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Report from *The Economist's* World Ocean Summit Asia-Pacific

聯合國「海洋科學促進永續發展十年」專刊

"United Nations Decade of Ocean Science for Sustainable Development
(2021-2030)" Special Issue



目錄 Contents

發行人語	海洋科學十年 邁向我們想要的海洋！	01
專題報導	經濟學人第一屆亞太地區世界海洋高峰會報導	02
國際議題	實現我們想要的海洋：海洋科學促進永續發展十年實施計畫 (2021-2030)	07
產業動態	淺談世界海洋資料庫及臺灣海洋資料庫之發展	12
組織焦點	聯合國海洋科學促進永續發展十年的協調治理架構	17
資訊新知	IOC海洋十年實驗室機制及其海洋教育衛星活動	22
法規制度	聯合國海洋科學促進永續發展十年：海洋素養行動架構摘要	26
Letter of Publisher	The Decade of Ocean Science, Working Towards the Ocean We Want!	31
Special Report	Report from <i>The Economist's</i> First World Ocean Summit Asia-Pacific	32
International Issues	Achieving the Ocean We Want: The Implementation Plan for the UN Decade of Ocean Science for Sustainable Development (2021-2030)	37
Industry Dynamics	An Overview of the Development of World Ocean Database and Taiwan's Ocean Database	42
Organization Focus	The United Nations as a Coordinating Governance Framework for the Decade of Ocean Science for Sustainable Development	47
Latest News	IOC Ocean Decade Laboratories Mechanisms and Marine Education Satellite Activities	52
Regulatory Systems	The United Nations Decade of Ocean Science for Sustainable Development: Summary of the Framework for Ocean Literacy	56



The Decade of Ocean Science, Working Towards the Ocean We Want!

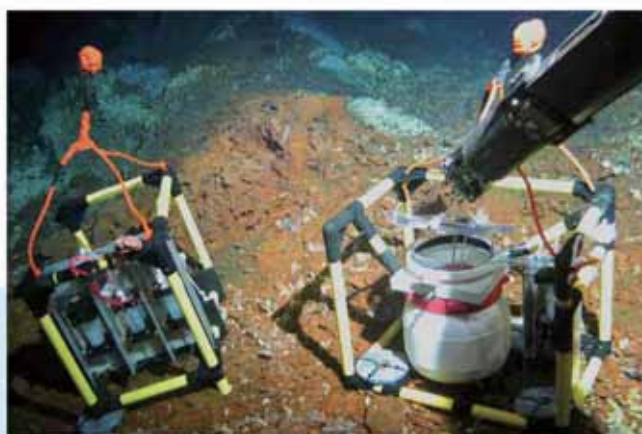
Translated by Linguitronics

Minister of the Ocean Affairs Council: Chung-Wei Lee

Resources from the ocean not only support billions of people with sustenance and livelihood, but also bring great economic, cultural, and social value. Human health and well-being also depend on the health and safety of the ocean. However, the wise use and maintenance of the ocean and marine ecosystems must be based on understanding and research of the ocean. The United Nations released its first World Ocean Assessment report in 2016, in which it initially established a baseline for the marine environment. In December 2017, the United Nations General Assembly proclaimed the period from 2021 to 2030 as the "Decade of Ocean Science for Sustainable Development" (the Decade of Ocean Science). The purpose of the "Decade of Ocean Science" is not to establish ocean policies, but to build momentum with ocean science and to generate knowledge, providing a solid knowledge framework for the 2030 Agenda for Sustainable Development and transforming the ocean we have into "The Ocean We Want".

The first issue of this periodical in 2022 will be titled "The Decade of Ocean Science". It will provide readers at home and abroad with introductions to the world's most critical ocean happenings in the next ten years, beginning with the "Decade of Ocean Science" implementation plan, the "Ocean Data for All" project based on the World Ocean Database, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization presiding over the project, the Ocean Decade Laboratories mechanism that promotes ocean literacy for all, and the ocean literacy action framework.

Actively participating in big international events and speaking out in the international arena have always been the tendency of Taiwan's continuous efforts. For this issue, Ocean Affairs Council deputy minister Dr. Ching-Piao Tsai was invited to participate in the first World Ocean Summit in Asia Pacific held by international magazine *The Economist*, officially representing Taiwan with a report on "Marine Energy in Taiwan", in which he shared Taiwan's research results with the world and discussed key marine economic sustainability issues with more than 100 speakers in the Asia Pacific. And Taiwan Marine Education Center was invited to participate in the satellite activities of the Ocean Decade Laboratories and share Taiwan's marine education policies and plans. In the movement towards "The Ocean We Want", Taiwan is never absent!



Sampling from the seafloor
Source/ ROV-Team, GEOMAR (CC BY 4.0)
<https://www.oceandecade-conference.com/en/press.html>

Report from *The Economist's* First World Ocean Summit Asia-Pacific

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Translated by Linguitronics

Keywords: Ocean energy, climate change, ocean summit



Figure 1/ *The Economist's* World Ocean Summit Asia-Pacific Official Website Summit Home Page
Source/ <https://events.economist.com/world-ocean-summit-asia-pacific/>

The ocean is the key factor to there being life on Earth, and it is also an important support for the survival and development of human civilization. However, since the industrial revolution, direct and indirect damage to the marine environment caused by human activity have increased dramatically. This has led to global climate change, while also posing a threat to the survival of humans and other species around the world. In recent decades, the international community has gradually realized the severe deterioration of the ocean environment. Passed on December 5, 2008, UN General Assembly Resolution 63/111 [1] designated June 8 as World Oceans Day, and called for global attention to marine issues. Ever since, large-scale international conferences and events taking the ocean as their theme have multiplied. Since 2014, the Our Ocean Conference initiated by the then-US Secretary of State John Kerry (current US special presidential envoy for climate) is expected to hold its 7th conference, in Palau in 2022; the UN Ocean Conference hosted first by the United Nations in 2017 is also expected to hold its second conference, in Portugal in 2022. Joining the list, the internationally renowned British media group *The Economist* also launched the World Ocean Initiative in 2012, and holds the World Ocean Summit every year; and from December 6 to 10 in 2021, this Summit has especially targeted the Asia-Pacific region, with the first World Ocean Summit Asia-Pacific [2].

Due to the impact of the COVID-19 pandemic, the event was held online, with more than 100 speakers from more than 50 countries invited to share knowledge and discuss their opinions on various ocean issues. Officially representing Taiwan with its official name on the summit stage, Ocean Affairs Council deputy minister Dr. Ching-Piao Tsai was invited to deliver a report on "Marine Energy in Taiwan."

An Ocean in Robust Health and with A Vital Economy -The Economist World Ocean Initiative

Although people have realized that human activities have already deteriorated the marine environment, they have remained unrestrained and indifferent to the situation. Thus, *The Economist* launched the World Ocean Initiative in 2012 [3], which focuses on three "cross-cutting levers of change": finance, governance and innovation. The ultimate goal and vision for our oceans: "We imagine an ocean in robust health, and with a vital economy."

Different from other international initiatives, the World Ocean Initiative focuses to a greater extent on the Blue Economy. Its core philosophy is to pursue economic growth while simultaneously taking into account sustainable development. However, there is still a considerable gap between the real and the ideal, and it is precisely this gap that challenges the international community. In order to meet such challenges and build consensus, *The Economist* has held the "World Ocean Summit" as the core activity of its initiative every year since 2012. Its purpose is to create a platform on which more diverse and extensive dialogues can happen among those involved, with the aim of finding key solutions to marine issues.

The First Ocean Summit to be Held for a Specific Area

The main organizer of the conference, *Economist* Editorial Director Charles Goddard pointed out in his opening speech that the Asia-Pacific region accounts for nearly one-half of the world's population and also plays an important role in global economic growth and protection of the oceans. When the oceans are unhealthy, the Blue Economy cannot flourish; that means that restoring the health of the oceans and accelerating the sustainable development of the ocean economy are important issues for the Asia-Pacific region.

Like previous World Ocean Summits, the World Ocean Summit in Asia Pacific is not divorced from the economic issues, as it took "Investing in blue economy" as its theme. The summit's agenda is divided into two parts. One is the "plenary," which contains a variety of marine issues, such as marine protected areas (MPAs), climate change, blue carbon, and the United Nations' Decade of Ocean Science; a total of 5 special lectures and 10 symposiums were arranged. The second is the "industry track," the scope of discussion including "energy," "fisheries," "aquaculture," "shipping," and "plastics" (pollution), "finance", and other individual industries; a total of 6 special lectures and 21 symposiums were arranged, which invited experts and scholars from all parties to engage in dialogue.

Taiwan's Unique Marine Energy Development is Seen on the International Stage

For Taiwan, one of the biggest highlights for this conference was that Ocean Affairs Council deputy minister Dr. Ching-Piao Tsai was invited to give a presentation, representing Taiwan under a full government title. With such a plethora of difficulties, Taiwan's being treated in a fair and reasonable manner on the international stage is worthy of everyone's praise and gratitude.

The content delivered to the event by deputy minister Tsai [4] is Taiwan's unique renewable energy development field and blue economy—marine energy. Taiwan's energy policy aims at the proportion of renewable energy being increased to 20% of the nation's total energy by 2025. In addition to its abundance of wind power and solar energy, Taiwan is also surrounded by the sea and has on its east coast the Kuroshio current, giving the island ideal potential for green marine energy.

At present, the three main development directions of Taiwan's marine energy are "wave energy," "current energy" and "thermal energy conversion." Ocean current energy is one focus of development. In recent years, its promotion has continued to achieve good results and breakthroughs. However, there are still challenges to entering the commercial transition stage, such as the survival rate of equipment and power generation efficiency. The research team in Taiwan is continually devoting its efforts to solving such problems.

Deputy minister Tsai also pointed out that in the development of marine energy, Taiwan looks forward to and welcomes more international cooperation; it is very willing to share its research results with the world, in hopes that the development of marine energy can make the Earth more sustainable and prosperous.



