

國際海洋資訊

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經濟學人亞太地區世界海洋高峰會報導

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



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主任委員：李仲威

海洋科學十年 邁向我們想要的海洋！

海洋蘊藏的資源不僅支持了數十億人的食物和生計，更在經濟、文化與社會等層面具有重大價值，而人類的健康和福祉也取決於海洋的健康和安全，但如何妥善運用與維護海洋與海洋生態系，需奠基於對海洋的瞭解與研究。聯合國於2016年發布第一期世界海洋評估（World Ocean Assessment）報告，初步建立了海洋環境資料基準（baseline），並於2017年12月聯合國大會上宣布2021年至2030年為「海洋科學促進永續發展十年」（Decade of Ocean Science for Sustainable Development，簡稱「海洋科學十年」）。「海洋科學十年」目的不在設定海洋政策，而是建立海洋科學研究調查能量並產生數據及公平分享數據，藉由數據累積與分享，提高人類對海洋的認知，在知識的基礎上推動海洋管理，希望建立以海洋科學為基礎的海洋管理體制，為2030永續發展議程（2030 Agenda for Sustainable Development）提供厚實的知識架構，將我們擁有的海洋轉變成我們想要的海洋（The Ocean We Want）。

2022年第一期，本刊以「海洋科學十年」為題，從「海洋科學十年」實施計畫、以世界海洋資料庫（World Ocean Database）為基礎的「海洋資料共享計畫」（Ocean Data for All）、主持計畫的聯合國教育科學及文化組織（United Nations Educational, Scientific and Cultural Organization, UNESCO）之政府間海洋學委員會（Intergovernmental Oceanographic Commission）、提升全民海洋素養的「海洋十年實驗室」（Ocean Decade Laboratories）機制到海洋素養行動架構，向國內外讀者介紹未來十年全球最關鍵的海洋行動計畫。

積極參與國際事務並在國際場域發聲，一直是我國持續努力的方向。本期主要內容包括本會政務副主任委員蔡清標博士受邀參與國際媒體「經濟學人」舉辦的第一屆亞太地區世界海洋高峰會（World Ocean Summit Asia-Pacific），代表臺灣以官方正式職銜報告「臺灣海洋能源」，與國際分享我國研究成果，並與亞太地區百餘位講者共同探討關鍵的海洋經濟永續議題；以及臺灣海洋教育中心受邀參與海洋十年實驗室的衛星活動，分享我國海洋教育政策與計畫。邁向「我們想要的海洋」，臺灣絕不缺席！



圖說／海底採樣

圖片來源／ROV-Team, GEOMAR (CC BY 4.0)

<https://www.oceandecade-conference.com/en/press.html>

經濟學人第一屆亞太地區世界海洋高峰會報導

撰文／李子嘉（海洋委員會國際發展處科長）

關鍵字／海洋能源、氣候變遷、海洋高峰會



圖1／經濟學人亞太高峰會官方網站活動首頁

圖片來源／<https://events.economist.com/world-ocean-summit-asia-pacific/>

海洋是地球孕育出生命的關鍵因素，更是人類文明存續發展的重要支持，然而，自工業革命以來，人類活動直接及間接對海洋環境所造成的破壞大幅地增加，造成全球性的氣候變遷，也形成人類以及全球物種的生存威脅。近數十年來，國際社會逐漸意識到海洋環境惡化的嚴重性，2008年12月5日，聯合國大會第63/111號決議[1]指定6月8日為「世界海洋日」，呼籲全球共同關注海洋議題，自此，以海洋為主題的大型國際會議和活動開始蓬勃發展。2014年起，由時任美國國務卿John Kerry（現任美國總統氣候特使）發起的「我們的海洋大會」（Our Ocean Conference），預計在2022年於帛琉舉辦第7屆大會；聯合國於2017年首次舉辦的「聯合國海洋大會」（UN Ocean Conference），也預計在2022年於葡萄牙舉辦第2次大會；其中，國際知名的英國媒體集團「經濟學人」（The Economist）也在2012年發起「世界海洋倡議」（World Ocean Initiative），並每年舉辦「世界海洋高峰會」（World Ocean Summit），而2021年的12月6日到10日，更針對亞太地區，特別舉辦了第一屆「亞太地區世界海洋高峰會」（World Ocean Summit Asia-Pacific）[2]。

由於COVID-19疫情的影響，此次活動採取全線上方式舉行，邀請來自超過50個國家百餘位講者，針對海洋各種領域的議題，進行知識的分享以及觀點的討論，而我國海洋委員會的政務副主任委員蔡清標博士，也獲邀以「臺灣海洋能源」為題進行報告，並以我國官方正式職銜登上國際舞臺。

一個健康而充滿經濟活力的海洋－經濟學人海洋倡議

雖然意識到人類活動已然造成海洋環境的惡化，而人們仍然對此漠視，同時毫無節制地開發海洋資源，經濟學人在2012年發起「世界海洋倡議」[3]，此倡議著眼於3個跨領域的主軸——財務、治理以及創新。最終的目標及願景，是期望我們的海洋能夠成為一個「健康而充滿經濟活力的海洋」（We imagine an ocean in robust health, and with a vital economy）。

有別於其他的國際性倡議，「世界海洋倡議」更大程度地聚焦在「藍色經濟」層面，其核心理念是在追求經濟成長的同時，也兼顧海洋的永續發展。然而，理想和現實仍然存在相當的差距，而此差距正是國際社會面臨的挑戰所在。為了應對這樣的挑戰與建立共識，經濟學人自2012年起，每年度舉辦「世界海洋高峰會」作為此倡議的核心活動，旨在創造一個平臺，讓海洋各類議題的相關人士集結在一起，促進更多元而廣泛的對話，共同找出解決海洋問題的關鍵方法。

首次針對特定區域舉辦的海洋高峰會

此次會議的主要籌辦人，經濟學人編輯主任Charles Goddard在開幕致詞中指出，亞太地區的人口占全球將近二分之一，在全球的經濟成長及海洋保護上占有重要的份量，當海洋不健康，藍色經濟就無法蓬勃發展，因此如何恢復海洋的健康，加速海洋經濟的永續發展，是亞太地區重要的議題。

如同以往的海洋高峰會，亞太地區世界海洋高峰會仍不脫離經濟議題，以「投資藍色經濟」（Investing in blue economy）作為主題。在議程的安排上區分成兩個部分，其一是「主議程」（plenary），當中包含了各式各樣的海洋議題，如海洋保護區、氣候變遷、藍碳、聯合國「海洋科學十年」等，安排了5個場次的專題演講以及10個場次的座談；其二為「產業」（industry track），討論範圍包含「能源」、「漁業」、「水產」、「航運」、「塑膠（污染）」、「財務」等個別產業領域，安排了6個場次的專題演講以及21個場次的座談，邀請各方專家學者進行對話。

臺灣獨特的海洋能源發展登上國際舞臺

對我國而言，此次會議最大的亮點之一，就是我國海洋委員會的政務副主任委員蔡清標博士，代表臺灣以完整的政府職銜獲邀進行發表，在一向險阻重重的多邊國際場域，對於主辦方能給予公平而合理的對待，實在值得大家給予掌聲以及感謝。

蔡副主委此次發表的內容[4]是臺灣發展再生能源領域及藍色經濟之要角——海洋能源。依據臺灣的能源政策，預計在2025年前要將再生能源占全國電力需求比例提升至20%，除了風力發電和太陽能以外，由於臺灣四面環海，加上流經東岸的黑潮，使得海洋能源是十分理想的潛在綠能來源之一。

目前臺灣海洋能源主要的3個發展方向，分別是「波浪能」、「洋流能」以及「溫差發電」。而「洋流能」則是其中的發展重點，近年的持續推動也取得相當的成果及突破。然而，要進入商轉階段，仍然有許多挑戰需要克服，例如提升設備的存活率及發電效率等，而臺灣的研究團隊也持續努力克服這些挑戰。

蔡副主委指出，在海洋能源發展上，臺灣期待也歡迎更多的國際合作，更是非常願意將研究成果與國際分享，希望海洋能源發展能讓地球永續繁榮。



圖2／蔡副主委於活動官網之講者介紹欄位，國籍以我國國旗顯示
圖片來源／經濟學人活動官方網站

會議綜合觀察

一、處理氣候變遷仍為海洋議題重心之一

聯合國氣候變化綱要公約第26屆締約方大會（COP26）甫於2021年11月12日落幕，吐瓦魯外長 Simon Kofe站在水中向世人發表演說的畫面，在世人的心中留下深刻的印象。此次亞太世界海洋高峰會也安排了相當分量的議程針對氣候變遷進行討論；亞太地區島國如斐濟、庫克群島、吐瓦魯等深受海平面上升衝擊的國家，均發聲對氣候變遷表達了憂慮，並呼籲國際社會採取更多行動對抗氣候變遷；而「減少碳排」、「維護海洋健康」等實踐減緩氣候變遷的議題，也是此次會議的重要討論核心之一。

二、「財務」——處理海洋挑戰的關鍵要素

相較過往的高峰會，「財務」首次被單獨列為一個獨立的產業領域，並安排了5場的座談，討論主題包含「藍債」、「混合金融模式」等，為各產業領域當中主題數量最大的一個議題，顯見將資本及金融模式導入海洋領域，必然是將來解決海洋問題的關鍵要素之一。

三、胸懷大志的日本財團

日本財團（The Nippon Foundation）是此次與經濟學人集團合辦高峰會的主要合辦方，該財團與經濟學人共同合作發起「回到蔚藍」（Back to Blue）倡議[5]，關注「塑膠污染」、「化學污染」以及「生物多樣性」等3個主要議題，在本次的主議程中，也安排了一個場次專門談此倡議的塑膠污染研究成果。另外，日本財團相關組織的重要人士如「笹川平和財團」（Sasakawa Peace Foundation）角南篤理理事長、「海洋政策研究所」（Ocean Policy Research Institute, OPRI）坂

口秀所長等，也都積極地參與各場次座談，日本對於海洋議題的重視與投入，由此可見一斑；除此之外，日本財團也戮力推動許多海洋的相關活動，例如推動「海床2030」（SEABED 2030）計畫（聯合國「海洋科學十年」的官方支持活動之一），舉辦世界海岸防衛隊高峰會等，不難看出日本對於掌握亞太地區海洋議題話語權的企圖心。

