complexity of the policy process and the distinct methods and epistemologies of science and policy (Claudet et al., 2020). Therefore, the Ocean Decade emphasizes the importance of connecting with end users such as governments, policy-makers, public and industries. And it will generate data, knowledge and solutions in an accessible and inclusive way, taking into account needs of end users (Caruso et al., 2022). The Ocean Decade takes co-design of research needs and co-production of new knowledge and data between scientists and policy-makers as an important avenue for more inclusive and effective science-policy interfaces (Claudet et al., 2020).

3 Recent main progress and challenges of the ocean decade

At the beginning phase, the Ocean Decade focuses on attracting more engagement and support through a new

stakeholder process that will be more inclusive, participatory, and global (Pendleton et al., 2020), including endorsing Decade Actions, establishing governance and coordination framework as well as developing comprehensive partnerships.

By now, four calls for Decade Actions have been announced. The first call was for Decade Actions, in particular the Programmes and Projects relating to all the ten Challenges. The second call was focused on thematic or regional actions addressing Challenge 1 – Marine Pollution, Challenge 2 – Ecosystem Management and Challenge 5 – Ocean Climate Nexus. And the third call had a primary focus on actions that contribute to Challenge 3 – Sustainable Blue Food and Challenge 4 – Sustainable Ocean Economy. The fourth call was just released on 14th October, 2022 with focus on Challenge 6 – Coastal Resilience and Challenge 8 – Digital Representation of the Ocean. Different from Programme proposals, Project proposals need to be linked to endorsed Decade Programmes. Contributions and Activities are welcomed to be submitted at any time. After the first two calls, totally 35 Programmes, 189 Projects, and 47 Contributions have been endorsed to be implemented under the framework of the Ocean Decade. Another 10 Programmes and 8 Projects that are led by UN entities have also been registered as Decade Actions.[1] Nearly 300 workshops, training courses and events have been organized contributing to the vision of the Ocean Decade. And submissions responding to the third call are under review.

Meanwhile, there have been great progress in establishing governance and coordination framework of the Ocean Decade. The DAB was established and put into operation in December of 2021. It is composed of 15 expert members, including 8 females, from 13 countries with high diversity in sectors and disciplines. The members meet regularly to discuss on scoping calls for Decade Actions, drafting important documents and other strategic issues, review Programme submissions, and finally provide recommendations. Besides, 3 DCOs, 6 DCCs, and 7 Decade Implementing Partners (DIP) have been endorsed, while 29 National Decade Committees have been established by countries all over the world. These mechanisms will be responsible for coordinating with related Decade Actions and other stakeholders, monitoring and evaluating progress of the Ocean Decade, contributing to drafting annual reports, and catalyzing engagement into the Ocean Decade.

In spite of the fruitful progress, there are still some challenges which might bring adverse impacts to the future implementation of the Ocean Decade.

Firstly, the engagement of developing countries, least developed countries (LDCs), small island developing states (SIDS), and land-locked developing countries (LLDCs) in the implementation of the Ocean Decade is unfortunately limited. Among all the 35 endorsed Decade Programmes, there are only seven Programmes whose lead institutes are from the developing countries. Among all the six approved DCCs till now, four are hosted by the developed countries, except for one location in China and one location in India. The percentage of leading institutes from developing countries in Decade Projects is considerably low, too. To change this situation, the Ocean Decade are taking measures to facilitate more involvement of developing countries, LDCs, SIDS, and LLDCs. For example, proposals of Decade Actions which are led by institutes from those countries are given priority in the endorsement process.

Secondly, there is a big gap between the resources secured and those required for the implementation of the Ocean Decade. Based on the brief analysis in the Ocean Decade Progress Report (2021-2022), the resources secured are even less than half of those needed by Decade Programmes for the first three years of implementation. Although this analysis will be updated annually, there is clearly much pressure on mobilizing resources for the implementation of the Ocean Decade (UNESCO-IOC, 2022), especially with the high pressure on world economy by the unexpected COVID-19 pandemic which has been lasting for more than 3 years. The Ocean Decade is actively catalyzing mobilization of resources such as working closely with the Ocean Decade Alliance, developing Ocean Decade Partnerships, convening Foundations Dialogue meetings, launching co-Branded calls for Decade Actions, and receiving strong supports from IOC-UNESCO Member States, etc.