Figure 2/ Deputy minister Tsai's introduction on the official event website; nationality is expressed using Taiwan's official flag

Source/ *The Economist's World Ocean Summit Asia-Pacific Official Website*

Overall Observation of the Summit

I. Dealing with climate change remains one of the focal points for ocean issues

With the UN Framework Convention on Climate Change Conference of the Parties (COP26) having just ended on November 12, 2021, and the shocking picture of Tuvalu's foreign minister Simon Kofe giving a speech to the UN COP26 climate summit while standing knee-deep in seawater still deeply set in many people's minds, the World Ocean Summit also arranged for a considerable amount of the agenda to focus on discussion of climate change; island countries in the Asia-Pacific region, such as Fiji, Cook Islands, Tuvalu, and other countries that have been impacted by sea-level rise, have voiced their concerns and called for more action from the global community to mitigate climate change. "Reducing carbon emissions" and "Maintaining the health of the ocean" and other practical ways to mitigate climate change were also the important cores of discussion at this meeting.

II. "Finance"—a key element in dealing with marine challenges

Compared with previous summits, this summit classified "Finance" as a full track for the first time, and five seminars were arranged to discuss related topics, including the themes "blue bonds" and "blended

finance models"; among the topics of various industries, finance represented the largest number, making it obvious that the introduction of capital and financial models into the marine field will inevitably be one of the key elements for solving future marine problems.

III. The Ambitious Nippon Foundation

The Nippon Foundation, along with The Economist Group, was one of the main hosts of the summit. The Foundation and *The Economist* jointly launched the "Back to Blue" initiative, which focused on the three main areas of "plastic pollution," "chemical pollution," and "biodiversity". There was also arranged a session dedicated to the plastic pollution research results of this initiative. In addition, major figures related to The Nippon Foundation, such as President Atsushi Sunami and President Hide Sakaguchi, respectively of the Sasakawa Peace Foundation and the Ocean Policy Research Institute (OPRI), were also active participants in the various forums, showing Japan's emphasis on and investment in marine issues. In addition, The Nippon Foundation has also worked hard to promote several ocean-related actions, such as the promotion of the SEABED 2030 project (one of the officially supported activities of the UN's Decade of Ocean Science for Sustainable Development) and the Coast Guard Global Summit (CGGS), so it is not difficult to see Japan's ambition to understand and possess the right to speak on maritime issues in the Asia-Pacific region.

Table 1/ World Ocean Summit in Asia Pacific-List of Speeches

Topic	Speaker/Panelist
Keynote Address Protecting the ocean: from words to action	Mahinda Rajapaksa Prime Minister, Sri Lanka
Keynote Address Advocating for ocean protection	Kate Walsh actress, activist, entrepreneur and ambassador, Oceana
Keynote Address Comprehensive action to restore ocean health	Henry Puna Pacific ocean commissioner
Keynote Address Act now to limit climate change impact	Frank Bainimarama Prime Minister, Fiji
Keynote Address Financing climate change adaptation measures	Mark Brown Prime Minister, Cook Islands
Energy presentation: Marine Energy in Taiwan	Ching-Piao Tsai Taiwan Ocean Affairs Council deputy minister
Case study: Achieving and maintaining healthy stocks	Manumatavai Tupou-Roosen Director-general, Pacific Island Forum Fisheries Agency
Green shipping in the Republic of Korea	Moon Seong-hyeok Minister for oceans and fisheries, Republic of Korea
Shipping decarbonisation-challenges and opportunities	Kitack Lim Secretary-general, International Maritime Organization (IMO)
Interview: Finding solutions to Asia-Pacific's marine plastic pollution crisis	Rana Karadsheh Regional industry director, International Finance Corporation (IFC)
Report: Is Extended Producer Responsibility (EPR) the trigger for systemic change?	Sumangali Krishnan Chief business officer, GA Circular

Source/ <https://events.economist.com/world-ocean-summit-asia-pacific/agenda/>

Table 2/ World Ocean Summit in Asia Pacific-List of topics of each session

Category	Topic	Category	Topic
Main agenda	● Governance for ocean restoration ● How to implement and manage marine protected areas (MPAs) ● Nature-based ocean solutions for climate change mitigation ● Making an impact with blue carbon ● Accelerating marine-based research during the UN Decade of Science for sustainable development ● Back to Blue: results of the plastics research ● The Economist's debrief on COP26 and the ocean ● Small Island Developing States (SIDS)—new challenges, new opportunities ● Coastal communities—engagement, resilience, restoration ● Harnessing the power of seaweed ● Harnessing the power of seaweed	Shipping	● Committing to clean and green shipping ● The business of decarbonisation – considering the (supply) chain, not just the links ● Sharing the responsibility to reduce emissions ● Addressing the economics of alternative fuels
		Plastics	● Finding solutions to Asia-Pacific's marine plastic pollution crisis ● Making the step from recyclable to recycled ● Creating value from waste ● How could plastic neutrality and credits revolutionise plastic action?
	Energy	Finance	● Can blue (economy) be the new green (economy)? ● Developing the business case to attract early investors ● Will blended finance tip the scales? ● How are blue bonds reframing marine project finance? ● Investors or investable projects: where is the deficit?
	Fishery		
	● From hook to plate - driving sustainability across supply chains ● Protecting small-scale fisheries ● Tools for trust and transparency		
Aquaculture	● Scaling sustainably to address food security concerns ● Preventing and managing disease sustainably ● Best-practice solutions for low-impact farming		

Source/ <https://events.economist.com/world-ocean-summit-asia-pacific/agenda/>

Conclusion

Compared with other environmental issues, the attention received by marine issues appears tepid, both domestically and internationally. However, the oceans are actually closely related to and even inseparable from other environmental issues, and thus require more people's attention and engagement. After the five-day meeting, the organizer Charles Goddard expressed in his closing speech his high expectations and willingness to organize the next World Ocean Summit in Asia Pacific in a physical manner. In addition, he has also scheduled a physical meeting in Lisbon, Portugal in March 2022, for the 9th World Ocean Summit [6]; however, the meetings all depend on the extent to which the international community has recovered from the COVID-19 pandemic by that time. The writing of this article coincided with the emergence of a new variant of the coronavirus (Omicron), which has spread worldwide. The author sincerely hopes that the pandemic will alleviate as soon as possible, so that everyone's lives can return to normal.

Finally, as of the deadline, the organizers of the summit have held open registration for participation, and the content of this conference will continue to be open for viewing online until mid-February. Those who are interested can seize the opportunity to register and watch online!

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Achieving the Ocean We Want: The Implementation Plan for the UN Decade of Ocean Science for Sustainable Development (2021-2030)

Chung-Ling Chen (Professor, Institute of Ocean Technology and Marine Affairs, National Cheng Kung University)

Keywords: Decade of Ocean Science, implementation plan, sustainable development

The United Nations proclaimed the UN Decade of Ocean Science for Sustainable Development 2021-2030 (referred to as 'the Ocean Decade') in the 72nd Session of UN General Assembly (UNGA). The vision of the Ocean Decade is 'the science we need for the ocean we want'. Seven outcomes describe the 'ocean we want': a clean ocean, a healthy and resilient ocean, a productive ocean, a predicted ocean, a safe ocean, an accessible ocean, an inspiring and engaging ocean. The Implementation Plan of the Ocean Decade focuses on using ocean science to solve ocean challenges, proposes seven types of tangible activities in order to facilitate sustainable development, connect people and our ocean, and fulfill the vision of the Ocean Decade.

Overview of the Implementation Plan for the Ocean Decade

The Intergovernmental Oceanographic Commission of UNESCO (IOC) has led the preparation of the Implementation Plan for the Ocean Decade through a highly participative and inclusive process that has spanned three years and submitted the Plan to the 75th session of UNGA (from 16 September 2020 to 15 September 2021) for the adoption [1]. The Plan provides a framework for transformational action that builds on existing achievements on marine research and management, and deliver action across geographies, sectors, disciplines, and generations. States implement the Ocean Decade on a voluntary basis, facilitating the generation of data, information and knowledge needed to move the 'ocean we have' to the 'ocean we want'.

The Implementation Plan builds on a Decade Action Framework (Fig. 1), which contains several tiers with the top one being 'the ocean we want', followed by Ocean Decade Challenges, and Decade Actions. The actions refer to tangible initiatives that are implemented by a wide range of stakeholders. They are grouped into seven types: designing the science we need, managing data and knowledge, developing capacity and ocean literacy, engaging in the Ocean Decade, coordinating the Ocean Decade, financing the Ocean Decade, and measuring success of the Ocean Decade.

Seven types of tangible initiatives of the Implementation Plan

I. Designing the science we need

The Ocean Decade identifies 10 challenges, referred as Ocean Decade Challenges. To solve these challenges, we need to design the science we need. Ten challenges are presented as below.

- Understand and map land and sea-based sources of pollutants and their potential impacts on human health and ocean ecosystems, and develop solutions to remove or mitigate them.