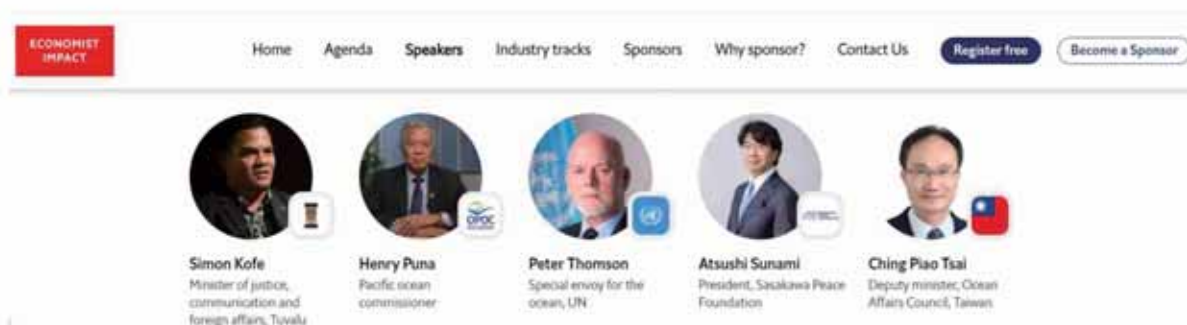


圖3／蔡副主委代表我國與各國政要並列於講者名單
圖片來源／經濟學人活動官方網站

表1／亞太地區世界海洋高峰會－專題演講列表

主題	演講者／與談人
專題演講 保護海洋：從文字到行動	Mahinda Rajapaksa 斯里蘭卡總理
專題演講 海洋需要保護	Kate Walsh 知名演員、行動主義者、企業家、非營利組織Oceana大使
專題演講 復原海洋健康的綜合行動	Henry Puna 太平洋島國論壇秘書長
專題演講 應該立即採取行動減低氣候變遷衝擊	Frank Bainimarama 斐濟總理
專題演講 資助氣候變遷調適措施	Mark Brown 庫克群島總理
能源報告：臺灣的海洋能源	Ching-Piao Tsai 蔡清標 臺灣海洋委員會政務副主任委員
案例學習： 如何達到並維持健康的漁業資源	Manumatavai Tupou-Roosen 太平洋島國論壇漁業局長
韓國的綠色航運	Moon Seong-hyeok 韓國海洋及漁業部長
航運減碳的挑戰和機會	Kitack Lim 國際海事組織（IMO）秘書長
訪談： 尋求亞太地區海洋塑膠污染解決方案	Rana Karadsheh 國際金融公司（IFC）區域產業主任
報告：擴大生產者責任（EPR） 會是促成系統性改變的關鍵嗎？	Sumangali Krishnan GA Circular首席商業官

資料來源／<https://events.economist.com/world-ocean-summit-asia-pacific/agenda/>
中文由筆者自譯

表2／亞太地區世界海洋高峰會－各場次座談主題列表

類別	主題	類別	主題
主議程	<ul style="list-style-type: none"> ● 海洋復原的治理 ● 如何執行與管理海洋保護區 ● 減緩氣候變遷－以自然為基礎的海洋解決方案 ● 用藍碳發揮影響力 ● 於聯合國為永續發展之海洋科學十年期間，加速以海洋為基礎的研究 ● 回到蔚藍倡議：海洋塑膠研究成果 ● 經濟學人COP26與海洋報告 ● 小島開發中國家－新挑戰與新機會 ● 沿岸社群－參與、韌性、復原 ● 利用海藻的能量 	航運	<ul style="list-style-type: none"> ● 對潔淨與綠色的航運的承諾 ● 減碳企業－不僅是連結，而是從供應鏈進行思考 ● 共同承擔減排的責任 ● 解決替代燃料的經濟問題
能源	<ul style="list-style-type: none"> ● 建立亞洲離岸風電的動能 ● 為亞洲注入綠色氫能 	塑膠	<ul style="list-style-type: none"> ● 為亞太海洋塑膠污染危機尋找解決方案 ● 邁進－從可回收已回收 ● 從廢棄物創造價值 ● 塑膠中和與塑膠信用如何為塑膠行動帶來變革？
漁業	<ul style="list-style-type: none"> ● 從漁釣到餐盤－推動供應鏈的永續性 ● 保護小規模漁業 ● 信任與透明的工具 	財務	<ul style="list-style-type: none"> ● 藍色（經濟）可以成為下一個綠色（經濟）嗎？ ● 建立商業案例以吸引早期投資者 ● 混合金融模式是否將起決定性作用？ ● 藍債如何重新建構海洋計畫的財務？ ● 投資者或可投資的計畫：虧損在何處？
水產	<ul style="list-style-type: none"> ● 透過提升永續性處理食物安全的議題 ● 永續地防止和管理疾病 ● 低度衝擊養殖業的最佳實踐解決方案 	資料來源／ https://events.economist.com/world-ocean-summit-asia-pacific/agenda/ 中文由筆者自譯	

結語

無論在國內及國際間，相較於其他的環境議題，海洋議題所受到的關注似乎相形薄弱，然而，海洋實質上卻又與其他的環境議題息息相關，密不可分，需要更多人的關心和投入。在5天的會議過後，籌辦人Charles Goddard在閉幕致詞中，表達了以實體方式籌辦下一屆亞太世界海洋高峰會的高度期待與意願，此外，也已預定2022年3月在葡萄牙里斯本以實體方式辦理第9屆海洋高峰會[6]；然而，這一切還要視國際社會從COVID-19疫情當中恢復的程度而定。筆者撰稿之時，恰逢新的變種病毒Omicron出現並侵襲全球，只能衷心期盼疫情可以儘速平息，讓所有人的生活得以回到原有的秩序。

最後，至截稿日止，大會籌辦方仍開放會議參與的報名，而此次會議的內容也會在線上持續開放觀看，直至2月中旬，有興趣的朋友也可以把握時間上網註冊收看喔！

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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）

撰文／陳璋玲（國立成功大學海洋科技與事務研究所教授）

關鍵字／海洋科學十年、實施計畫、永續發展

聯合國大會於2017年第72次會期宣布海洋科學促進永續發展十年（Decade of Ocean Science for Sustainable Development 2021-2030；英文簡稱Ocean Decade，以下中文簡稱「海洋科學十年」）。「海洋科學十年」的願景是「我們需要的科學達成我們想要的海洋」（the science we need for the ocean we want）。我們想要的海洋以7個成果予以描述：潔淨的海洋、健康和具回復力的海洋、生產力的海洋、可預測的海洋、安全的海洋、可公開和平等地接近海洋、令人啟發和參與的海洋。「海洋科學十年」實施計畫於2021年提出，致力於使用海洋科學，解決海洋面臨之挑戰，提出7大類具體行動，以促進永續發展、強化人類和海洋連結，最終達成「海洋科學十年」願景。

「海洋科學十年」實施計畫簡介

聯合國教育科學及文化組織（United Nations Educational, Scientific, and Cultural Organization, UNESCO）政府間海洋學委員會（Intergovernmental Oceanographic Commission, IOC）主導「海洋科學十年」實施計畫，在各方高度參與，歷經3年醞釀與討論，於聯合國第75屆會期（2020年9月16日至2021年9月15日）通過此計畫[1]。此計畫提供一個轉型的行動架構，以既有海洋研究與管理成就為基礎，並規劃跨區域、跨部門、跨領域和跨世代的行動。各國在自願性參與基礎上實踐「海洋科學十年」，促進資料、訊息和知識的產生與分享，將「我們擁有的海洋轉變成我們想要的海洋」。

實施計畫建立在一個行動架構上（圖1），此架構分為幾個層次，由上而下依序是：我們想要的海洋、「海洋科學十年」挑戰，以及「海洋科學十年」行動。十年行動係指具體的活動，由廣泛的各利益關係者執行，其可分為7大類：規劃需要的海洋科學、管理資料和知識、建立能量和海洋素養、參與「海洋科學十年」、整合「海洋科學十年」、財務支持「海洋科學十年」，以及評量「海洋科學十年」成效。

實施計畫的7大類具體行動

一、規劃需要的海洋科學

「海洋科學十年」指出10項挑戰，稱之為海洋科學十年挑戰（Ocean Decade Challenges）。為解決這些挑戰，必須規劃我們需要的科學。10項挑戰如下：

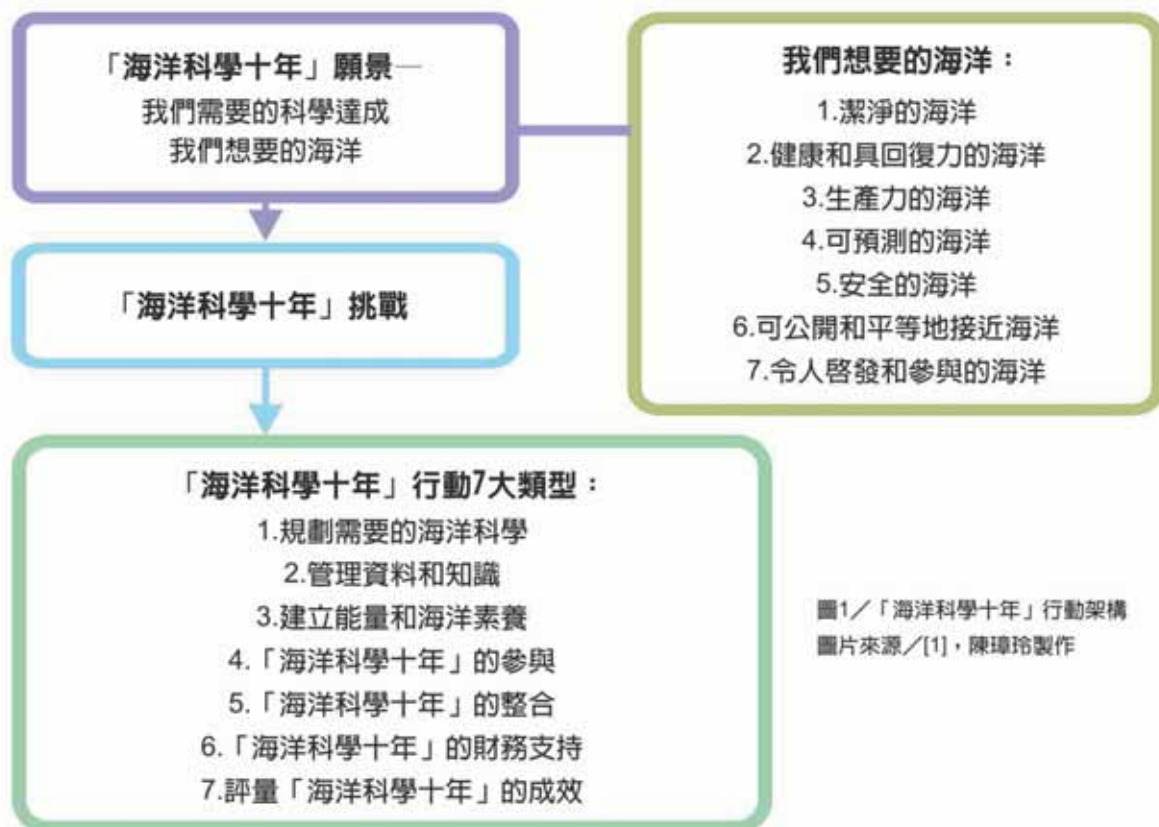


圖1/「海洋科學十年」行動架構
圖片來源/[1]，陳璋玲製作

- 瞭解和描繪來自陸地和海洋的污染物，以及這些污染物對人體健康和海洋生態系可能造成的影響，並發展移除或減少污染物的方法。
- 瞭解多重壓力環境因子對海洋生態系的衝擊，同時在考量環境、社會和氣候變化狀態下，提出監測、保護、管理和復育生態系及生物多樣性的方法。
- 產生知識、支持創新，以及提供解決方法，使海洋在環境、社會和氣候變化狀態下，能永續提供全球人口所需食物。
- 探討新知、支持創新，以及提供解決方法，使海洋經濟在環境、社會和氣候變化狀態下，朝向公平和永續發展。
- 增進瞭解海洋和大氣的關係，提出減緩、調適和提升海洋回復力的方法，以因應氣候變遷對海洋帶來的影響。
- 提升複合型災害早期預警服務，包括所有的地球物理、生態、生物、天氣、氣候和人為相關的海洋和海岸災害，以及強化社區準備和災害回復能力。
- 確保一個跨洋區的永續海洋觀測系統，提供所有使用者可以即時取得資料和資訊。
- 透過各不同利益關係人的合作，發展一套全面性的海洋數位系統，提供公開和免費使用，其中包括動態的海洋地圖，以視覺化研究探討海洋過去、現在與未來的狀態。
- 全面地建置資訊取得能量，確保所有利益關係能公平地取得所有海洋科學的資料、資訊、知識和科技。
- 確保能廣泛瞭解海洋對人類福祉、文化和永續發展的多重服務和價值，且確認並克服造成人類和海洋關係改變所需的行為改變的障礙。