The Ocean Decade Alliance is a group of global Decade champions from governments, philanthropies, industries and UN agencies. It is mandated to catalyze mobilization of resources to achieve the vision of the Ocean Decade. Alliance Partners commit to provide significant financial or in-kind resources, and advise the IOC on resource mobilization strategies to enhance funding for Decade priorities. Contributions and supports from Canada, China, Egypt, France, Germany, India, Japan, the Republic of Korea, Norway, Portugal, Sweden, and Thailand have been playing a crucial role in the implementation of the Ocean Decade at its initial stage. There have been two Foundations Dialogue meetings which brought together more than 25 foundations from different continents to discuss how to effectively mobilize resources for Decade priorities. Besides, almost USD 15 million have been leveraged for 22 Decade Projects through launching six sponsored calls for Decade Actions (UNESCO-IOC, 2022).

Thirdly, the seven outcomes of the Ocean Decade are qualitative and narrative, and lack of quantitative contents which are definitely needed for its successful implementation. It is necessary and important to regularly evaluate the implementation of the Ocean Decade with suitable indicators and quantitative results. The quantitative evaluation is helpful for timely revision of the Ocean Decade. To this end, DCU is working on drafting Monitoring and Evaluation Framework of the Ocean Decade. It might not be difficult to formulate indicators of what

1 *Meet all the endorsed Ocean Decade Actions.* https://www.oceandecade.org/decade-actions/. (Accessed 2022/11/5)

we have done. But it is definitely challenging to formulate indicators of what the ocean has changed. Both of these two ways of quantitative evaluation are necessary and important.

4 China's actions and its national plan

China, with steady attitude and diligent practice, is always dedicated to achieving the sustainable development of ocean, in particularly the Goal 14 of 2030 Sustainable Development Agenda. From domestic perspective, China is devoted to innovating of economic developing model with particular attention to the sustainability of the ocean ecosystem. There have been brilliant achievements which can be excellent practice for sustainable development. From global perspective, China is always active in international cooperation including providing impressive contribution to the capacity-building of ocean science in developing countries. In 2019, President Xi Jinping of China proposed a concept of Maritime Community of Shared Future calling upon the whole international community to struggling together for and cooperating closely on ocean sustainable development. All of the above concept and practice are consistent with the vision and mission of the Ocean Decade.

Actually, China has deeply engaged in the preparation and implementation of the Ocean Decade. At the preparatory phase, the corresponding author of this paper was selected as a member of the Executive Planning Group of the Ocean Decade. He was lately selected as an expert member of the DAB and continued contributing to the implementation of the Ocean Decade. The National Ocean Decade Kickoff Conference of China was held on 8th June, 2021 with aiming to stimulate more engagement of all related communities from China into the Ocean Decade. By now, China is leading four endorsed Decade Programmes, five endorsed Decade Projects including two that are co-led with UN entities, and several Decade Activities. Besides, China has started the operation of a DCC for Ocean-Climate Nexus and Coordination amongst Decade Implementing Partners in P. R. China (DCC-OCC).[2] And there are two endorsed DIPs from China.

As one of the biggest coastal countries, China is expected to be an important stakeholder of and contributor to the Ocean Decade. Furthermore, as guided by the concept of Maritime Community of Shared Future, actions of China contributing to the Ocean Decade are aiming to be beneficial for all the world instead of for only one country or one region.

For example, the four endorsed Decade Programmes, which are led by institutes or universities from China, will contribute to enhancing human capability of sustainable development. They respectively aim to dramatically improve world forecasting capability for the ocean and climate,[3] develop and evaluate approaches to enhance global ocean negative carbon emission,[4] develop a global network to monitor environmental contaminants in major urbanized estuaries worldwide,[5] and study the present status and threats of 25 representative deltas in the world.[6] They are globally co-designed and cooperated with themes relating to common concerns of mankind. They will provide knowledge, solutions, and public products and service for the world instead of researching on exploration and development of marine resources. The DCC-OCC with focus on Ocean-Climate Nexus is hosted by the First Institute of Oceanography of Ministry of Natural Resources of China. It will play a key role in coordination framework of the Ocean Decade through communicating with related endorsed Decade Actions, assisting DCU to scope and review calls for Decade Actions, contributing to annual reports on progress of the Ocean Decade, and promoting capacity building. Besides these general mandates as other DCCs have, DCC-OCC will establish a model development sharing mechanism that will be a valuable legacy of the Ocean Decade for all humankind.