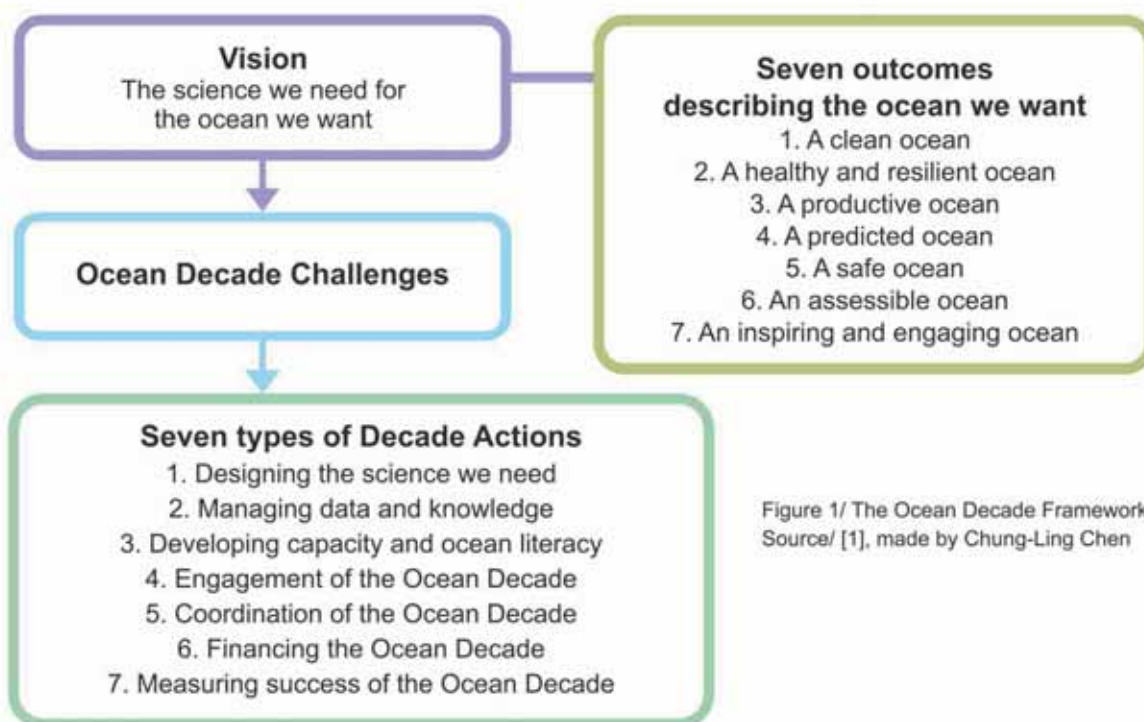


Figure 1/ The Ocean Decade Framework
Source/ [1], made by Chung-Ling Chen

- Understand the effects of multiple stressors on ocean ecosystems, and develop solutions to monitor, protect, manage and restore ecosystems and their biodiversity under changing environmental, social and climate conditions.
- Generate knowledge, support innovation, and develop solutions to optimize the role of the ocean in sustainably feeding the world's population under changing environmental, social and climate conditions.
- Generate knowledge, support innovation, and develop solutions for equitable and sustainable development of the ocean economy under changing environmental, social and climate conditions.
- Enhance understanding of the ocean-climate nexus and offer solutions to mitigate, adapt and enhance resilience to the effects of climate change.
- Enhance multi-hazard early warning services for all geophysical, ecological, biological, weather, climate and anthropogenic related ocean and coastal hazards to strengthen community preparedness and resilience.
- Ensure a sustainable ocean observing system across all ocean basins that delivers accessible and timely data and information to all users.
- Through multi-stakeholder collaboration, develop a comprehensive digital representation of the ocean, including a dynamic ocean map, which provides free and open access for exploring, discovering, and visualizing past, current, and future ocean conditions.
- Ensure comprehensive capacity development and equitable access to data, information, knowledge and technology across all aspects of ocean science and for all stakeholders.
- Ensure that the multiple values and services of the ocean for human wellbeing, culture, and sustainable development are widely understood, and identify and overcome barriers to behavior change required for a step change in humanity's relationship with the ocean.



Figure 2/ One of the Ocean Decade challenges is to understand land and sea-based sources of pollutants and their potential impacts on human health and ocean ecosystems, and develop solutions to remove or mitigate them

Image by Chung-Ling Chen

II. Managing data and knowledge

Data and information are key enablers of the Ocean Decade outcomes. Digitizing, accessing, managing, and using ocean related data, information and knowledge are cornerstones of the success of the Ocean Decade. Designing and constructing a digital network, collecting distributed and diverse components of data, is an important undertaking. This digital network is capable of representing the entire ocean system, embracing all types of ocean data including physical, geological, bathymetric, biogeochemical, geological, social, economic, cultural, and governance-related data. The data sources also include industry and citizen-science data as well as indigenous and local knowledge.

III. Developing capacity and ocean literacy

All parts of the ocean are connected and all countries need the knowledge and capacity to understand, observe, and manage the ocean. However, ocean science and skills remain unequally distributed across genders, geographies, and generations. If the Ocean Decade is to achieve its ambition, there needs to be an accelerated effort to reverse this existing imbalance.

Capacity development initiatives facilitate the development of individual and institutional capacity in accessing ocean data, as well as improve equitable access to data and knowledge, technology and infrastructure, for example research facilities, equipment, high power computing. A wide variety of types of capacity development initiatives will be implemented to best respond to local, national and regional priorities and stakeholder needs. One of the capacity development initiatives is Ocean Literacy Strategy, which identifies four priority areas for action, including policy formulation, formal education, corporate action, and community engagement. In addition, the Ocean Decade supports governments and other stakeholders to develop National Ocean Literacy Strategies and conduct the monitoring and evaluation of the impacts of increased Ocean Literacy.



Figure 3/ The ocean supporting sustainable food supply is the ocean we want

Image by Chung-Ling Chen

IV. Engagement of the Ocean Decade

Active engagement of diverse stakeholders including the scientific community, national governments, UN bodies and intergovernmental organizations, business and industry, philanthropic foundations, NGOs are central to the success of the Ocean Decade. There is no limit to the ways that an individual or an organization can engage in the Ocean Decade. One of the ways is becoming members of the Global Stakeholder Forum. The Decade Coordination Unit uses this Forum to convene communities of practice around the Ocean Decade Challenges and promote exchange between stakeholder groups. Furthermore, Funding opportunities, partnership opportunities, training events, meetings or conferences, will also be broadcast via this virtual platform. The members of the Forum meet in regular regional and international conferences.

V. Coordination of the Ocean Decade

The Ocean Decade involves a large number of partners and activities around the world. There needs a simple, robust coordination structure to manage implementation. The Decade Coordination Unit serves this role and is the central hub for the coordination of Ocean Decade activities. Governments or partners host a number of Decade Coordination Offices are located in different regions around the world. These structures help to coordinate between national, regional, and global initiatives, share knowledge and tools, create links between potential partners, and monitor and report the progress of the Ocean Decade.

In addition, the Decade Advisory Board, consisting of UN entities, provides advice on the implementation of the Ocean decade and the IOC reports to the UNGA regarding the implementation.

VI. Financing the Ocean Decade

The Ocean Decade itself is not a funding mechanism, but it includes mechanisms and opportunities to increase funding available for ocean science. Resources for ocean science come from a range of organizations including governments, philanthropic foundations, and business and industry. To achieve the vision of the Ocean Decade, the amount of resources need to increase significantly in coming years. Both financial support and in-kind support (e.g. use of research vessels, data, access to infrastructure) are important to the success of the Ocean Decade.

The Ocean Decade Alliance is an important mechanism for resource mobilization. Alliance members provide financial and in-kind support. Initiatives usually financed in two ways. One is the traditional way, i.e., research grants. The other is that via the Global Stakeholder Forum and Ocean Decade Alliance, the Decade Coordination Unit creates connections between partners with some providing resource and some carrying out ocean science projects. This thus becomes a collective, highly visible global effort to transform ocean science.

VII. Measuring success of the Ocean Decade

The Ocean Decade is taking place in a dynamic world. Changing social and economic conditions influence society's needs for ocean knowledge. Moreover, advances in technology and scientific discoveries, as well as global events like the COVID-19 pandemic, continue to reveal new priorities and opportunities for the Ocean Decade. Therefore, there needs to develop a detailed monitoring and evaluation framework, allowing tracking of the impact and achievements of the Ocean Decade. The information derived from the framework facilitate adaptive management of the Ocean Decade, including reviews and updating of the implementation plan, production of regular reports on progress towards the Ocean Decade vision, and matching of available resources to the highest actions.

Review process contains eight tasks:

- Biennial action plan: showing priority actions for upcoming two-year period.
- Resource needs assessment: analyzing required vs. secured funding for action plans and coordination costs.
- Review and update Decade Action Framework: review of progress emerging scientific issues and review and updating of Decade Action Framework.
- Global & regional conferences series: global and regional gatherings of stakeholders to catalyze partnerships and review Decade priorities.
- Annual progress report: annual overview of operational, financial and scientific progress.
- Flagship publication in 2024, 2027, 2029 documenting the impact of the Ocean Decade and progress the Decade's vision.
- Mid-term review: comprehensive review of progress and update of the implementation in 2025.
- Final review: comprehensive evaluation of the Ocean Decade in 2031.



Figure 4/ Using marine science (e.g., underwater earthquake detection system) to solve ocean challenges is the cornerstone of the Implementation Plan

Image by Chung-Ling Chen

Conclusion

The Ocean Decade does not set ocean policy, but it builds scientific capacity and generate knowledge that will directly contribute to the goals of the 2030 Agenda for Sustainable Development. The Implementation Plan offers an ocean science-based action framework, containing seven types of tangible initiatives, as a way to solve ocean challenges and thus transform the 'ocean we have' to the 'ocean we want'. During the ten-year period of implementation, the plan is subject to regular review and evaluation. At the end of the implementation, a comprehensive review and evaluation will be conducted in 2031 to check the success of the Ocean Decade as well as the realization of its vision.

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An Overview of the Development of World Ocean Database and Taiwan's Ocean Database

Compiled by Cheng-Chi Chung (Distinguished Professor, Dept. of Shipping and Transportation Management, and Chairman of Bachelor Degree Program in Ocean Tourism Management, National Taiwan Ocean University); Chao-Chun Hsu, Ching-Wen Shih, and Hsin-Wei Tseng (Master Degree Student, Dept. of Shipping and Transportation Management, National Taiwan Ocean University)

Keywords: Ocean Decade, World Ocean Database, National Oceanic and Atmospheric Administration

In 2017, the United Nations proposed the Decade of Ocean Science for Sustainable Development ("Ocean Decade"), a ten-year programme from 2021 to 2030, hoping that all countries can work together for the scientific foundation and applications needed to protect the oceans [1]. This article will introduce the World Ocean Database (WOD) Programme in the "Ocean Decade," and discuss how to properly use WOD to make climate change adaptation decisions, strengthen fishery management, ensure food supply and promote ocean health and well-being. We also review the construction of Taiwan's ocean databases that built by the National Science Council and the Fisheries Research Institute, and introduces how to use the data collected over the years to alleviate fishery depletion. By collecting and sharing ocean data, it can provide as a basis for the development of national ocean and climate policies in order to strive for the goal of ocean sustainability.