圖2／瞭解來自陸地和海洋污染物對人體健康和海洋生態系的影響，發展移除或減輕污染物的方法是「海洋科學十年」的挑戰

圖片提供／陳璋玲

二、管理資料和知識

資料和資訊是達成「海洋科學十年」成果的主要關鍵。數位化、取得、管理和使用海洋資料、資訊和知識是「海洋科學十年」成功的主要核心。設計和建置一個數位網路系統，將多元且分散的資料整合是重要的工作。此網路系統包括全體海洋系統及涵蓋所有形式的海洋資料及涵蓋物理、地質、海底測深、生地化學、生物、生態、社會、經濟、文化和治理等相關資料。資料來源亦包括產業和公民科學家資料，以及原住民和當地知識。

三、建立能量和海洋素養

所有海洋是相連一體的，所有國家都需要有知識和能力去瞭解、觀察和管理海洋。然而，海洋科學和技能在性別上、不同地理區域間，以及不同世代間存有不平等分布的現象。若要達成「海洋科學十年」的願景，則必須加速努力去扭轉這既存不平衡的現象。

能量建置計畫有助於發展個人和機構取得海洋資料的能力，以及增進公平取得資料、知識、科技和基礎設備等，如研究設施、設備、高效能計算電腦等。多樣類型的能量建置計畫將最佳反應地方、國家和區域的優先事項，以及利益關係人的需求。例如，海洋素養策略（Ocean Literacy Strategy）為能量建置計畫之一，該計畫確定4大行動優先領域，包括政策形成、正規教育、企業行動和社區參與。此外，「海洋科學十年」亦協助政府和其他利益關係團體研擬國家海洋素養策略，以及進行監測和評估海洋素養提升的影響。



圖3／永續供應食物的海洋是我們想要的海洋

圖片提供／陳璋玲

四、「海洋科學十年」的參與

不同利益關係者的積極參與是「海洋科學十年」成功與否的關鍵。參與者包括科學社群、各國政府、聯合國轄屬組織和國際組織、業界、慈善機構、非政府組織等。個人或組織參與的方式沒有限制，其中包括加入成為「全球利益關係人平臺」（Global Stakeholder Forum）會員。「十年協調總辦公室」（Decade Coordination Unit）使用此平臺，召開社群會議，討論有關「海洋科學十年」挑戰的實務問題，同時促進不同團體互相交流。此外，經費、合作夥伴機會、訓練活動、會議等資訊公布於此平臺，平臺的會員亦定期參加區域或國際會議。

五、「海洋科學十年」的整合

「海洋科學十年」涉及全球許多夥伴和活動，需要一個簡單、穩定的整合結構來管理計畫執行情形。「十年協調總辦公室」即扮演此角色，是整合「海洋科學十年」所有活動的核心。政府或夥伴設立許多「十年協調辦公室」（Decade Coordination Offices），分散於全球各不同的地區。這些單位（十年協調總辦公室和辦公室）協助整合國家、區域和全球的活動；分享知識和工具；建立和可能夥伴的連結；以及監測和報告「海洋科學十年」推展情況。

此外，由聯合國會員組成的「十年諮詢委員會」（Decade Advisory Board）提供「海洋科學十年」執行情形的意見，並由政府間海洋學委員會向聯合國大會報告有關「海洋科學十年」的執行情形。

六、「海洋科學十年」的財務支持

「海洋科學十年」本身不是經費贊助機構，但它有許多機制和機會，可增加海洋科學經費的來源。資源來自於各種支持機構，包括政府、慈善基金會和業界。為達成「海洋科學十年」的願景，未來幾年資源的數量必須大幅成長。經費和實物資源的支持（如研究船使用、資料、基礎設備使用等）對於「海洋科學十年」的成功非常重要。

「海洋科學十年聯盟」（Ocean Decade Alliance）為重要的資源調動機制，聯盟會員提供財務和實務支持。財務支持有兩種方式，一為傳統方式——給予研究經費；另一為透過全球利益關係人論壇和「海洋科學十年聯盟」，由「十年協調總辦公室」建立各夥伴之間的連結，有些夥伴提供資源，有些執行海洋科學計畫，因此形成了一個集合性、高能見度能轉變海洋科學的全球行動。

七、評量「海洋科學十年」的成效

「海洋科學十年」是發生於動態的世界。不斷改變的社會和經濟狀態影響社會對海洋知識的需求。另科技進步和科學新發現，以及全球發生的重大事件（如COVID-19）亦持續影響「海洋科學十年」優先事項和機會。因此，有必要研擬一個詳細的監測和評估架構，追蹤「海洋科學十年」的影響和完成的事項。這些資訊有助於「海洋科學十年」進行調適性管理（adaptive management），包括執行計畫的修正和更新、定期出版「海洋科學十年」願景的進度報告，以及匹配可行的資源給予優先計畫。

評估過程包含8項工作：

- 兩年期行動計畫：列出未來2年的「海洋科學十年」優先行動。
- 資源評估：分析行動計畫和整合工作所需要的資金和已確保可得的資金。
- 評估和更新十年行動架構：評估進度和新興海洋科學議題，以及評估和更新十年行動架構。
- 全球和區域會議：利益關係人參與全球和區域會議，促進建立夥伴關係及檢視「海洋科學十年」優先事項。
- 每年進度報告：每年檢視運作面、財務面和科學面的進度。
- 「海洋科學十年」狀況的報告：2024年、2027年、2029年出版旗艦報告，記錄「海洋科學十年」的影響和願景的進度。
- 期中檢視：2025年全面檢視「海洋科學十年」執行計畫的進度，並進行更新。
- 最終檢視：2031年進行「海洋科學十年」的全面評估。



圖4／使用科學方法（如偵測海底地震系統）解決海洋挑戰是實施計畫主要的核心
圖片提供／陳璋玲

結論

「海洋科學十年」不在設定海洋政策，而係建立科學能量和產生知識，直接為2030年永續發展目標作出貢獻。實施計畫提供一個海洋科學為基礎的行動架構，包含7類具體行動，致力於解決10項海洋挑戰，將我們擁有的海洋轉變成我們想要的海洋。計畫執行的10年期間，除定期檢視和評估執行情形外，並於2031年，全面檢視計畫的成效和是否達成「海洋科學十年」的願景。

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淺談世界海洋資料庫及臺灣海洋資料庫之發展

編譯／鍾政棋（國立臺灣海洋大學航運管理學系所特聘教授兼海洋觀光管理學士學位學程主任）

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關鍵字／海洋十年行動、世界海洋資料庫、美國國家海洋暨大氣總署

聯合國在2017年提出「海洋科學促進永續發展十年」（Decade of Ocean Science for Sustainable Development，簡稱「海洋科學十年」）計畫，自2021～2030年為期十年，希望各國共同為保護海洋所需的科學基礎與應用而努力[1]。本文簡介「海洋科學十年」中的世界海洋資料庫計畫，探討如何妥善將世界海洋資料庫（World Ocean Database, WOD）作為氣候變遷調適決策之用，並加強漁業管理、保障糧食供應與促進海洋健康福祉。再回顧臺灣行政院農業委員會水產試驗所、科技部自然司海洋學門資料庫之建立，並介紹如何應用其歷年蒐集資料改善漁業枯竭問題。藉由蒐集並共享海洋資訊，可提供政府海洋及氣候政策發展之依據，共同朝向海洋永續目標邁進。

世界海洋資料庫

一、研究機構及研究領域

世界海洋資料庫（WOD）由美國國家海洋暨大氣總署（National Oceanic and Atmospheric Administration, NOAA）旗下研究團隊國家環境資訊中心（National Centers for Environmental Information, NCEI）之海洋氣候研究室（Ocean Climate Laboratory Team）所建立，針對NOAA及NCEI簡單介紹如下。

美國NOAA負責監測全球天氣數據及氣候趨勢，以提高預測和應對危及地球自然資源、人類生活和經濟活力的氣候變化和其他環境挑戰之能力。在制定國際海洋、漁業、氣候、空間和天氣政策方面，扮演著關鍵領導角色[2]；其所屬NCEI為開放給大眾的公開數據庫，係全球最重要的環境數據檔案之一。此中心網站提供天氣與氣候、海洋與海岸及地球物理3大領域的地球環境資料。透過NCEI提供之分析工具及資料，可進行氣候風險與環境生態脆弱度評估，作為氣候變遷調適決策之參考依據[3]。



圖1／美國國家海洋暨大氣總署標誌

圖片來源／<https://oceanservice.noaa.gov/facts/noaalogo.html>

二、世界海洋資料庫之介紹

世界海洋資料庫（WOD）係經科學品管的海洋資料庫，內容包含物理海洋學的海流、海溫、鹽度及降水等；化學海洋學的溶氧、酸鹼度及營養鹽等；生物海洋學的葉綠素與浮游生物。本文依2018年WOD介紹如下[4]。

WOD最初構想係為世界海洋圖集（World Ocean Atlas, WOA）提供海洋各種參數水平及垂直剖面分布圖，自2007年開始每季更新一次，蒐集海洋標準深度級別之海洋參數。希望瞭解海洋各種參數的平均變化範圍，將來自不同來源的海洋測量值，彙總轉化為統一形式，並進行品質控制[4]。

WOD之資料，包含在NCEI接收和存檔20,547個不同資料集，此等資料代表來自全球798個研究所及553個獨立計畫，在8,215個不同平臺上216,845次海洋航行之結果。有關WOD之資料組織操作定義如下[4]。