China has taken further solid steps to enhance its level of organizing and coordinating actions for the implementation of the Ocean Decade. On 19 August 2022, the inaugural meeting of establishing China's National Decade Committee was held in Beijing.[7] With the approval of the State Council, the Ministry of Natural Resources of China has taken the lead in coordinating relevant departments to establish the Committee. Founding member organizations of the Committee include the Ministry of Foreign Affairs, Development and Reform Commission, Ministry of Education, Ministry of Science and Technology, Ministry of Finance, Ministry of Industry and Information Technology, Ministry of Ecology and Environment, Ministry of Transport, Ministry of Agriculture and Rural Affairs, International Development Cooperation Agency, Chinese Academy of Sciences, Meteorological Bureau, and natural Science Foundation

2 *Decade Collaborative Centre for Ocean-Climate Nexus and Coordination amongst Decade Implementing Partners in P.R. China (DCC-OCC)*. Available at: https://www.oceandecade.org/actions/decade-collaborative-centre-for-ocean-climate-nexus-and-coordination-amongst-decade-implementing-partners-in-p-r-china-dcc-occ/ (Accessed 2022/12/3).

3 *Ocean to Climate Seamless Forecasting System*. Available at: https://www.oceandecade.org/actions/ocean-to-climate-seamless-forecasting-system/ (Accessed 2022/12/3).

4 *Global Ocean Negative Carbon Emission*. Available at: https://www.oceandecade.org/actions/global-ocean-negative-carbon-emission/ (Accessed 2022/12/3).

5 *Global Estuaries Monitoring*. Available at: https://www.oceandecade.org/actions/global-estuaries-monitoring-gem-programme/ (Accessed 2022/12/3).

6 *Mega-Delta*. Available at: https://www.oceandecade.org/actions/deltas-associated-with-large-rivers-seeking-solutions-to-the-problem-of-sustainability/ (Accessed 2022/12/3).

Committee etc. The first meeting of China's National Decade Committee considered and adopted in principle the Framework of China's Action Plan for the Ocean Decade, and agreed to establish an expert advisory working group to guide and coordinate submissions for Decade Actions from China.

Furthermore, China identified 6 priority actions on Ocean Decade. Priority 1 is the research on and implementation of intelligent ocean observing and forecasting technologies and high-quality public service products; Priority 2 is to advance integrated ecosystem-based ocean management; Priority 3 focuses on ocean actions that serve the carbon neutrality goal; Priority 4 is to develop deep ocean typical habitat discovery and protection; Priority 5 devotes to conducting a monitoring program for polar marine environment and ecosystems; Priority 6 is to enhance the international cooperation platforms and mechanisms. More details will be officially published soon later. We can expect that China will provide strong and sustainable supports and contribution to, and solid solutions and high-quality public products for the Ocean Decade and the world.

5 Influences to ocean governance

Decision-makers at different level and the public are regarded as important end-users of outcomes of the Ocean Decade. As described in the IP, the Ocean Decade will generate and contribute data, information, knowledge and increased capacity relevant to achieving aspirations contained in global legal and policy frameworks, including the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), the 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage, the Convention on Migratory Species (CMS) and other emerging agreements such as a legally binding instrument under UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ) (UNESCO-IOC, 2021). The recent progress of the Ocean Decade is encouraging, and it still needs several more years to actually see how the Ocean Decade will change the ocean governance. Even though, it is valuable for us to predict some key influences of the Ocean Decade with the assumption of its successful implementation through reasonable analysis. And these conclusions will be helpful for improving the way in which scientific results can quickly and effectively inform actions, and how the impact of global, regional and national policies on the ocean is measured (Claudet et al., 2020).

Firstly, great improvement and transformation in ocean governance tools could be expected. Endorsed Decade Actions are encouraged to be co-designed and co-delivered by scientists and policy-makers with the aim of generating sets of effective, friendly and easy-use ocean governance tools. Based on the ideal design of endorsed Decade Programmes, we can anticipate that two transformative governance tools are emerging.