The World Ocean Database

I. Introduction of the Research Institution and Research Field

The World Ocean Database (WOD) is built by Ocean Climate Laboratory Team of the National Centers for Environmental Information (NCEI), the research team under the National Oceanic and Atmospheric Administration (NOAA). A brief introduction of NOAA and NCEI is as follows.

The NOAA is responsible for monitoring global weather data and climate trends to advance our ability to predict and respond to changes in climate and other environmental challenges that imperil earth's natural resources, human life and economic vitality. And it holds key leadership roles in shaping international ocean, fisheries, climate, space and weather policies [2]. Under NOAA, NCEI is one of the most important environmental data archives in the world open to the public. Its website provides data of the earth's environment in three major areas of weather and climate, oceans and coasts, and geophysics. By the resources and data provided by NOAA and NCEI, climate risk and vulnerability assessment can be carried out as a reference for climate change adaptation decision-making [3].



Figure 1/ Logo of the National Oceanic and Atmospheric Administration
Source/ <https://oceanservice.noaa.gov/facts/noaaalgo.html>

II. Introduction of the World Ocean Database

The WOD is a collection of scientifically quality-controlled ocean database containing ocean currents, sea temperature, salinity and precipitation in physical oceanography; dissolved oxygen, pH and nutrients in chemical oceanography; chlorophyll and plankton in biological oceanography. The following introduction is based on the WOD 2018 [4].

The WOD was first conceived to provide the World Ocean Atlas (WOA) with horizontal and vertical profile distribution graphs of various ocean parameters. It has been updated quarterly since 2007 to collect the oceanographic variables at standard depth levels in the ocean. In order to understand the comprehensive mean fields of oceanographic variables, it aggregates subsurface oceanographic measurements from different sources, transform them into a unified form, and control the quality [4].

The data from the WOD contains 20,547 different data sets received and archived at NCEI. The data represent the results of 216,845 oceanographic cruises on 8,215 different platforms from 798 institutes and 553 separate projects around the world. The operational definitions of the data organization of WOD are as follows [4].

- Profile: A set of measurements for a single variable (temperature, salinity, etc.) at discrete depths taken as an instrument is being lowered or raised vertically in the water column, so a profile is a discrete set of concurrent measurements from the instruments placed at different depths on a wire attached to the buoy.
- Cast: A set of one or more profiles taken concurrently or nearly concurrently.
- Station: A particular geographic location at which one or more casts are taken.
- Cruise: A set of stations is grouped together if they fit the "cruise" definition. A cruise is defined as a specific deployment of a single platform for the purposes of a coherent oceanographic investigation.
- Accession number: A group of stations received and archived at the NCEI.
- WOD dataset: All casts from similar instruments with similar resolution. For convenience, each dataset is stored in a separate file in WOD.

The WOD datasets group together data acquired in a similar manner. The three-letter notation for each dataset is the abbreviation used for the naming of the output data files [4].

III. Comparison of WOD Databases

In oceanography, data from the same oceanographic cast may be located at different institutions in different countries. From its inception, NCEI recognized the importance of building oceanographic databases in which as much data from each station and each cruise as possible are placed into standard formats, accompanied by appropriate metadata that make the data useful to future generations of scientists [4].

In recent years, the archives of historical oceanographic data have grown due to special data management and data observation projects, as well as due to normal submission by scientists and operational ocean monitoring programs. The comparison between the number of oceanographic casts in WOD 18 and previous ocean databases as shown in Table 1.

Table 1/ Comparison of the number of oceanographic casts in WOD 18 compared to previous WOD versions

Dataset (Cast)	NCEI		WOA 1994	WOD					
	1974	1991		1998	2001	2005	2009	2013	2018
OSD	425,000	783,912	1,194,407	1,373,440	2,121,042	2,258,437	2,541,298	3,115,552	3,220,635
CTD	n/a	66,450	89,000	189,555	311,943	443,953	641,845	848,911	1,029,231
MBT	775,000	980,377	1,922,170	2,077,200	2,376,206	2,421,940	2,426,749	2,425,607	2,430,807
XBT	290,000	704,424	1,281,942	1,537,203	1,743,590	1,930,413	2,104,490	2,211,689	2,303,354
MRB	n/a	n/a	n/a	107,715	297,936	445,371	566,544	1,411,762	1,585,135
DRB	n/a	n/a	n/a	n/a	50,549	108,564	121,828	251,712	227,871
PFL	n/a	n/a	n/a	n/a	22,637	168,988	547,985	1,020,216	1,867,873
UOR	n/a	n/a	n/a	n/a	37,645	46,699	88,190	88,190	127,544
APB	n/a	n/a	n/a	n/a	75,665	75,665	88,583	1,713,132	1,804,605
GLD	n/a	n/a	n/a	n/a	n/a	338	5,857	103,798	1,148,669
Total costs	1,490,000	2,535,163	4,487,519	5,285,113	7,037,213	7,900,368	9,133,369	13,190,569	15,745,724
Plankton	n/a	n/a	n/a	83,650	142,900	150,250	218,695	242,727	245,059
SUR	n/a	n/a	n/a	n/a	4,743	9,178	9,178	9,289	9,289

Source/ WOD, 2018. (p. 27)

Table 1 shows that as scientists continue to investigate and organize the historical data, the publication of data increases every 4 to 5 years, which will help everyone using this database as a basis for decision-making.

IV. The Difficulties in WOD

20 years ago, more than 60 countries regularly contribute to WOD, but now there are fewer than 30 countries [5]. WOD is the oldest oceanographic database that contains the most countries in the world. Without these data, global ocean and climate models do not account for conditions in many of the world's sovereign ocean areas and thus unable to assess the impacts of climate change or progress towards certain sustainable development goals.

To address these hurdles to ocean data sharing, a unique partnership - Ocean Data for All - has been created by the Intergovernmental Oceanographic Commission, the High-level Panel for a Sustainable Ocean Economy, the World Economic Forum's Future of a Connected Planet Program, and the Centre for the 4th Industrial Revolution Ocean. They explored how to improve global cooperation from every aspect, and publish the data that they gathered to benefit the countries in need [5].

Taiwan's Ocean Database

I. Taiwan's Ocean Database and the Promotion of Climate Change Adaptation Actions

There is also a database similar to WOD in Taiwan, called Ocean Data Bank [6]. It was founded by the

National Science Council, Taiwan (NSC, renamed on 2014/3/3 to the Ministry of Science and Technology, MOST) in 1987, and has been operated by the Institute of Oceanography, National Taiwan University (IONTU). The Ocean Data Bank is an interdisciplinary oceanographic information system based on a service oriented architecture for providing ocean data of the western Pacific Ocean. The database has been integrated with geographic information system, so it can provide graphs and maps for physical, geophysical, or biological oceanographic information.

In addition, the Fisheries Research Institute is the basis for environmental monitoring of fishing grounds in the waters surrounding Taiwan. It conducts ocean environmental surveys on large-scale offshore fishing grounds, promoting the "environmental monitoring" project since 2003, sends vessels to 62 fixed measuring stations in the surrounding waters in different seasons to measure water temperature and salinity, and collects water samples for nutrient and biota to explore fisheries under the changing ocean environment. These analyses play crucial role in ensuring the sustainable use of fishery resources [7].

The database can be applied to many fields, from national security to ocean conservation. If information can be popularized in the future, it can help people who depend on the sea for their livelihoods to improve their work efficiency [7]. In Taiwan it has also made progress in policy [8]. Figure 2 shows the promotion process of Taiwan's climate change adjustment actions.

Figure 2 shows that in order to improve Taiwan's ability to respond to climate change, the National Development Council established a task force to continue promoting the plan and set up a national climate change adjustment promotion mechanism every year. The "National Climate Change Adaptation Policy Program" and the "National Climate Change Adaptation Action Plan (102~106)" have been completed one after another, building the foundation for Taiwan to promote climate change adaptation. The latest version of the "National Climate Change Adaptation Action Plan (107~111)," in addition to continuing to implement coastal and ocean environmental protection, it has also been included in the competent business of the Ocean Affairs Council that established in 2018, and will promote the monitoring, early warning and evaluation mechanism of ocean resources to effectively protect the coast biological habitats and ocean resources promote sustainable ecological development [8].

In 2020, the National Academy of Marine Research (NAMR) began to carry out the Nationwide Marine Database Establishment Project. Currently, the database system has been preliminarily completed, and the relevant marine data from various government agencies, academic and research units and private institutions have been gradually collected. The Nationwide Marine Database has now interfaced with 97 data sets, hoping that the data circulation mechanism of marine data storage can be further improved in the future [9].



Figure 2/ History of National Climate Change Adaptation
Source/ <https://adapt.epa.gov.tw/>

II. Practical Application of Ocean Data Bank

After reviewing the construction and operation of Taiwan's ocean databases, the following will introduce a practical case of applying ocean database to traditional fisheries. Taiwan had a rich and diverse ocean ecology; however, in recent years, yield of catch around Taiwan is gradually decreasing.

Traditional fishery determines the location of fishing grounds by fishing experience. However, due to changes in the global climate and ocean environment, the distribution of fishery resources has lost its regularity. By the analyses of the water temperature, chlorophyll concentration, and nutrient composition can accurately predict the location of fish schools, assist fishery management, moderately restrict fishermen's fishing, and achieve the goal of sustainable development of marine resources [9]. Provided by Fisheries Research Institute, Figure 3 shows satellite sea surface temperature charts around Taiwan.