- **縱斷面**：當儀器在水柱中垂直升降時，對離散深度之單一參數（溫度及鹽度等）測量值。即不同深度儀器所得到離散測量值，將各不同深度離散數值收集整合一組斷面數值。
- **採樣**：一組同時或幾乎同時蒐集之單一或多重縱斷面資料。
- **測站**：進行一次或多次採樣資料蒐集的特定地理位置。
- **航次**：航次定義為單一平臺特定部署以進行連貫之海洋調查，若一組測站皆符合同航次定義，則會被組合在一起。
- **登錄號**：在NCEI接收並存檔之一組測站。
- **WOD資料集**：來自具有相似解析的儀器之所有資料，為方便起見，每個資料集皆在WOD中單獨歸檔。

WOD將以類似方式獲取的數據組合在一起，每個資料集以3個字母表示，用於命名輸出資料文件之縮寫[4]。

三、世界海洋資料庫之對照

在海洋學中，來自同一個採樣之數據，可能位於不同國家之不同機構。NCEI成立之初，便瞭解構建海洋資料庫之重要性，將來自每個測站和每航次的資料放入標準格式，並附上適當的詮釋資料（Metadata）使資料對其後的科學家有所助益[4]。

近年由於特殊資料管理及資料觀測專案，科學家定期提交和海洋監測計畫之運行，使資料量大幅增加。有關2018年WOD與先前全球海洋資料庫之比較，如表1所示。

表1 / WOD與先前全球海洋資料庫之比較

(單位：件數)

資料	NCEI		WOA 1994年	WOD					
	1974年	1991年		1998年	2001年	2005年	2009年	2013年	2018年
海洋監測站資料	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
溫鹽深儀	n/a	66,450	89,000	189,555	311,943	443,953	641,845	848,911	1,029,231
機械式溫深儀	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
拋棄式溫深儀	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
繫泊浮筒	n/a	n/a	n/a	107,715	297,936	445,371	566,544	1,411,762	1,585,135
飄移浮標	n/a	n/a	n/a	n/a	50,549	108,564	121,828	251,712	227,871
剖面浮標	n/a	n/a	n/a	n/a	22,637	168,988	547,985	1,020,216	1,867,873
波狀海洋記錄儀	n/a	n/a	n/a	n/a	37,645	46,699	88,190	88,190	127,544
自動鰭足溫深儀	n/a	n/a	n/a	n/a	75,665	75,665	88,583	1,713,132	1,804,605
滑翔翼自主載具資料	n/a	n/a	n/a	n/a	n/a	338	5,857	103,798	1,148,669
資料總數	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
浮游生物	n/a	n/a	n/a	83,650	142,900	150,250	218,695	242,727	245,059
海面溫度鹽度	n/a	n/a	n/a	n/a	4,743	9,178	9,178	9,289	9,289

資料來源／[4] (頁27)

由表1可知，因科學家持續進行觀測並統整過去資料，每4~5年資料發表有所增加，此將有助於各方將此資料庫作為決策之依據。

四、世界海洋資料庫之困境

WOD在20年前有超過60個國家定期提供該國附近海域之海洋資訊，但現在未達30個國家[5]。WOD是歷史最悠久，涵蓋國家最多的海洋資料庫，現今資料不足將使地球上許多領海區域內之情況，被摒除在全球海洋與氣候模型之外，導致無法衡量氣候變遷之影響，亦無法評估邁向聯合國永續發展目標之進度。

為解決海洋數據共享之障礙，政府間海洋學委員會（Intergovernmental Oceanographic Commission, IOC）、國際永續海洋經濟（Sustainable Ocean Economy）高級小組、世界經濟論壇的「連結星球未來計畫」（Future of the Connected Planet Program）與第四次工業革命海洋中心（Centre for the 4th Industrial Revolution Ocean, C4IR Ocean）攜手合作，共創獨特的「海洋資料共享計畫」（Ocean Data for All）。從不同面向探討如何促進全球合作，將蒐集的資料彙整後公開，讓需要之人皆能從中受惠[5]。

臺灣的海洋資料庫

一、臺灣的海洋資料庫與氣候變遷調適行動推動歷程

科技部自然司海洋學門資料庫[6]，為臺灣類似WOD之資料庫，由科技部（前身為國科會）在1987年建立，並委託國立臺灣大學海洋研究所營運。海洋資料庫（Ocean Data Bank）是基於服務面向架構的跨學科海洋資訊系統，提供西太平洋之海洋數據。此數據庫整合地理資訊系統（Geographic Information System），可提供海洋之物理、地質或生物學資訊的圖表或地圖參考。

我國行政院農業委員會水產試驗所，為瞭解臺灣周邊海域漁場環境，對近海的大範圍漁場進行海洋環境調查。自2003年推動「臺灣周邊海域漁場環境監測」計畫，每年4次進行季採樣，前往周邊海域62個固定測站測量水溫、鹽度，並蒐集水體樣本進行營養鹽及生物相之研究，對探究海洋環境變遷下漁業資源之變動、確保漁業資源之永續利用具有重要意義[7]。

此等資料可應用範圍相當廣，從國家安全到海洋環境保育皆可運用。期望未來可將資訊公開化，幫助靠海維生之人民增加工作效率[7]。在政策面上，臺灣亦有進展[8]，有關臺灣氣候變遷調適行動推動歷程，如圖2所示。

由圖2可知，為健全氣候變遷因應能力，由行政院國家發展委員會成立專案小組，每年持續推動計畫並建立國家氣候變遷調適推動機制。陸續完成「國家氣候變遷調適政策綱領」及「國家氣候變遷調適行動計畫（102～106年）」，構建我國推動氣候變遷調適之基礎。最新版「國家氣候變遷調適行動方案（107～111年）」，除了持續落實海岸與海洋環境保護，納入2018年設立的海洋委員會主管業務，將推動海洋資源監測預警及評估機制，以有效保護海岸生物棲地和海洋資源，促進生態永續發展[8]。

2020年我國國家海洋研究院開始執行全國海洋資料庫建置計畫，目前已初步完成資料庫系統之型態，並逐步收納各部會、學研單位與民間機構的相關海洋資料，共介接97個資料庫，期望未來能更加完善海洋資料之流通機制[9]。

二、臺灣海洋資料庫實際案例

在回顧臺灣海洋資料庫之建立及運作後，於此介紹海洋資料庫實際應用於傳統漁業之案例。臺灣原具有豐富及多樣的海洋生態，近年來卻面臨漁獲量漸減之問題。

臺灣氣候變遷調適行動推動歷程



圖2／臺灣氣候變遷調適行動推動歷程（本文繪製）
圖片參考來源／<https://adapt.epa.gov.tw/>

傳統漁撈作業係以經驗研判漁場位置，但因全球氣候及海洋環境變遷，漁業資源分布已逐漸失去規律性。透過資料分析水溫、葉綠素濃度、營養鹽成分，可預測漁場位置，協助漁業管理，適度限制漁民出海捕撈，達到海洋資源永續發展之目標[10]；有關水產試驗所提供之臺灣附近海域衛星水溫影像圖，如圖3所示。

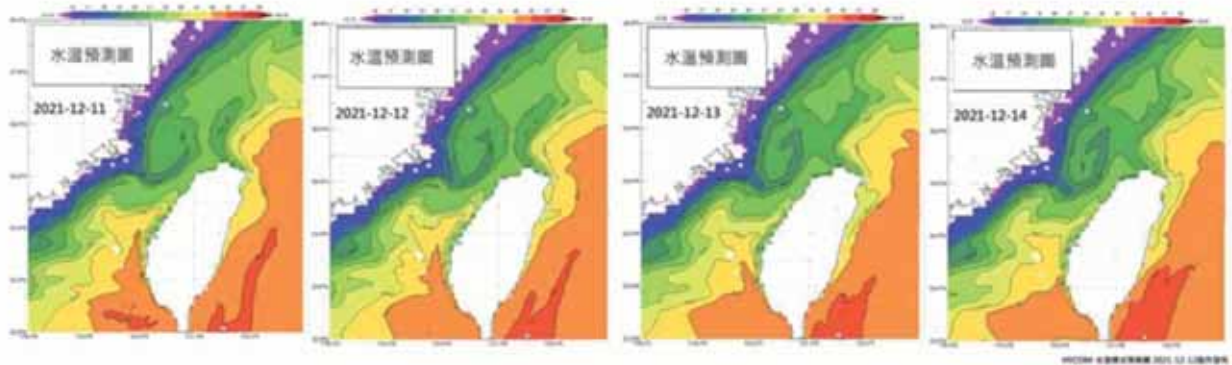


圖3／臺灣附近海域衛星水溫影像圖

圖片來源／<https://www.tfrin.gov.tw/News.aspx?n=4229&sms=9038>

結語

WOD為世界各國提供多元之海洋資料，作為氣候變遷調適決策之用，所蒐集之資料彙整後公開，讓所有人從中受惠。本文介紹WOD之資料內容及貢獻，WOD於學術及實務應用上皆具重要參考價值，也能感受到國際對海洋環境保育之重視。

臺灣目前亦積極打造自己之資料庫，希望提供資訊給有需求之大眾，也作為國家海洋及氣候政策發展之依據。本文亦提出實際利用臺灣海洋資料庫於傳統漁業之案例，以及全國海洋資料庫之建置計畫，未來期許能將海洋資料庫應用在更多領域，並努力爭取與國際合作，共同規劃海洋永續發展計畫。

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聯合國海洋科學促進永續發展十年的協調治理架構

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關鍵字／海洋科學十年、協調架構、永續發展

聯合國於2016年所發布之首次全球海洋評估報告（First World Ocean Assessment）指出，海洋在多重壓力下（包含：氣候變遷、人口成長或人為活動等），其結構、功能與益處之健康狀態，已經處在不斷惡化的循環體系[1]。因此，該報告呼籲聯合國必須採取緊急行動，透過全球跨領域的海洋科學合作，建立以科學為基礎之海洋管理體制，以填補科學與政策間的落差採取急迫的行動[1]，以減緩當今不斷惡化的海洋健康狀態，才有機會創造、改善與維持海洋永續發展之條件[2]。

在上述背景下，聯合國大會於2017年12月5日做成決議（A/RES/72/73），責成聯合國教育科學及文化組織（United Nations Educational, Scientific and Cultural Organization, UNESCO）之政府間海洋學委員會（Intergovernmental Oceanographic Commission, IOC），負責推動「聯合國海洋科學促進永續發展十年」（The UN Decade of Ocean Science for Sustainable Development，簡稱「海洋科學十年」）。在此一倡議準備過程中，經歷了將近3年從全球到區域的籌備與諮詢過程，海洋學委員會於2020年6月正式決議提出「海洋科學十年」實施計畫，並在當年11月提交聯合國大會決議通過，而於2021年1月正式啟動此一為期十年之倡議與行動。