One is a digital decision-support system including digital products and digital twin both of which can be used in the process of decision making and law enforcement. For example, the approved Decade Programme of Coral Reef Sentinels: A Mars Shot for Blue Planetary Health seeks to develop and demonstrate a scalable monitoring, modeling and decision-support system for reef conservation. The approved Programme of the Ocean to climate Seamless Forecasting system (OSF) will bring us accurate, reliable and professional prediction products of ocean and climate, which can be used by end-users for reduction and adaptation to marine disasters and climate change.

The other is a comprehensive and inclusive framework. For instance, the endorsed Decade Programme of ForeSea - The Ocean Prediction Capacity of the Future has the purpose of building a seamless ocean information value chain that is from monitoring and researching to decision-making. At the same time, the endorsed Decade Programme of Fisheries Strategies for Changing Oceans and Resilient Ecosystems by 2030 (FishSCORE 2030) will develop assessment and modeling frameworks that synthesize complex ecological, social, cultural, economic, and governance dimensions of fishery systems. And the endorsed Decade Programme of Pacific Solutions to Save Our Ocean seeks to create opportunities for ocean science to feed into decision making through focusing on three major aspects of regulatory frameworks, decision support systems, and increased considerations for Pacific culture and context.

Secondly, outcomes of the Ocean Decade will contribute to the generation of evidence-based legal rules. The current situation is that human beings are trying to make and improve more laws and rules applied for ocean sustainable development with quite limited knowledge of the ocean. It is difficult to make laws and rules of ocean without sufficient information and knowledge. This awkwardness can be improved through a big progress in co-production of data, information, knowledge and solutions of the ocean, especially in currently data-poor regions such as the deep ocean, the Southern Ocean and the polar regions. And this progress is the major mission of the Ocean Decade. For instance, we know little about the shape of the ocean floor with 81% yet to be fully mapped, and the endorsed Decade Programme of The Nippon Foundation-GEBCO Seabed 2030 Project is working hard to produce the definitive bathymetric map of the entire ocean by 2030. The map will be freely available for all users including decision and law makers. Another endorsed Decade Programme of Challenger 150 - A Decade to Study Deep-Sea Life aims to advance understanding of the diversity, distribution, function and services provided by deep-ocean biota; and to use this new knowledge to educate, inspire, and promote better management and sustainable use of the deep ocean. Outcomes of the endorsed

7 *China establishes National Decade Committee*. Available at: https://www.oceandecade.org/news/china-establishes-national-decade-committee/ (Accessed 2022/10/3).

Decade Programmes related to deep sea will be valuable for the negotiation and drafting of BBNJ.

There is another important negotiation of international legally binding instrument of plastic pollution. The fifth session of the United Nations Environment Assembly, which was held in February and March of 2022, launched the negotiation of a new international treaty on plastic pollution, including that in the marine environment. This negotiation needs solid and sufficient scientific data, knowledge and conclusions. Meanwhile, there are lots of endorsed Decade Actions relating to plastic pollution to the ocean. And there is no doubt that the outcomes of these Actions will strongly support this negotiation procedure. For example, the goal of the endorsed Decade Project of Global Marine Plastic Litter Monitoring Network Project is to create a global network hub to share and compile the monitoring activities and data on marine plastic litter distribution. And the endorsed Decade Project of Plastic Drawdown is a proven rapid assessment tool to help countries develop an evidence-based policy response to ocean plastic pollution, including understanding plastic waste flows, identifying policy interventions, and announcing evidence-based strategies that address the full life cycle of plastics. Another endorsed Decade Project of Stem the Tide of Asia's Riverine Plastic Emission into the Ocean seeks to generate timely and reliable riverine plastic data to inform waste management and policy recommendations.