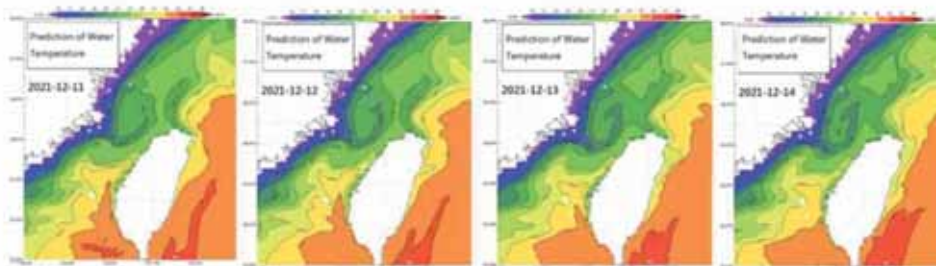


Figure 3/ Satellite Sea Surface Temperature Charts around Taiwan
Source/ <https://www.tfrin.gov.tw/News.aspx?n=4229&sms=9038>

Concluding Remarks

The World Ocean Database provides countries around the world with diversified ocean data in different aspects. The data is collected and publicly available for everyone to benefit from it, which is used to make climate change adaptation decisions. This article briefly introduces the content and contribution of the WOD. It can be seen that the WOD has important reference value in both academic and practical applications, and can feel the international attention to the ocean conservation.

Taiwan is currently actively building own database, hoping to provide information to the public in need, and serve as the basis for the development of national ocean and climate policies. This article also presents a case of practical application of Taiwan's ocean database in traditional fisheries and the Nationwide Marine Database Establishment Project. Hoping that this database can be used in more fields in the future, and efforts will be made to strive for international cooperation to jointly plan ocean sustainable development plans.

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The United Nations as a Coordinating Governance Framework for the Decade of Ocean Science for Sustainable Development

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Translated by Linguitronics

Keywords: Decade of Ocean Science, Coordinating Framework, Sustainable Development

The First World Ocean Assessment (WOA I) issued by the United Nations in 2016 pointed out that under multiple stressors (including climate change, population growth, and human activities), the health of its structure, function, and benefits have been in a cycle of continual deterioration [1]. That being the case, the assessment calls on the United Nations to take urgent action to fill the gaps between science and policy through global and inter-disciplinary cooperation in marine science [1] to decelerate the current deterioration in the health of the ocean; only then will the conditions for creating, improving, and maintaining the sustainable development of the ocean exist [2].

From the context described above, the United Nations General Assembly made resolution A/RES/72/73 on December 5, 2017, in which it tasked the Intergovernmental Oceanographic Commission (IOC) under the UN Educational, Scientific and Cultural Organization (UNESCO) with the responsibility for promoting the UN Decade of Ocean Science for Sustainable Development. In the process of preparing for this initiative, the IOC has undergone nearly three years of preparation and consultation, both globally and regionally. The IOC formally resolved in June 2020 to propose the Implementation Plan for the Decade of Ocean Science for Sustainable Development and submitted it to the United Nations General Assembly, which passed the resolution in November of that year. The Decade initiative and actions were officially launched in January 2021.

The Decade of Ocean Science has two over-arching goals; these are: first, to generate the scientific knowledge and underpinning infrastructure and partnerships needed for sustainable development of the ocean; and second, to provide marine science, data, and information to inform policies for a well-functioning ocean in support of all Sustainable Development Goals of the 2030 Agenda. According to IOC Executive Secretary Vladimir Ryabinin, "ocean observation" is at the heart of the initiative, and is a decisive contribution to the implementation of the ocean-related Sustainable Development Goals (SDGs). (Ocean-related SDGs here refer not only to the 2030 SDG 14, the "Ocean" goal, but include all other goals that may be ocean-oriented. For example, SDG 5 "Gender Equality" also has important implications in the marine field (such as the ratio of male to female employees in the marine industry). Therefore, the Decade of Ocean Science is a cross-cutting issue related to the ocean within the sustainable development goals, and can be regarded as within the scope of the initiative [3].

On such grounds, global fluency with marine scientific data has become more sophisticated, more open-ocean, and more deep-sea. However, under such a massive global marine science initiative, coordinating actions without causing unnecessary duplication of resources while also meeting the challenges of sustainable ocean development described by the Decade of Ocean Science involves the coordinating framework of the Decade of Ocean Science. The purpose of this article is to first explain the concept of

co-produce research on sustainability science research in today's international society, then to further explain its relationship with the arrangement of the IOC coordination framework, followed lastly by a conclusion.

Sustainability Science and Co-Produce Theory

Although, the dynamic sequential relationship among society, economy, politics, technology, and the ecosystem has always been the core of the problem of sustainable development ever since the concept was proposed. In particular, sustainability science is an important agenda or target in related research for the complexities, uncertainties, solutions, and related obstacles that exist among these issues. However, sustainability science research has always lacked the system-level condition for transformation needed to achieve global sustainability. From a policy perspective, determining the agenda of sustainability science research and applying scientific research to other areas of knowledge is a goal pursued by sustainability science. One of the important means to achieving this goal is through the "co-produce" process.

"Co-produce" refers to the process of continuous integration of people's ideas, norms, practices, and discourses to allow our knowing and our actions to find mutual reinforcement and thus change social results (different disciplines have different definitions of "co-produce"; the definition cited in this article leans more toward the perspective of public policy, and is supplemented by the perspective of sustainable science or science and technology studies [STS]). Scientific research under this concept emphasizes the benefits that research results can bring to the public, the use of inter-disciplinary knowledge to solve the challenges of today's society, and the cooperation of scientists across institutional borders (referring both to the boundaries between nations, and also to boundaries between different departments, ministries, fields of knowledge, communities... as well as other "boundaries"). Within this conceptual context, there are three types of "co-produce": co-producing science for sustainability, co-production of governance, and co-producing science and governance [4].

"Co-producing science for sustainability" means that traditional science or scientists not only provide scientific information, but also become able to share their knowledge with different knowledge groups (for example: indigenous peoples who possess traditional knowledge) or various partners of decision making. Therefore, through the process of co-produce, knowledge possessed by scientists can be made into usable information, rather than rarified knowledge that exists in the academic community. In order to ensure the political and social legitimacy of sustainability science research, it will also emphasize participation, tolerance, and consultation in the research planning process, so that social changes are based on a fully informed society and on a scientific foundation.

Next, "co-production of governance" refers to the effective support of the state and citizenry in creating public goods and public services through specific institutional arrangements, procedures, and capabilities. For example, as the well-known public policy scholar Elinor Ostrom once pointed out, "co-produce" means that citizens who are not in the same organization can actively participate in the process of contributing to the provision of services and production of public goods under current budgetary shortages [5]. Therefore, the empowerment of citizens, the synergy among public goods contributors, the commitment of the participants both to one another and the co-produce process, the governance mechanism for supervision of legal compliance, and even allowing for flexibility in policy experiments and failures are all the concerns of institutional arrangements in "co-production of governance".

Finally, "co-producing science and governance" is mainly based on the viewpoint of science and technology studies (STS), in which science is actually a product of a specific political society and institutional environment design. Therefore, for STS, co-produce also means the production of scientific

knowledge, which is actually the relationship between a producer and a product of society and the natural system. Therefore, for STS, co-producing science and governance is essentially a kind of "knowledge governance" process that analyzes different subjects of knowledge production and shapes the creation, sharing, and utilization of knowledge through formal and informal systems. In other words, this co-produce concept is mainly for interpreting and exposing the power relationships between the generation and use of knowledge; while co-produce as mentioned in the previous two paragraphs is a subjective policy practice within the scientific and public administration circles. (In the STS concept of man and nature, the objective itself is also subjective. Therefore, under the subjective referred to here, in addition to scientists, immaterial systems of life, computer simulation programs, animals and plants, oceanic landscapes, etc., can all be subjective as referred to by STS.)

Co-Produce Coordination framework for the UN Decade of Ocean Science

As mentioned in the preface to this article, the Decade of Ocean Sciences, being a global co-produce operation of the natural and social sciences, will not be able to effectively face the challenges identified by the Decade of Ocean Science without a coordinating framework. According to the Decade of Ocean Science Implementation Plan, there are ten challenges to be addressed in the Decade of Ocean Science. These ten challenges are also the ten research themes of the Decade of Ocean Science. Therefore, the governing and coordination framework of the Decade of Ocean Science has been proposed in the "Implementation Plan". Among which, those related to the Decade Coordination Offices (DCO), Decade Collaborative Centers (DCC), and Decade Implementing Partners (DIP), could be said to be a "co-produce" governance system for the Decade of Ocean Science; the Decade Coordination Unit (DCU) established under the IOC Secretariat is the top-level unit of this coordination system, and it cooperates closely with the Decade Advisory Board (DAB). The operational guidelines for this coordinated governance framework for DCC and DIP, the Decade Collaborative Centres and Decade Implementing Partners: Operational Guidelines, was announced by the IOC in April 2021.