此一「海洋科學十年」有兩個主軸目標，分別為：第一，產生為了海洋永續發展所需要之科學研究數據與資訊，並建立資訊分享之夥伴關係；第二，為了建立一個有效海洋治理體制，提供政策制定所需之充分海洋科學、數據與資訊是非常重要之基礎工作。根據IOC執行秘書Vladimir Ryabinin的說法，「海洋觀測」（ocean observation）即位於此政策倡議中的核心，並以此貢獻於與海洋相關的所有永續發展目標中。（此處所指涉與海洋有關之永續發展目標，不僅指2030永續發展目標14「海洋」之目標，也包含其他所有可能帶有海洋面向之目標。例如，永續發展目標5「性別平等」之目標，在海洋領域中也同樣具有重要意涵〔如海洋產業從業人員之男女比例〕。因此，「海洋科學十年」是一個跨聯合國永續發展目標之計畫，此一政策倡議的範疇涵蓋涉及海洋相關的跨域議題〔cross-cutting issues〕[3]。）

據此，在「海洋科學十年」推動後，全球對於海洋科學數據的掌握需求，也就越趨精密化、遠洋化與深海化。然而，在規模如此龐大的全球海洋科學行動下，要如何協調彼此的行動不會造成資源的重複投入，以及符合「海洋科學十年」所欲達成海洋永續發展所面臨之挑戰，也就涉及到IOC有關「海洋科學十年」的協調架構。本短文的目的，將先說明當今國際社會有關永續科學研究的共同製造（co-produce）研究之概念進行說明，再進一步說明其與IOC協調架構安排之關係，最後則是本文的結語。

永續科學與共同製造理論

雖然從永續發展的概念提出後，對於社會、經濟、政治與技術對生態系統之間的動態順序關係，始終是永續發展的問題核心。尤其，永續科學對於這些問題之間的複雜性、不確定性、解決方法與相關障礙，都是相關重要研究議程或對象。不過，永續科學研究始終缺乏一個具有達到全球永續所需要的系統層次之轉變條件。從政策的角度來說，如何決定永續科學研究的議程，以及如何將科學研究結果與其他知識領域整合或應用於其他知識領域，是目前永續科學研究所追求的一項目標。而達到此項目標的其中一種重要手段，即可透過「共同製造」程序。

所謂的「共同製造」，係指藉由不斷結合人們的觀念（ideas）、規範（norms）、實踐（practices）與論述（discourses），讓我們所理解（knowing）的事務與我們的行動（acting）得以相互強化，而得以改變社會結果的過程（不同學科對「共同製造」的定義不盡相同，而在本文中所援引的定義，比較偏向從公共政策的角度，輔以永續科學或科學與科技研究領域的視角）。在此概念下的科學研究，比較強調研究結果所能帶來的公共益處、以跨領域知識解決當今社會的挑戰，以及科學家的跨制度邊界（institutional borders）之合作（所謂「跨制度邊界」可以指涉國家之間的國界，更多則是可以指涉不同部門、部會、知識領域、社群……等邊界概念）。在此概念脈絡下，「共同製造」具有3種層面：為永續的共同製造科學（co-producing science for sustainability）、治理的共同製造（co-production of governance）、以及共同製造科學與治理（co-producing science and governance）[4]。

所謂「為永續的共同製造科學」，是指讓傳統的科學或科學家不僅僅提供科學資訊，而是要成為能夠分享其知識予不同知識團體（例如：擁有傳統知識的原住民族）或各類決策者之夥伴。因此，透過共同製造的過程，可以使科學家的知識成為有用（usable）的資訊，而不是純粹在學術社群中的知識而已。而為了確保永續科學研究具有政治與社會層面的正當性，也就會強調如何透過置入參與、包容、與諮詢等規範於研究過程中，以使社會的改變奠基在充分知情的科學研究基礎上。

又，所謂「共同製造的治理」係指透過特定的制度安排、程序與能力，以有效支持國家與公民創造公共財與公共服務。例如，著名的公共政策學者Elinor Ostrom曾經指出，共同製造即意味著在當前預算普遍不足的狀況下，讓不在同一個組織內的公民，可以共同積極地扮演貢獻於公共財製造與服務的過程中[5]。因此，公民的賦權（empowering）、不同公共財貢獻者間的協力（synergy）、參與者對彼此與共同製造程序的承諾（commitment）、法遵監督的治理機制，乃至於允許政策實驗與失敗的彈性等，都是「治理的公共製造」所關注的制度安排事項。

最後，有關「共同製造科學與治理」主要是從科學與科技研究理論的觀點（science and technology studies, STS），認為科學其實是特定政治社會與制度環境設計下的產物。因此，對STS來說，共同製造也就意味著科學知識的產生，實際上是社會與自然體系之間互為製造者（producer）與產物（product）的關係。因此，對STS而言，共同製造科學與治理實質上是一種分析

不同的知識製造主體，透過正式與非正式制度，形塑知識的創造、分享與利用的「知識治理」（knowledge governance）過程。換言之，此一類型的共同製造概念，主要是在於詮釋與揭露知識產生與利用的權力關係，而前面兩段所提到的共同製造，則是科學與公共行政學界的一種主觀的政策實踐。（在STS人與自然的觀念中，「物體」[objective]的本身也是主體。因此，此處所指的主體，除了科學家外，不具有形體生命的制度、電腦模擬程式、動植物、海洋地景……等，都可以是STS所指涉的主體概念。）

聯合國「海洋科學十年」的「共同製造」協調架構

如本文前言所述，「海洋科學十年」作為一個全球規模的自然與社會科學的共同製造行動，若沒有一套協調架構，勢必無法有效面對「海洋科學十年」所欲處理的挑戰。依據「海洋科學十年」《實施計畫》（Implementation Plan）所述，「海洋科學十年」所要處理的挑戰共有10項，而這10項挑戰也是「海洋科學十年」的10大研究主題。因此，在該《實施計畫》中，即已提出「海洋科學十年」的治理與協調架構。其中，有關「十年協調辦公室」（Decade Coordination Offices, DCO）、「十年合作中心」（Decade Collaborative Centers, DCC）、與「十年合作夥伴」（Decade Implementing Partners, DIP），即可說是「海洋科學十年」的一種「共同製造」治理體系，並以設於IOC秘書處的「十年協調總辦公室」（Decade Coordination Unit, DCU）作為此一協調體系的頂層單位，並與「十年諮詢委員會」（Decade Advisory Board, DAB）密切合作。此一協調治理架構中的DCC與DIP的運作指南（Decade Collaborative Centres and Decade Implementing Partners: Operational Guidelines），IOC已經在2021年4月公布。



圖1／聯合國「海洋科學十年」協調治理架構圖

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

從組織的集中化程度來說，在此次「海洋科學十年」的治理架構下（請參見圖1的治理架構），可說是集中與分散式的兩種元素所共同組成。前段所提到的DAB與DCU，都是集中化的單一單位。DAB是由多元利益方所共同組成，並提供實施上的策略建議。又，DCU則是「海洋科學十年」計畫實施的中央協調單位，並與其他聯合國機構之秘書長進行密切的協調工作，必要時，也可能借調其他聯合國機構官員來DCU，以確保跨機構行動協調得以一致。從前述共同製造的概念來說，由於前段的集中式協調機構的目的，是為了確保共同製造階段可以達成預期結果的手段。所以，此一集中式的協調機構（此處為DAB），還必須要確保其具有包括文化上的代表性，且讓邊緣團體可以獲得妥適的賦權。（此即前述「共同製造科學與治理」中所強調的知識治理概念，以及自然與社會文化規範互動的產物所推導出來的制度安排結果。）

此一治理協調架構中的分散式單位，不論是前述的DCO、DCC與DIP，都可說是實際執行「海洋科學十年」各項行動與計畫的主體。因此，DCU必須設置數個DCO（目前，IOC尚未正式公布DCO的具體設立與操作指南），作為類似DCU的次級單位，協調不同DCC和DIP，以支持DCU在不同區域（region）或不同研究主題中（前述所說十年挑戰）的運作。DCO將會由聯合國的機構，或者該機構的秘書處所在國家來履行此一協調功能，但亦可視情況新設立一個單位，均是由聯合國人員所組成。因此，DCO的主要職責，除了協調相關各方的行動外，尚包括審查各方請求DCU認可（endorsement）之十年計畫行動、尋求自願強化十年計畫實施之夥伴、與進行監督及資源之動員。如前所述，為了確保共同製造的結果可以有效處理海洋十年的挑戰，就必須要有聯合國的認可過程。如果沒有此一認可行動，對於資源的動員將會產生障礙。

至於DCC的設置條件，可以由聯合國會員國、國際或主要（major）區域海洋科學組織（不論是研究機構、非政府組織、基金會、大學、或私部門）來擔任。而DCC的主要職責，是輔助DCO在不同區域或研究主題中的協調工作。同樣地，DIP的設置條件與DCC相似，但不需要是「主要」海洋科學組織，且可以包含研究中心、平臺或甚至非正式的工作小組。據此，DCO與DCC之間的主要不同，在於前者是由聯合國體系的全職人員與資源所組成，並具有十年計畫行動之審查權。不過，兩者的協調、動員與地理（海盆）或議題規模（一個以上的十年挑戰）均相同。至於DIP與DCO和DCC的主要不同，在於支持DCU、DCO、DCC的部分工作任務或活動，且地理（次海盆、陸地區域）與議題（特定十年挑戰中的一個要素）規模，均遠不及於DCO或DCC。因此，DIP並不需要為了「海洋科學十年」，而設置為全職人員所組成。

另外值得注意者，欲設立DCC者，必須先向DCU申請，並進行初步的評估與可行性研究。此一可行性研究將成為IOC執行秘書決定是否允許其設立時的重要依據。一旦IOC認可該DCC的申請後，即可與IOC簽訂協議。不過，其他聯合國機構（如：國際海底管理局）依據自己的程序設立DCC時，該等討論必須在DCU中進行，以確保各項活動的一致性。因此，DCC的設立會經過比較嚴格的審查設立程序。截至2021年底為止，一共有4個DCC在申請設立的審查過程。其中，只有Tula Foundation申請成為區域性規模的DCC，而其他3項申請案的主體（Ocean Visions, University of Bologna, Mercator Ocean

International) , 則是以特定十年挑戰之單一議題作為DCC申請設立的條件。至於要成為DIP , 雖然也要經過DCU的審查 , 但並不需要經過嚴格的可行性研究 , 只要經過「適當注意」 (due diligence) 的程序通過後 , 即可完成成為DIP的註冊程序。

結語

從目前「海洋科學十年」的協調治理架構來看 , 大致上符合本文所說的永續科學之共同製造理論所強調的制度安排。往後所需要觀察者 , 可能仍是如何與不同的社會文化脈絡相結合 , 並有效轉化為符合社會改變需求的一場長期的科學行動。主要關鍵在自然科學家仍是主導研究議程的情況下 , 如何讓社會科學家可以扮演此一中介者的角色 , 也有待後續的觀察。再者 , 在實際各種不同的科學研究計畫或活動中 , 雖然聯合國非常強調共同製造的元素 , 但究竟何種模式或程序比較有助於達成面對十年挑戰的目標 , 可能需要在日後的檢討中加以分析。最後 , 國際社會或個別國家 , 要提供什麼樣的政策誘因 , 讓不同行為者願意加入到此一長達10年的行動 , 也必須進一步觀察。