Lastly, the Ocean Decade will contribute to just and inclusive ocean governance besides science-based ocean governance. Recently, there have been increasing concerns about exclusionary decision-making process and social injustice. These considerations are generally related to inclusion of local communities and people at local and national level, and developing states, SIDS, LLDCs, LDCs at global level, in decision-making process (Bennett, 2018). It is also suggested that greater heed to the human dimensions is needed in ocean science, and the social sciences should be central to the domain of the Ocean Decade (Bennett, 2018). Just and inclusive ocean science also should be taken into account. For example, the inclusion of developing states, SIDS, LLDCs, LDCs in global decision-making process will not be achieved without equitable access to data, information, knowledge and technology, and inclusion in the ocean science of those countries. Therefore, just and inclusive ocean science is the key part of ocean governance. The Ocean Decade is designed to realize just and inclusive ocean science. As presented in the IP, equity, inclusiveness, respect, fairness and scientific integrity are core principles of the Ocean Decade (UNESCO-IOC, 2021). The Ocean Decade aims to achieve the equity in several aspects including equitable access to data, information, knowledge and technology, equitable ocean economy, equity in gender, geography and generation (UNESCO-IOC, 2021). An accessible ocean, which is one of seven expected outcomes of the Ocean Decade, means open and equitable access to data, information, knowledge and technology. One of ten Challenges to the Ocean Decade is to generate knowledge, support innovation and develop solutions for equitable and sustainable development of the ocean economy under changing environmental, social and climate conditions. The Ocean Decade also aims to create more opportunities for developing states, SIDS, LLDCs, LDCs, women and local and indigenous knowledge holders. For instance, there is an endorsed Decade Programme of Ocean Voices: Advancing Equity through the Decade focused on enabling conditions for equity in the Decade. Since marine spatial planning procedures can help to find more sustainable and equitable regimes of ocean use and access (Visbeck, 2018), some endorsed Decade Actions will facilitate marine spatial planning, such as the endorsed Project of Accelerate Marine Spatial Planning in the Western Pacific. All of these endeavors will highly promote equitable capability of the ocean science and then contribute to the achievement of just and inclusive ocean governance.

All the above conclusions are based on the assumption that more science will eventually lead to better policy-making. However, as analyzed in Section 2.4, the process of science-policy interfaces is very complex and challenging. Moreover, science-based ocean governance is only part of good ocean governance, just and inclusive ocean governance is also needed for good ocean governance. Even though, more science and endeavors on science-policy interfaces which will be made by the Ocean Decade should be deemed as a good start to approaching better policy-making and good ocean governance.

6 Conclusion

Whoever is equipped with scientific tools leads the global ocean governance for long-term sustainable development. Ideal ocean governance could not be fulfilled without neither enough scientific data, information, knowledge nor effective science-policy interfaces which could lead to the science-based solutions and tools. As an UN-led global initiative, the Ocean Decade is designed to bring more opportunities for the development of ocean science and ocean governance in the following decades, by means of implementing a large quantity of Decade Actions to echo the ten Challenges, and synergizing outcomes of endorsed Decade Actions through its governance and coordination framework. The success of the Ocean Decade highly depends on effective, friendly and easy-use science-policy interaction and then interfaces, which need close cooperation between both scientists and decision-makers, and is the reason that the Ocean Decade pays so much attention on multidisciplinary especially natural and social sciences. It should be stressed that although scientific research, new novel scientific findings and technical breakthroughs are exciting, what the decision-makers and other end-users need are solutions instead of academic data or papers. Governance tools could serve as an effective bridge, based on the achievements of science communication, to further strengthen connections between

science and end-users, and should be the foci of the Ocean Decade. To this end, it is important for scientists to co-design and co-deliver Decade Actions with policy-makers and other end-users on one hand, and policy-makers and other end-users to actively engage into the Ocean Decade including communicating their needs and establishing evidence-based decision making on the other hand. More engagement of policy-makers and other end-users will be decisive contribution to the successful implementation of the Ocean Decade, in particular when we recognize that the Ocean Decade is one of the most important joint-effort outcomes of the science and policy communities under the coordination of IOC during its 60-year history. Therefore, demand-driven and science-based governance tools will be the spirit of the Ocean Decade.

It is worthy to notice that the Ocean Decade starts exactly fifty years after the International Decade of Ocean Exploration (IDOE) took place (Ryabinin et al., 2019). It might be coincident that the IDOE was successfully implemented in 1971-1980, and the third UN Conference on the Law of the Sea was convened in 1973-1982 with the adoption of the UNCLOS. The almost parallel timing implies the connection between ocean science and the Law of the Seas, which gives international community more expectation on the Ocean Decade.

Author contributions

SG and FQi conceived the manuscript. SG wrote the first draft of the manuscript. All authors contributed by writing and revising the text.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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