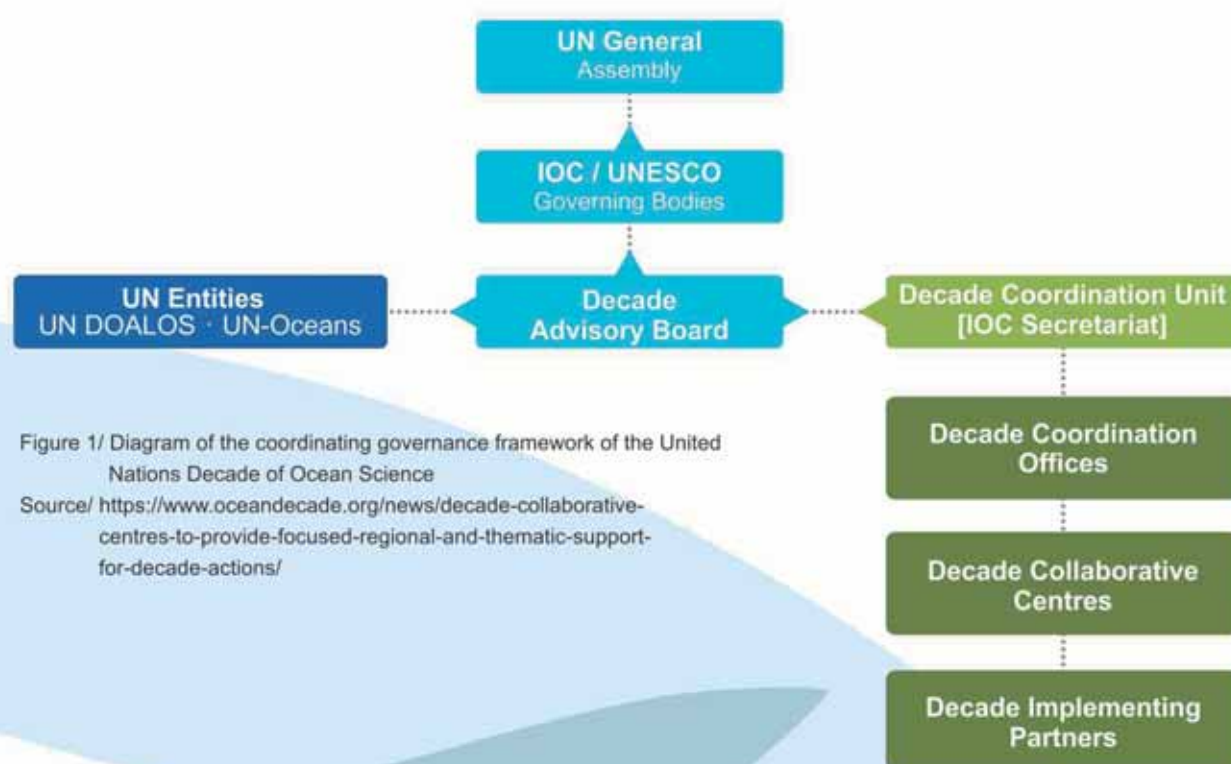


Figure 1/ Diagram of the coordinating governance framework of the United Nations Decade of Ocean Science

Source/ <https://www.oceandecade.org/news/decade-collaborative-centres-to-provide-focused-regional-and-thematic-support-for-decade-actions/>

In terms of the degree of organizational centralization, under the governance framework of the Decade of Ocean Science (see the governance framework in Figure 1), it can be said that it is composed of two elements: centralized and decentralized. DAB and DCU mentioned in the previous paragraph are both centralized and single units. DAB is composed of multiple stakeholders and provides strategic suggestions for implementation. In addition, DCU is the central coordinating unit for the implementation of the Decade of Ocean Science, and it conducts close coordination with the secretaries-generals of other United Nations agencies. If necessary, officials of other United Nations agencies may also be seconded to DCU to ensure the consistent coordination of inter-agency actions. Speaking in terms of the aforementioned co-produce concept, the co-produce of the centralized coordination agency in the previous paragraph is to ensure that the co-produce phase after planning can achieve the expected results. Therefore, this centralized coordination agency (here, referring to DAB) must also ensure that it is culturally representative and that marginal groups can be appropriately empowered. (This is the concept of knowledge governance emphasized in the aforementioned "co-produce science and governance" and the result of institutional arrangements derived from the product of the interactions among nature, society, and cultural norms.)

The decentralized units in this governance coordinating framework, regardless of whether it is the DCO, DCC, or DIP, can be said to be the main body that actually implements the actions and plans of the Decade of Ocean Science. Therefore, the DCU must set up several DCOs (currently, the IOC has not officially announced the specific establishment and operation guidelines of the DCOs) as sub-units similar to the DCU, and coordinate different DCCs and DIPs in the support of DCUs in different regions or operations of different research topics (the Ocean Decade Challenges previously mentioned). The DCO will be performed by a United Nations agency or the country where the agency's secretariat is located. However, a new unit may be established depending on the situation, and all are staffed with United Nations personnel. Therefore, in addition to coordinating the actions of the relevant parties, the main responsibilities of the DCO include reviewing all parties' requests for DCU endorsement of the actions of the Decade plan, seeking partners to voluntarily strengthen the implementation of the Decade plan, and conducting supervision and mobilization of resources. As mentioned above, there must be a UN endorsement process to ensure that co-produce results can effectively deal with the Ocean Decade Challenges. Without this endorsement action, there will be obstacles to the mobilization of resources.

As for the conditions for setting up the DCC, UN member states or international or major regional marine science organizations (whether they are research institutions, NGOs, foundations, universities, or private sector bodies) can assume the role. The main responsibility of the DCC is to assist the DCO in coordinating work across different regions or research topics. Similarly, the conditions for setting up a DIP are similar to those of a DCC, but it does not need to be a "major" marine science organization, and can include research centers, platforms, or even informal working groups. Accordingly, the main difference between a DCO and DCC is that the former is composed of full-time staff and resources from the United Nations system, and it has the right to review the Decade plan. However, the coordination, mobilization, and geography (ocean basin) or the scale of the issue (more than one of the Ocean Decade Challenges) are the same for both. As for the main differences among DIP and DCO and DCC, the part of the tasks or activities supporting DCU, DCO, and DCC, and the scale of the geography (sub ocean basin, land area) and theme (an element of a specific Ocean Decade Challenge) are far less than that of DCO or DCC. Therefore, a DIP does not need to be composed of full-time staff for the Decade of Ocean Science.

It is also worth noting that those who wish to establish a DCC must first apply to the DCU and conduct a preliminary assessment and feasibility study. This feasibility study will be an important basis for the IOC Executive Secretary's decision of whether to allow its establishment. Once the IOC approves the DCC

application, an agreement with the IOC can then be signed. However, when other UN agencies (such as the International Seabed Authority) set up a DCC according to their own procedures, such discussions must be conducted in the DCU to ensure the consistency of activities. Therefore, the establishment of a DCC undergoes a stricter review and establishment procedure. As of the end of 2021, there are a total of four DCCs under application review for establishment, among which, only the Tula Foundation has applied to become a DCC on a regional scale, while the subjects of the other three applications (Ocean Visions, University of Bologna, Mercator Ocean International) are each based on a single Decade Challenge as the condition for DCC establishment. Although the establishment of a DIP must be subject to the review of the DCU, it does not need to undergo a rigorous feasibility study. As long as it passes the "due diligence" process, the registration process for becoming a DIP is complete.

Conclusions

Judging from the current coordinating governance framework of the Decade of Ocean Science, it can be seen as roughly in line with the institutional arrangements emphasized in the co-produce theory of sustainability science described in this article. What must subsequently be really observed is integrating with different social and cultural contexts and effectively transforming them into long-term scientific actions that meet the needs for social change. Related to this, with natural scientists still dominating the research agenda, enabling social scientists to play the role of this intermediary requires subsequent observation. Furthermore, although the United Nations places great emphasis on the elements of co-produce in the actual scientific research projects or activities, finding which model or procedure is more conducive to achieving the goal of facing the Decade Challenges may require future review and analysis. Finally, which policy incentives the international community or individual countries should provide to enable different actors to participate in this decade-long operation also require further observation.

In addition, Taiwan established the Taiwan Ocean Union (TOU) under the leadership of the Ministry of Science and Technology in 2021, which is a very important step for domestic investment in marine science research operations being in line with international trends. In the future, to actually participate in this action led by the United Nations, Taiwan may perhaps consider cooperating with allies, since that seems a more feasible path to apply to become a DCC or DIP. Regardless, even if Taiwan does not become a DCC or DIP through cooperation, it seems that a certain degree of participation can be achieved through cooperation with a specific DCC or DIP in the future.

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IOC Ocean Decade Laboratories Mechanisms and Marine Education Satellite Activities

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Keywords: Decade of Ocean Science, IOC Ocean Decade Laboratories Mechanisms, Marine Education in Taiwan

In 1960, the United Nations Educational, Scientific and Cultural Organization (UNESCO) established the Intergovernmental Oceanographic Commission (IOC), which is the United Nations body responsible for supporting global ocean science and services. On June 8, 2021, World Ocean Day, the "United Nations Decade of Ocean Science for Sustainable Development" was officially announced for 2021 to 2030. During the "Ocean Decade", there are more than 60 projects that form the first wave of formal marine actions to facilitate the development of marine science.

These "Ocean Decade" pilot projects are coordinated by the scientific community, government, civil society, United Nations bodies, the public and private sectors, charitable organizations, and international organizations, to achieve a broad global participation [1]. Oceans cover 71% of the Earth, and are vast and rich in resources. People centuries ago used ocean resources as if they were inexhaustible and could be used on demand. Today, however, our oceans are facing depletion of resources and a serious marine ecological crisis. Globally, 75% of the commercial fish catch is on the verge of collapse, because people in the past had misestimated the speed of scientific and technological progress in fishery. Over mere decades, the main fishing method has advanced from fishing by hand to fishing boats and fishing fleets equipped with high-tech equipment, such as global positioning systems (GPS), fish finders, and echo sounders, while those very same advancements to human fishing technology have not increased marine resources [2][3].

The 2018 report of the UN's Food and Agriculture Organization (FAO) shows that about 88% (more than 151 million tons) of the total aquaculture output in 2016 was directly used for human consumption, which shows the importance of marine aquatic products. As human science and technology have continued to advance, the health of the ocean has gradually deteriorated, and the multiple impacts of ocean pollution, climate change, and acidification on the ocean environment have intensified. With the current state of the ocean, nearly 90% of the world's fish species are approaching or have already fallen below the threshold for sustainable survival. Among which, more than 30% of fish species populations can no longer survive. Thus, it is difficult for human beings to imagine what the world will become in the next few decades [4]. We urgently need scientific strategies to respond to global climate change. The Decade of Ocean Science will create a new foundation for the interaction between science and policy. The goal of the United Nations Decade of Ocean Science for Sustainable Development is to reverse the malignant trend in ocean health, and convene and propose a global ocean benefit plan, formulate and plan to form a common framework. This framework will ensure that marine science can create more advantageous conditions for countries to achieve the sustainable development of the oceans.