又 , 我國已經在2021年在科技部的主導下成立了「臺灣海洋聯盟」 , 對於國內投入此一與國際接軌的海洋科學研究行動 , 是具有相當重要的一步。未來 , 若要實際參與聯合國主導的此項行動 , 或許可以考慮透過與友邦合作 , 由友邦申請成為DCC或DIP似乎比較可行。或者 , 即便沒有共同成為DCC或DIP , 似可透過與未來特定DCC或DIP的合作 , 達到一定的參與效果。

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IOC海洋十年實驗室機制及其海洋教育衛星活動

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關鍵字／海洋科學十年、IOC海洋十年實驗室機制、臺灣海洋教育

聯合國教育科學及文化組織（UNESCO）於1960年創立政府間海洋學委員會（IOC），負責支持全海洋科學與服務聯合國的單位。在2021年6月8日，即「世界海洋日」當天，正式宣布從2021年至2030年為聯合國「海洋科學促進永續發展十年」（Decade of Ocean Science for Sustainable Development，簡稱「海洋科學十年」），在「海洋科學十年」期間有60多項計畫，作為首批正式海洋行動，以助力海洋科學發展。

這些「海洋科學十年」領航計畫由科學界、政府、公民社會、聯合國機構、公私營部門、慈善機構和國際組織協力，實現了廣泛的全球參與度[1]。海洋占全地球71%面積，是如此廣闊無際，資源是如此豐富，數個世紀前的人們曾覺得海洋資源應當用之不盡、取之不竭，予取予求的利用海洋資源。然而，今日我們的海洋正面臨著資源枯竭與嚴重的海洋生態危機，全世界已有75%的商業漁獲瀕臨崩潰，因為過去的人們錯估漁業科技進步的速度，數十年來，從傳統人力為主的捕魚方式進步到船上配備全球定位系統、魚群探測儀、回聲測深儀等高科技設備的漁船或捕撈船隊，但海洋資源並未因人類的撈捕科技增強而增加[2][3]。

聯合國糧農組織（Food and Agriculture Organization of the United Nations，簡稱FAO）的2018年度報告顯示，2016年水產品的總產量約88%（超過1.51億噸）直接用於人類消費，足見海洋水產的重要性。伴隨著人類的科技不斷進步加速了海洋健康情況逐漸更加惡化，對海洋環境的海洋污染、氣候變遷及酸化影響加深加劇。目前海洋狀況，全球有將近90%的魚種逼近或是已低於永續生存的數量門檻。其中更有超過30%魚種種群已經無法持續生存，人類在未來幾十年裡無法想像世界將會變成什麼模樣[4]。我們迫切需要以科學為基礎的策略來因應全球氣候變化，「海洋科學十年」將會在科學與政策的互動上創造全新基礎，聯合國「海洋科學十年」的目標在於扭轉海洋健康惡化的趨勢，並且召集與提出全球海洋利益方案，制訂與策進成共同框架。這個框架將確保海洋科學能夠為各國創造更優勢的條件，進而實現海洋的永續發展。

海洋十年實驗室項目與活動

「海洋科學十年」的60多項獲批倡議與計畫中其中第33項：UNESCO-IOC提出：面向所有人的海洋素養實現人類想要的海洋所需的變革，該計畫旨在：「面向所有人的海洋素養」通過不同的利益攸關方在地方和全球層面設計並實施具有變革意義的研究活動和項目，由國際夥伴關係和國際網絡推動海

洋素養。該計畫有助於構建能力，改變行為，以實現海洋素養社會並確保全球海洋的永續發展。第53項：美國國家海洋暨大氣總署（NOAA）將海洋保護區作為海洋保護、科學和素養的監測中心（MPAs as sentinel sites for ocean conservation, science and literacy）。該計畫旨在：一、認識氣候對海洋的影響；二、加強對海洋保護區利用和海岸社區社會經濟效益的研究；三、制定有助於促進海洋素養的倡議；四、支持建立海洋保護區網絡的國家和國際相關倡議。

從上可知，「海洋科學十年」首重全民海洋素養的提升，但臺灣在海洋科學素養的相關研究較為缺乏，所以未來10年國家教育政策發展應全方位致力推動國民海洋科學教育，普及全民海洋素養基礎教育及海洋科學的概念[5][6]。於是「海洋十年實驗室」（Ocean Decade Laboratories，簡稱海洋十年）機制，於網路上開放各式活動及研討會，激勵所有對海洋感興趣並與海洋有連結的人，包含科學家、決策者、管理人員等，將來自全球的不同參與者聯繫起來，以實現海洋十年的願景，強化多方交流及連結，構建促進夥伴關係和共同設計海洋十年行動的平臺。

臺灣海洋教育中心受亞洲海洋教育者協會（AMEA）之邀請，參與以海洋十年實驗室「鼓舞人心且引人入勝的海洋」為題的其一衛星活動，由協會會長日本東京海洋大學佐佐木剛（Tsuyoshi Sasaki）教授主持。中心以影片介紹臺灣海洋教育政策與計畫，並透過現場教師推廣，達到將海洋教育融入課程、與生活情境結合，內容包含建構海洋素養資料庫、海洋教育者培訓機制、海洋職涯試探及與全臺各地方政府教育局處的合作和教學研發海洋教育基地課程研發，讓臺灣海洋教育於國際發光發熱，使與會的國際學者無不讚嘆臺灣海洋教育之多元性及豐沛能量。



圖1／聯合國政府間海洋學委員會（IOC）海洋十年實驗室的衛星活動（亞洲區活動）

圖片來源／<https://www.youtube.com/watch?v=CZyxLTmuGnU>

臺灣海洋科學教育的發展

臺灣海洋教育包含5大主軸，分別為海洋休閒、海洋文化、海洋社會、海洋科學與技術及海洋資源與永續。其中推動過程包含社會科學與自然科學領域，這與美國海洋素養7大原則及歐盟、聯合國IOC推動主軸在自然—海洋科學上略不同。但臺灣除了海洋科學外，亦包含海洋文化與社會，面向更為廣闊與深化。依照教育部公布的108新課綱內容，19項議題包含海洋教育實質內涵，共有55項，將可提升學生海洋素養，落實於生活當中。綜合海洋十年實驗室的衛星活動，臺灣長期推動海洋教育下，具備了與其他國家不同的推動模式與成功經驗，將可作為世界推動海洋教育活動參考。全世界推動海洋教育，影響學生的海洋素養有3大關鍵因素。第一、師資：正式教育中，職前教師或現職教師的海洋教育的培訓不足，教師並無具備足夠的海洋素養來推動海洋教育；第二、海洋教育者培訓：海洋教育者就是在推動海洋教育的人員。目前海洋教育透過正式教育與非制式教育推動，但海洋教育者的培訓與訓練機制仍未建立到位；第三、海洋教育媒材：海洋教科書與素材的缺乏，教育部以海洋教育議題融入各領域，並無實際的海洋教育課程教材，以及相對應的媒材來推動，造成教師現場推動不易[5][7][8][9]。

結語

配合聯合國「海洋科學十年」活動與實踐，對於臺灣海洋教育政策上，教育當局應予持續評估各校海洋教育的傳遞與實行成效，以及非制式的海洋教育推廣，基於《海洋基本法》公布，全民的海洋教育普及與推廣，茲建議如下：

- 規劃合乎國際海洋科學發展趨勢之海洋教育補充教材，以及教學資源的擴充。
- 積極鼓勵各級教師、國家公務人員、非政府組織人員培養海洋教育專長，強化學科知能，有效地傳遞海洋知識，做出有責任的海洋政策。
- 師資培育過程中，規劃開設海洋教育相關課程，使師資生於職前即具備相當的海洋素養，落實於現場教學當中。
- 安排戶外教育之海洋體驗活動與踏查，或參觀相關的海洋類博物館、臺灣地區各地海洋驛站，以增進學生對海洋的瞭解，進而提升學生之海洋素養。
- 長期舉辦海洋教育研習與工作坊，持續強化教師與公務員的海洋素養，能於授課課程融入相關海洋科普素養與海洋文化概念。
- 投入海洋科普多媒體製作，運用海洋宣導影片暨科普書籍的閱覽，與現階段課程結合，以達到海洋教育的實施成效。
- 培育海洋公民科學家，瞭解家鄉水域環境狀況，愛護海洋。
- 海洋教育者培訓機制建立，長期培訓正式教育與非制式海洋教育人員。

目前全臺正積極配合聯合國「海洋科學十年」與聯合國永續發展目標，各階段的研發海洋科學教育的課程，並與各國共同提出寶貴見解與交流，傳遞臺灣海洋文化、海洋生態和生物多樣性、保護海洋、永續漁法的概念等，讓各國為地球環境維護盡一份心力，讓我們的下一代更瞭解臺灣是如何跟海洋共生共存，展現出具備海洋DNA的特色！

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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

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關鍵字／聯合國海洋科學促進永續發展十年、海洋科學十年、海洋素養

2017年，聯合國提出「海洋科學促進永續發展十年」計畫（以下簡稱「海洋科學十年」），多達193個國家認可：海洋對地球與人類生態系統具有關鍵的影響力，目前地球面臨氣候變遷等重大劇變，海洋為解決此一難題的關鍵，海洋科學扮演重要關鍵性角色[1]。歷史性的成功創舉需要廣泛的社會參與，透過合作創造新知識，利用知識轉化為實際行動。目前海洋正面臨提供迫切解決方案拯救「我們擁有的海洋」。因此，「海洋科學十年」首要目標即確保世界公民具備海洋素養，認知其必要性且有能力推廣並採取正確行動，以因應海洋所面臨的迫切威脅，建立合作夥伴關係網絡，經驗分享彼此交流，藉此制定新的措施與解決方針。希望海洋素養能引領我們達到2030年的里程碑——「我們想要的海洋」。

「海洋科學十年」成功關鍵——海洋素養

海洋素養（Ocean Literacy, OL），係指具備海洋科學知識，同時能夠對海洋做出負責任的決策。海洋具有7項基本特色包含：地球擁有一個多元特徵的大洋，海洋及其生物形塑了地球上的各種特徵，海洋是主要影響氣象及氣候變化的因素之一，海洋為地球許多生物的棲地，海洋提供了生物多樣性存在的生態系統，海洋與人類是息息相關，大部分海洋仍未被探測[1]。

海洋與氣候變遷、糧食安全、人類健康和全球經濟等世界重大議題息息相關。瞭解海洋對我們以及我們對海洋的影響，體認我們對海洋依賴的程度及海洋所提供的價值，以及我們如何為海洋的延續奉獻己力，確保所有人類實現永續、公平且健康的未來，此為海洋素養之基本精神。要實現海洋永續發展，強化海洋素養是「海洋科學十年」的成功關鍵。

海洋素養可以採取多種形式，包括：發展國家海洋素養策略全面性融入正規教育、海洋科學界間的經驗交流提升知識水準、青年賦權計畫與公民覺醒運動等。海洋素養倡議行動係利用「改變理論」，希望所有利益相關者從認知與瞭解；進而態度改變，最終產生行為改變。

「海洋科學十年」行動方案：海洋素養計畫

「海洋科學十年——海洋素養計畫」（以下簡稱「海洋素養計畫」）的協調單位為聯合國教育科學及文化組織（United Nations Educational, Scientific and Cultural Organization, UNESCO）

下之政府間海洋學委員會（Intergovernmental Oceanographic Commission, IOC），並由多個利益相關者團體合作實施，包括學術界、政府組織和非政府組織、私部門與教育機構等，制定小規模計畫與活動，以海洋素養為核心，協調並發揮協同合作達到最大效益，建立與評估海洋素養活動及其影響，全面地理解海洋素養的概念和做法，強化既有的海洋素養網絡間的聯繫並促成新的網絡建立，同時促進相關「海洋科學十年」發展。

目前提出的「海洋素養計畫」有6大組成要素（圖1），包括：精進研究能力、成立海洋素養專案中心、規劃培育課程、普及海洋素養資源、強化海洋素養網絡及計畫的協調與監督。

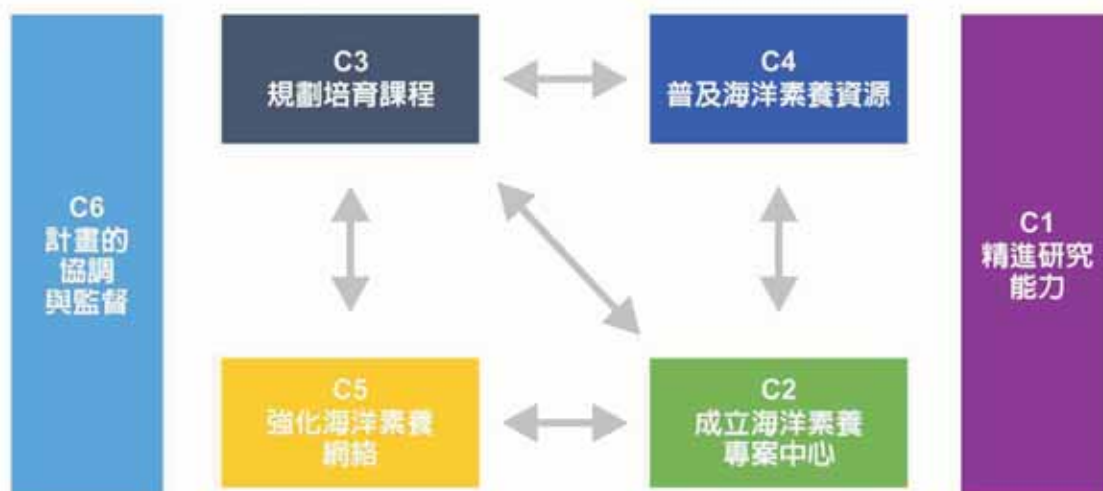


圖1／說明「海洋素養計畫」的主要組成要素
圖片來源／[2]

C1精進研究能力：提供基礎評估並制定各項標準、指標及方法，以評量海洋素養在整個「海洋科學十年」中的影響，以納入「海洋科學十年監督與評估架構」。

C2成立海洋素養專案中心：推廣、支持並促進國際海洋素養研究合作，共同確定研究優先事項和干預領域的空間；適合共同發展專案，建立核心的海洋素養研究資料庫。

C3規劃培育課程：開發適性的海洋素養訓練課程，這些團體包括教育工作者、媒體、政府、私部門、公民社會、非政府組織和外交專業人士。

C4普及海洋素養資源：擴大及改善海洋素養教育資源與計畫的可取得性，促進多元教育管道推廣（如人工智慧、擴增實境與虛擬實境等技術等應用）。

C5強化海洋素養網絡：加強區域層級的合作，支持國家海洋素養策略的合作聯盟，建立全球性的藍色學校網絡、發展藍色城市網絡、發展海洋素養基地網絡等。

C6計畫的協調與監督：監督並報告海洋素養專案執行狀況，透過新專案與活動擴展「海洋素養計畫」，增加夥伴關係會議、分享與推廣活動、發布海洋素養專案計畫成果、協調並同步「海洋素養計畫」項下的各項專案。

表1／「海洋科學十年」的優先事項、目標、「海洋科學十年」行動與「海洋素養計畫」組成要素

優先事項	目標	行動	要素
讓海洋素養成為制定教育政策的主流	<ul style="list-style-type: none"> 到2025年，70%的會員國都制定國家海洋素養策略，並將海洋素養納入正規教育制度的課程與教育政策中。 到2025年，政府代表已具備知識、能力、技能並承諾，將海洋永續納入地方、國家與區域政策當中。 到2028年，已充分實施、監督海洋素養政策。 到2025年，會員國提高海洋素養的年度支出。 	<ul style="list-style-type: none"> 確立國家海洋素養策略及海洋素養協調機制，並指定「海洋素養國家聯絡單位」（National Focal Point for Ocean Literacy）。 將海洋素養納為國定課程標準（National Curriculum Standard），以便將海洋教育納入中小學課程當中。 為政府官員提供及安排海洋永續、藍色經濟訓練計畫。 增加對海洋素養學校或海洋素養計畫的投資。 	<ul style="list-style-type: none"> • C5 • C3
強化海洋素養的正規教育	<ul style="list-style-type: none"> 到2025年，全球學校都可以使用自己的語言取用優質的海洋素養教育資源（全球學校都可提供各自國家海洋素養教育資源）。 到2030年，70%的所有正規教育人士將接受訓練，將海洋素養納入課程。 到2030年，全球70%的學生接受海洋素養教育，為海洋永續付出努力。 到2030年，全球正規教育機構將針對海洋素養展現全方位規劃，其中海洋永續將已納入各級管理部門。 	<ul style="list-style-type: none"> 為多重領域的職前師資教育工作者與積極的教育工作者安排訓練計畫，包括面對面和線上海洋素養研討會、課程與實地考察。 正規教育工作者與專家之間的知識交流。 為中小學制定教材，包括數位資源與工具。 為學生安排以自然為主的教學機會與教育活動（如野外實習、互動工作坊）。 	<ul style="list-style-type: none"> • C3 • C4 • C5
動員企業採取海洋素養行動	<ul style="list-style-type: none"> 到2025年，全球私部門的員工與投資人都接受海洋素養訓練。 到2030年，海洋永續確實納入業務規劃與營運中，包括策略規劃和環境實務與政策。 到2030年，全球企業將強化海洋永續與藍色經濟的行動，並將其納入到他們的營運當中，包括研發、產品與服務、投資與報告。 到2025年，企業之間及／或企業與非營利組織之間將建立並加強合作關係，以強化海洋永續。 	<ul style="list-style-type: none"> 安排員工、客戶與供應商的海洋永續與藍色經濟訓練計畫。 投資於以海洋創新、技術、永續與社會企業為主的育成中心。 訂定在海洋科學與保育方面能賦予婦女和女孩權力的計畫。 訂定以學校為基礎的計畫，以增強能力建構並培養下一代海洋專業人員。 為具備海洋素養的企業引入認證方案，以證明其對海洋保育永續的承諾。 	<ul style="list-style-type: none"> • C2 • C3 • C4
提高社區參與海洋素養	<ul style="list-style-type: none"> 到2025年，將在地方層級上建立並執行多方利益相關者網絡與合作，以促進海洋議題的永續活動。 到2025年，在海洋素養工作上，有越來越多人認可並融入原住民與地方知識。 到2030年，全球各地的社區法規、政策與治理架構都將建立海洋素養。 到2030年，沿海和非沿海社區成員有更多機會接受教育並參與海洋永續活動。 	<ul style="list-style-type: none"> 互動式的海洋素養推廣措施，諸如展覽或電影放映。 以海洋為主題的公眾覺醒運動。 公民海洋科學計畫，讓民眾可參與「海洋科學十年」。 科學家與社會成員間的知識交流與轉移，包括原住民族群、教育組織、政府等等。 媒體與新聞工作者的訓練計畫。 	<ul style="list-style-type: none"> • C2 • C3 • C4 • C5

資料來源／[2]

海洋素養行動的支持系統

「海洋科學十年」行動是倡議也是創舉，將由廣泛的利益相關者來實行，以達成目標與挑戰，包括海洋素養倡議，將由廣大的行動者提出並執行，這些行動者包括研究機構、政府、聯合國實體、政府間組織、國際與區域組織、企業與產業、慈善與企業基金會、非政府組織、教育人士、社區團體和個人（如透過社區主導的海洋科學倡議行動）。提升海洋素養行動的資金支持的方式，有3個主要機制：

- 一、直接資助「海洋科學十年」行動與協調費用，例如透過實物支持或會員國的捐贈。
- 二、透過「海洋科學十年」聯盟資助，將是「海洋科學十年」資源調動工作的關鍵要素，側重重要的自願資源承諾。「海洋科學十年」聯盟並非資助或贈款機構，它是一個串連大型資源提供者與「海洋科學十年」行動倡議者的參與平臺。
- 三、由合作夥伴主導的資助或贈款機制。透過此機制，本身有贈款能力的獨立實體（例如慈善基金會、非政府組織或政府實體）可表達動員資源支持「海洋科學十年」行動的意願，並主動提出擔任動員其他捐贈者財務捐助的樞紐。

結論

「海洋科學十年」旨在推廣參與性和跨領域的科學理念，透過海洋素養行動與活動，所有利益相關者不僅有能力更完整的瞭解海洋知識與永續，也能成為廣大研究族群中積極的成員。一個對海洋有全方位瞭解的社會，將能更深刻的體會海洋知識的價值，並知道如何將其融合以促進行動和永續的海洋實務產生。

一、讓海洋素養成為制定教育政策的主流

教育政策能管理同時彰顯正規與非制式教育制度的運作，儘管環境與永續發展相關的教育政策在全球正逐步增加，但這些議程仍需進一步強化具體的海洋教育議題。希望提供決策者充分的資訊，協助制定出促進海洋素養發展教育政策。

二、強化海洋素養的正規教育

海洋素養正規教育，主在培育學生海洋科學與海洋永續的知識、態度與行為，社會對於海洋和海洋永續的觀念往往相對薄弱，透過跨領域及全方位的課程規劃，海洋素養可被納入課堂與科目，藉由培養因地制宜的能力和動手學習與探究學習，海洋素養可以強化批判性的思維，問題解決與領導的能力以及其他重要的教育成果。

三、動員企業採取海洋素養行動

在實現「海洋科學十年」與更廣泛的永續發展議題上，企業可發揮更具影響力的行動，海洋素養對企業而言，意謂著能更瞭解海洋與各種經濟領域之間的關係，並能將這種瞭解轉化為負責任的行動，同時解決或減緩氣候危機等迫切問題。不論是大型或小型企業，都因其上市策略及由此衍生的商業實務、投資、產品與服務、宣傳、行銷傳播與慈善活動而塑造並影響環境面與社經面的政策、投資、行為與態度。