Ocean Decade Laboratories Projects and Activities

33 of the more than 60 approved initiatives and plans of the "Ocean Decade": The IOC of UNESCO proposed: Ocean Literacy for All realizes the changes needed to achieve "the ocean that we want." The initiative aims to: "Ocean Literacy for All" has designed and implemented transformative research activities and projects at the local and global levels that are implemented by various stakeholders; and it promotes Ocean Literacy through international partnerships and international networks. The initiative helps build capacity and change behaviors to achieve ocean-literate society and ensure the sustainable development of the world's oceans. Action 53: The US National Oceanic and Atmospheric Administration (NOAA) regards "MPAs as sentinel sites for ocean conservation, science and literacy." The plan aims to: 1.Understand climate impacts affecting the oceans; 2.Promote research on MPA uses and socioeconomic benefits to coastal communities; 3.Develop initiatives to promote Ocean Literacy; 4.Support national and international initiatives to establish networks of MPAs.

From the above, it may be seen that the first priority in the Ocean Decade is to improve the Ocean Literacy of all people. However, Taiwan's research on ocean scientific literacy is relatively lacking. So, the development of the national education policy over the next 10 years should be committed to promoting national marine science education in a comprehensive manner and popularizing the foundation of national Ocean Literacy and the concepts of marine science education [5][6]. Therefore, the "Ocean Decade Laboratories" mechanism holds various activities and conferences over the Internet to inspire all people who are interested in and connected to the ocean, including scientists, decision makers, and managers. It connects various participants from all over the world to realize the vision of the Ocean Decade, strengthen multi-party exchange and connection, and build a platform for the promotion of partnerships and joint design of actions for the Decade.

The Taiwan Marine Education Center was invited by the Asia Marine Educators Association (AMEA) to participate in one of the satellite activities, entitled "An Inspiring and Engaging Ocean" and presided over by Professor Tsuyoshi Sasaki, under the Ocean Decade Laboratories. The center introduced Taiwan's marine education policies and plans in videos, and through on-site teacher promotion, achieved integration of marine education into the curriculum and integration with real-life situations. The content of the action included the construction of an Ocean Literacy database, a training mechanism for marine educators, marine career exploration, and cooperation of local education bureaus in Taiwan and the development of courses in teaching and research bases, which have contributed to making Taiwan's marine education shine internationally. All participating international scholars praised the diversity and abundance of vitality of marine education in Taiwan.



Figure 1/ Satellite activities of the UN's Intergovernmental Oceanographic Commission (IOC) Ocean Decade Laboratories (Asian region activities)

Source/ <https://www.youtube.com/watch?v=CZyxLTmuGnU>

Development of Marine Science Education in Taiwan

Marine education in Taiwan consists of five main axes, these being: marine recreation, marine culture, marine society, marine science and technology, and marine resources and sustainability. The promotion process includes fields from social sciences and natural sciences, which is slightly different from the seven Ocean Literacy principles of the United States and the promotion of the main cores of the European Union and the IOC in the natural marine sciences. However, in addition to the marine sciences, Taiwan also includes marine culture and society for a broader and deeper orientation. Within Taiwan's "108 Curriculum" content, 19 topics contain the essentials of marine education, and a total of 55 items will improve students' Ocean Literacy and can be implemented in daily life. Integrating the satellite activities of the Ocean Decade Laboratories, Taiwan has been promoting ocean education for a long time. It possesses promotion models and successful experiences that make it different from other countries, which may be used as a reference for the world to promote ocean education activities. In the global promotion of marine education, there are three key factors that affect the ocean literacy of students. First, teachers: In formal education, there is insufficient training for marine education of preservice and inservice teachers, and teachers do not have sufficient ocean literacy of their own to promote marine education. Second, marine educator training: Marine educators are those who promote marine education. At present, promotion of marine education is conducted through both formal and non-formal education, but training mechanisms for marine educators have not yet been established. Third, marine education materials: Addressing the lack of marine textbooks and materials, the Ministry of Education has integrated marine education issues into various subjects; but there are as yet no actual marine education curriculum materials or corresponding media promotion, making it difficult for teachers to promote marine education in places of education [5][7][8][9].

Conclusion

To converge with the activities and practices of the United Nations' Ocean Decade, education authorities should continuously evaluate the effectiveness of the delivery and implementation of marine education in Taiwan's marine education policies and the promotion of non-standard marine education. And based on the promulgation of the Ocean Basic Act, authorities should popularize and promote marine education for all. The following suggestions are offered:

- Plan supplementary teaching materials for marine education that are in line with the development trends of international marine science, and expand teaching resources.
- Actively encourage teachers at all levels, national public servants, and personnel of non-governmental organizations to cultivate marine education expertise, strengthen subject knowledge, transfer marine knowledge effectively, and make responsible marine policy.
- In the process of teacher training, plan to offer marine education courses, so that teachers will have considerable Ocean Literacy before entering the workforce, which can then be implemented in on-site teaching.
- Arrange marine experience activities and visits for outdoor education; or visit marine museums and marine stations in Taiwan to enhance students' understanding of the ocean and enhance their Ocean Literacy.

- Long-term marine education seminars and workshops held to continuously strengthen the Ocean Literacy of teachers and civil servants; be able to integrate marine science literacy and marine cultural concepts into teaching courses.
- Investing in marine science popularization and multimedia production, using marine popularization films and reading of popular science books, combined with the current curriculum, to achieve implementation of marine education.
- Cultivate marine citizen scientists who can understand and care for the environmental conditions of the waters in their hometowns.
- Establishment of a training mechanism for marine educators, long-term training of both formal and non-standard marine educators.

At present, the entirety of Taiwan is actively cooperating with the United Nations Decade of Ocean Science and the United Nations Sustainable Development Goals by developing marine science education courses at various stages, and jointly proposing valuable insights and exchanges with other countries to convey the concepts of Taiwan's marine culture, marine ecology and biodiversity, ocean protection, and sustainable fishing methods. This allows countries to contribute their efforts to the maintenance of the Earth's environment, so that our next generations can better understand how Taiwan coexists with the ocean and demonstrates its ocean DNA!

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The United Nations Decade of Ocean Science for Sustainable Development: Summary of the Framework for Ocean Literacy

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In 2017, the United Nations proposed the "2021-2030 United Nations Decade of Ocean Science for Sustainable Development" (hereinafter referred to as the "Ocean Decade Plan"), which was recognized by 193 countries: The ocean plays a key role in the Earth and the human ecosystem; and ocean science plays an important role in strategies dealing with major changes for solving global challenges [1]. A successful historic initiative requires broad social participation to create new knowledge through cooperation, uses that generated knowledge to transform it into practical actions, and provides urgent solutions to save "the oceans we have". Therefore, the primary goal of the Ocean Decade Plan is to ensure that citizens of the world possess Ocean Literacy, recognize its necessity, and have the ability to promote and take corrective actions to respond to the urgent threats facing the ocean. It also looks to establish a network of partnerships, share experiences and exchange, formulate new measures and solutions, and use Ocean Literacy to guide us to reach the 2030 milestone—"The Ocean We Want".

The Key to the Success of the Ocean Decade —Ocean Literacy

Ocean Literacy (OL) refers to the ability to make responsible decisions about the ocean while possessing marine scientific knowledge. The seven basic principles of Ocean Literacy include: Earth has one big ocean with many features. The ocean and life in the ocean shape the features of Earth. The ocean is a major influence on weather and climate. The ocean makes Earth habitable. The ocean supports a great diversity of life and ecosystems. The ocean and humans are inextricably interconnected. The ocean is largely unexplored.

The ocean is closely bound to major world issues, such as climate change, food security, human health, and the global economy. Strengthening ocean literacy is the key to the success of the Ocean Decade Plan and thus achieving sustainable development and well-being. Understanding the ocean's impact on us and our impact on the oceans, recognizing the extent to which we depend on the ocean and the value it provides us, and how we contribute to the sustainability of the ocean, all ensure that human beings can achieve a sustainable, fair, and healthy future.

Ocean Literacy can take many forms, including: The development of national Ocean Literacy strategies fully integrated into formal education, experience exchanges between different marine sciences to improve levels of knowledge, and youth empowerment projects and citizenship awareness campaigns.

The Ocean Literacy for All initiative uses the Theory of Change model to help all stakeholders move from awareness and understanding to attitude changes and, ultimately, desired behaviour change.

Implementation Plan of the Ocean Decade Plan: Ocean Literacy for All initiative

The coordinating unit of the "Ocean Decade - Ocean Literacy Programme" is the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), and is implemented by multiple stakeholder groups, including those from academia, governmental and non-governmental organizations, private sector and educational institutions, who work together to formulate small-scale plans and activities, with Ocean Literacy at their core. The implementers coordinate and make use of collaborative cooperation to achieve maximum effects, establish and evaluate Ocean Literacy activities and their impact, comprehensively understand the concepts and practices of Ocean Literacy, strengthen the links between existing OL networks while promoting the establishment of new networks, and at the same time promote the development of related Ocean Decade plans.

The currently proposed "Ocean Decade - Ocean Literacy Programme" has six major components (Figure 1), including: Improving research, establishing Incubator of Ocean Literacy Projects, Capacity Development and Trainings, making Ocean Literacy Resources more widely available, strengthening Networks, and Programmatic Coordination and Monitoring.

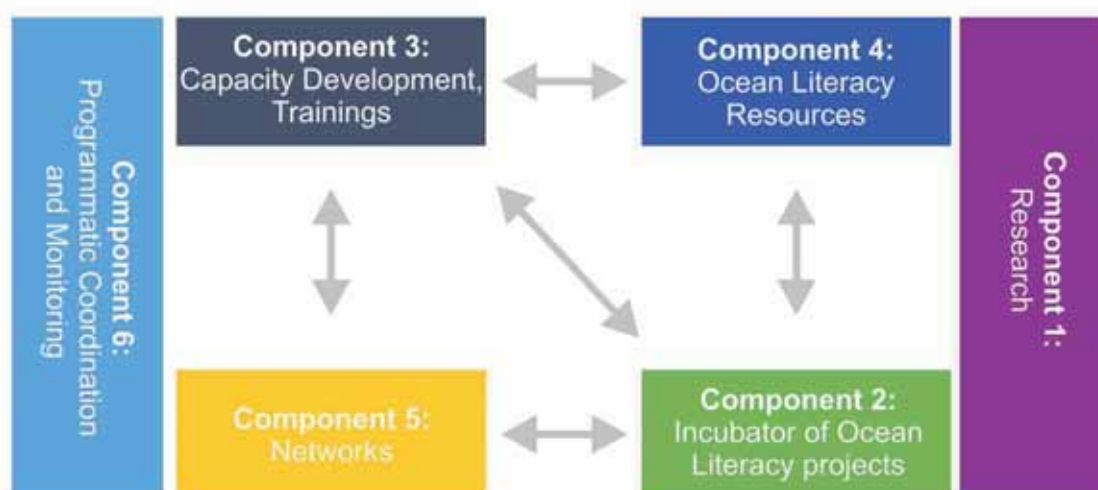


Figure 1/ Explanation of the main elements of the "Ocean Decade - Ocean Literacy Programme"

Source/ [2]

C1 Research: Provide a baseline assessment and develop standards, indicators and methods for measuring the impact of Ocean Literacy through the Ocean Decade to feed into the Ocean Decade Monitoring and Evaluation Framework.

C2 Establishing Incubator of Ocean Literacy Projects: Promote, support and facilitate international OL research collaborations, and co-identify research priorities and areas of intervention. It is ideal for co-developing projects and creating a central database of OL research.

C3 Capacity Development and Trainings: Develop OL training courses for different target groups including educators, media, government, the private sector, civil society, NGOs and diplomacy professionals.

C4 Making Ocean Literacy Resources more widely available: Amplify and improve the accessibility of

Table 1/ Priorities, targets, Ocean Decade Actions and OL Programme Components for the Ocean Decade

Priority Area	Targets	Mobile	Components
Mainstreaming Ocean Literacy in Education Policy Formulation	- By 2025, 70% of Member States have a National Ocean Literacy Strategy and integrate Ocean Literacy into the curriculum and education policies of formal education systems. - By 2025, governmental representatives and officials possess the knowledge capacity, skills and commitment to incorporate ocean sustainability into local, national and regional policies. - By 2028, Ocean Literacy policies are adequately monitored and measured. - By 2025, Member States increase annual spend on Ocean Literacy.	- Establish a National Ocean Literacy Strategy and Ocean Literacy coordination mechanism, and designate a National Focal Point for Ocean Literacy. - Include Ocean Literacy in National Curriculum Standards in order to embed ocean education in primary and secondary schools. - Offer/organize training programmes for government officials on ocean sustainability and/or Blue Economy opportunities. - Boost investments in Ocean Literacy schools and/or Ocean Literacy programmes.	• C5 • C3
Enhancing Formal Education	- By 2025, schools across the world have access to high-quality Ocean Literacy educational resources in their own language (all schools around the world can provide Ocean Literacy education resources in their respective countries). - By 2030, 70% of all formal educators receive training and pedagogical tools to incorporate Ocean Literacy in the classroom. - By 2030, 70% of students worldwide are educated on Ocean Literacy and are provided with opportunities to contribute to ocean sustainability. - By 2030, formal education institutions worldwide exhibit a whole-institution approach towards Ocean Literacy where ocean sustainability is incorporated at each level of the administration.	- Training programmes for pre-service educators and active educators from multiple disciplines, including Ocean Literacy workshops, courses and field trips, in person and online. - Knowledge exchanges between formal educators and experts. - Development of curriculum materials for primary and secondary schools, including digital resources and tools. - Nature-based opportunities and educational actions for students (e.g. field trips, interactive workshops).	• C3 • C4 • C5
Mobilizing Corporate Action	- By 2025, private sector employees and investors worldwide receive training in Ocean Literacy. - By 2030, ocean sustainability is strongly incorporated into business planning and operations, including strategic planning and environmental practices and policies. - By 2030, companies around the world enhance and incorporate actions for ocean sustainability and Blue Economy opportunities within their operations, including R&D, products and services, investments and reporting. - By 2025, partnerships are developed and enhanced among companies and/or companies and non-profit organizations to strengthen ocean sustainability.	- Training programmes for employees and/or customers and suppliers on ocean sustainability and Blue Economy. - Investments in incubators focused on ocean innovation, technology, sustainability and social enterprise. - Development of programmes that empower women and girls in ocean science and conservation. - Development of school-based programmes that empower capacity building and developing the next generation of ocean professionals. - Introduction of certification schemes for ocean-literate companies demonstrating commitment to ocean conservation/sustainability.	• C2 • C3 • C4
Increasing Community Engagement	- By 2025, multi-stakeholder networks and collaborations are built and operate at a local level, fostering sustainable action for ocean issues. - By 2025, there is increased recognition and incorporation of Indigenous and local knowledge in Ocean Literacy efforts. - By 2030, Ocean Literacy is built into community regulations, policies and governance structures around the world. - By 2030, coastal and non-coastal community members have increased opportunities to receive education and engage in ocean sustainability actions.	- Interactive interventions of Ocean Literacy, Literacy such as art exhibitions or movie screenings. - Public awareness campaigns on key ocean topics. - Citizen science programmes that empower the general public to engage in the Ocean Decade. - Knowledge exchanges and transfer between scientists and members of society, including Indigenous communities, educational organizations and governments, among others. - Training programmes for media and journalists.	• C2 • C3 • C4 • C5

Source/ [2]

OL educational resources and programmes promoting the use of new technologies (such as Artificial Intelligence, Augmented Reality, Virtual Reality).

C5 Strengthening Networks: Increase collaborations at the regional level; support collaborative alliances of national OL strategies; create a Global Network of Blue Schools; develop a Blue Cities Network; develop a network of OL centres, including aquariums; connect OL networks and partners to the Ocean Decade Global Stakeholder Forum.

C6 Programmatic Coordination and Monitoring: Monitor and report OL projects carried out under the Programme Provide resource mobilization; Ocean Decade OL Programme expansion through new projects and activities; strengthen partnership meetings for OL project leaders and programmes; support communications and outreach activities to engage new partners in the Ocean Decade OL Programme and provide visibility of achievements of OL projects and programmes; and coordinate and create synergies between projects developed under the Ocean Decade OL Programme.

Support System for Ocean Literacy Action

Ocean Decade Actions are initiatives and endeavours that will be implemented by a wide range of Ocean Decade stakeholders to achieve the objectives and Ocean Decade Challenges. Ocean Decade Actions, including Ocean Literacy initiatives, will be proposed and carried out by a wide range of actors including research institutes, governments, UN entities, intergovernmental organizations, international and regional organizations, business and industry, philanthropic and corporate foundations, NGOs, educators, community groups or individuals (via community-led science initiatives, for instance). There are three main mechanisms for the funding support of the Ocean Literacy Initiative:

- I. Direct support for Ocean Decade Actions and Coordination Costs, through for example in-kind support or contributions from Member States.
- II. Support via the Ocean Decade Alliance will be a key component of the resource mobilization efforts for the Ocean Decade, focusing on significant voluntary resource commitments. The Alliance is not a funding or grant-making facility; rather, it is an engagement platform to connect large-scale resource providers with proponents of Ocean Decade Actions.
- III. Mechanisms of partner-led financing/ grant-making facilities, through which an independent entity with its own grant-making capacity (such as a philanthropic foundation, an NGO or a government entity) will express the desire to mobilize resources to support Ocean Decade Actions and offer to act as a hub for mobilizing financial contributions from other donors.

Conclusion

The "Ocean Decade Plan" aims to promote participatory and cross-disciplinary scientific concepts. Through Ocean Literacy actions and activities, all stakeholders not only have the ability to have a more complete understanding of marine knowledge and sustainability, but also are able to become part of the broader research community. A society that is in possession of a comprehensive understanding of the ocean will be able to appreciate the value of ocean knowledge more deeply; such a society will also know how to integrate that knowledge in the promotion of action and sustainable ocean practice.

I. Mainstreaming Ocean Literacy in Education Policy Formulation

Policies govern and help shape the operation of formal and non-formal education systems globally. While the adoption of overall policies regarding environmental education and education for sustainable development is increasing worldwide, in many cases there remains a critical need to further strengthen

specific ocean issues within these agendas, by considering the importance to inform policy-makers and develop further policies to advance Ocean Literacy.

II. Enhancing Formal Education

Formal education institutions at every level from primary to secondary are key to help shape knowledge, attitudes, behaviours and actions towards ocean sustainability. Too often the ideas and knowledge of society around the ocean and sustainability issues in general are conceived in silos. Ocean Literacy, applied through a multi-disciplinary and cross-cutting approach, can be incorporated into most classroom courses and subjects, thus supporting ocean stewardship and regular subject delivery. Additionally, by fostering context-specific and hands-on learning and inquiry-based learning, Ocean Literacy can provide opportunities to enhance critical thinking, problem-solving and leadership skills, among other significant educational outcomes.

III. Mobilizing Corporate Action

The private sector has a powerful role to play in achieving the ambitions of the Ocean Decade and more broadly the sustainable development agenda. Ocean Literacy for business means being able to understand the connections between the ocean and various economic sectors, and to transform this understanding into taking responsible actions. Ocean Literacy can support the understanding within the private sector of the ocean's role for a sustainable ocean economy, as well as a source of solutions for urgent issues such as the climate crisis. Both large and small businesses shape and influence environmental and socio-economic policies, investments, actions and attitudes through the implementation of their go-to-market strategies and resultant business practices, investments, products and services, advocacy, marketing communications and philanthropy. Mobilizing corporate action also reaches a broad range of stakeholders across the value chain, including, but not limited to, employees, investors, suppliers, vendors and customers.

IV. Increasing Community Engagement

Non-formal education, commonly referred to as community education or lifelong education, refers to all education efforts occurring outside the formal school system. It includes a diverse range of approaches, ranging from home-based learning to community initiatives, and creates opportunities to engage a wide range of stakeholders. Through this, stakeholders and communities can be empowered to make informed and ocean-literate behavioural choices in their daily lives.

The implementation of the Ocean Decade Plan focuses on the implementation of Ocean Literacy, formulating education policies, fulfilling corporate social responsibility, planning formal education courses, and improving community participation. Overall development will be the key to success and development goals over the next decade.

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