四、提高社區參與海洋素養

非制式的教育做法包羅萬象，從日常生活中的在家學習到社區行動倡議等，以促進民衆對於海洋及環境能夠做出有根據且負責任的決定，守護海洋、永續發展，創造更多機會讓廣泛的利益相關者參與。

「海洋科學十年」的推動著重海洋素養的施行，制定教育政策、善盡企業社會責任、規劃正規教育課程及提高社區參與等行動改革，由上而下的發揮縱向、橫向的普及參與，全面性整體發展，將是未來10年的成功關鍵及發展目標。

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

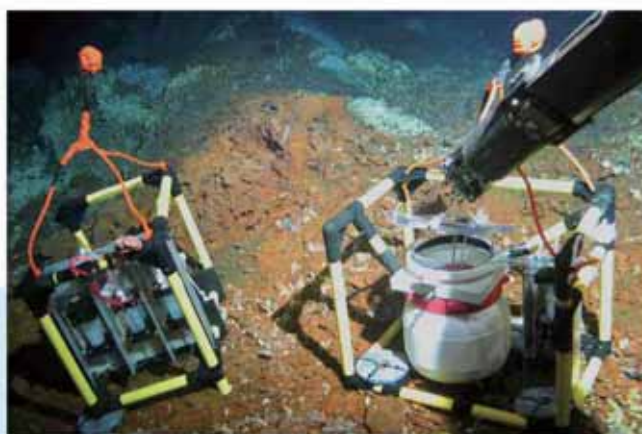
Translated by Linguitronics

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	<ul style="list-style-type: none"> ● 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	<ul style="list-style-type: none"> ● 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	<ul style="list-style-type: none"> ● 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	<ul style="list-style-type: none"> ● 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		
	<ul style="list-style-type: none"> ● From hook to plate - driving sustainability across supply chains ● Protecting small-scale fisheries ● Tools for trust and transparency 		
Aquaculture	<ul style="list-style-type: none"> ● 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)

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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.

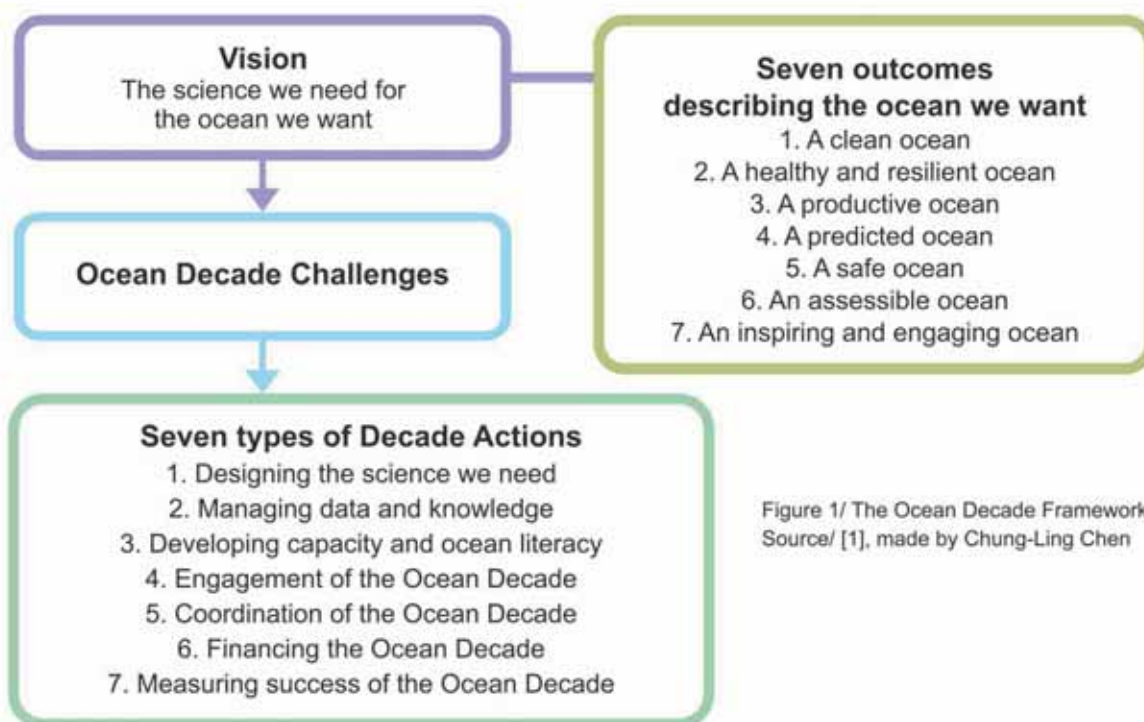


Figure 1/ The Ocean Decade Framework
Source/ [1], made by Chung-Ling Chen

- 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

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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.

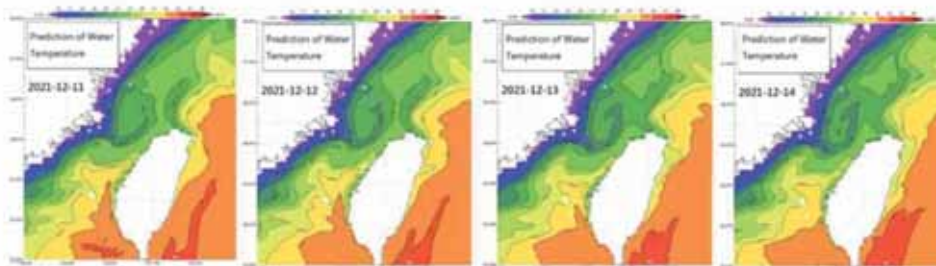


Figure 3/ Satellite Sea Surface Temperature Charts around Taiwan
Source/ <https://www.tfrin.gov.tw/News.aspx?n=4229&sms=9038>

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.

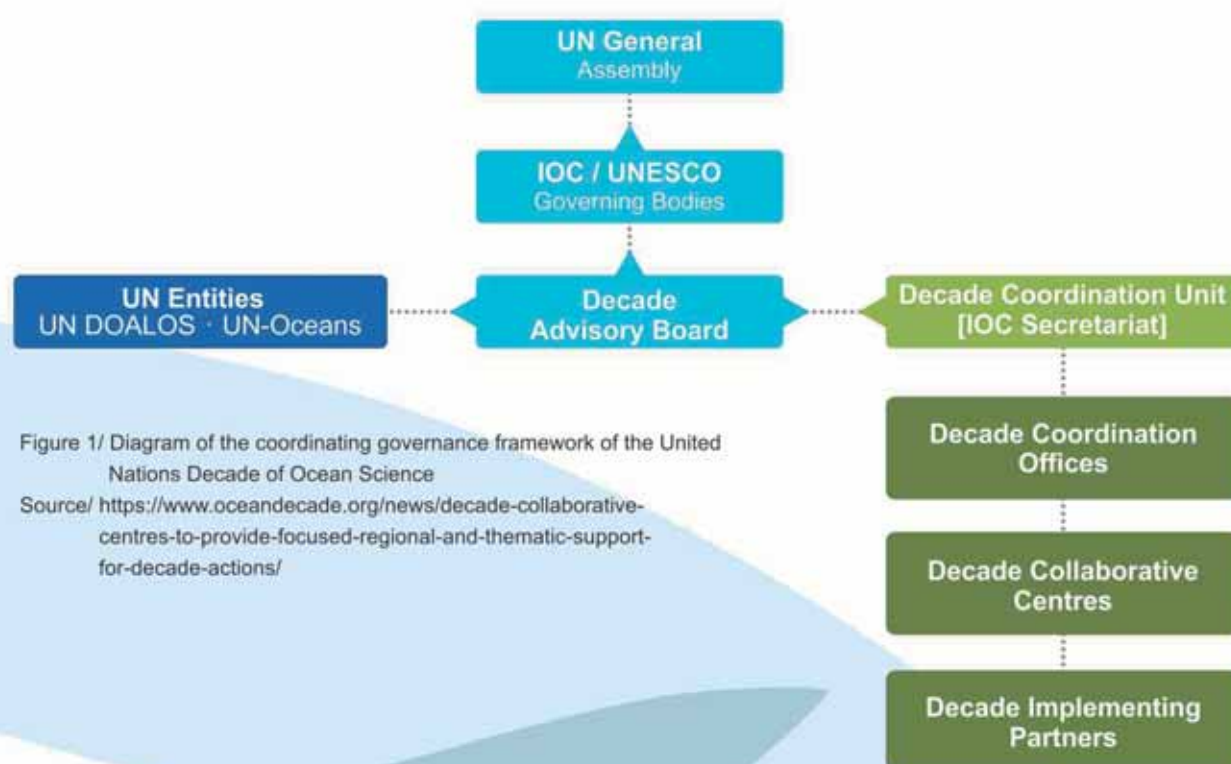


Figure 1/ Diagram of the coordinating governance framework of the United Nations Decade of Ocean Science

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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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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Keywords: United Nations Decade of Ocean Science for Sustainable Development, Decade of Ocean Science, Ocean Literacy

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.

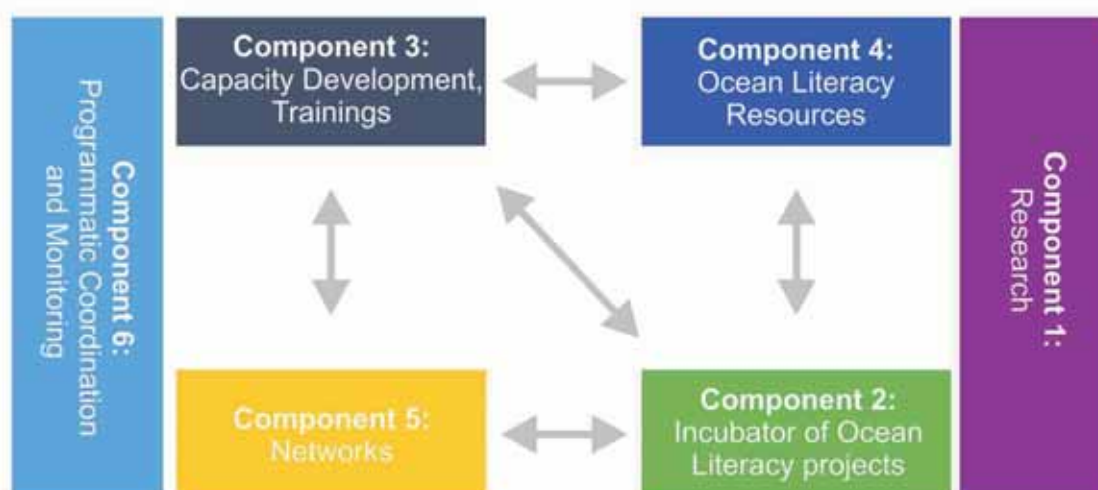


Figure 1/ Explanation of the main elements of the "Ocean Decade - Ocean Literacy Programme"

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	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> • C5 • C3
Enhancing Formal Education	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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). 	<ul style="list-style-type: none"> • C3 • C4 • C5
Mobilizing Corporate Action	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> • C2 • C3 • C4
Increasing Community Engagement	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> • 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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