

HIGHER EDUCATION AND SDG14

PRAISE FOR *HIGHER EDUCATION AND SDG14*

‘[This] is an ambitious series and I am especially interested to know that attention will be paid to SDG14, “Life Below Water”, dealing with a vital part of our planet that calls for urgent support. The book in question will clearly make a valuable contribution to our understanding of what needs to be done.’

‘As the Series Editor, Professor Purcell points out that higher education is well placed to drive the agenda forward. In my own research and advocacy, I have always emphasised the importance of harnessing the skills, knowledge and energy that young people can bring to the campaign. Delivering this crucial goal for the ocean requires action at all levels, through small organisations as well as large. We cannot simply wait for national governments and international bodies to take a lead.’

James Alix Michel, Former President of the Republic of Seychelles and Chairman of the James Michel Foundation

HIGHER EDUCATION AND THE SUSTAINABLE DEVELOPMENT GOALS

Series Editor

Wendy Purcell

Emeritus Professor and University President Emerita, and Academic Research Scholar with Harvard University

About the Series

Higher Education and the Sustainable Development Goals is a series of 17 books that address each of the SDGs in turn specifically through the lens of higher education. Adopting a solutions-based approach, each book focuses on how higher education is advancing delivery of sustainable development and the United Nations global goals.

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Higher Education and the Sustainable Development Goals

HIGHER EDUCATION AND SDG14

Life Below Water

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Malaysia – China

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INVESTOR IN PEOPLE

CONTENTS

<i>Preface</i>	ix
1 Sustainable Development Goal 14 in the 2020s and Beyond <i>Simon J. Davies and Paul Robert van der Heijden</i>	1
2 Assessment of River Quality for Aquatic Life: A South England Case Study <i>Vera Cirinà</i>	11
3 Impact Assessment of a Subsea Tidal Generator on Biodiversity <i>Matt Elliott Bell</i>	35
4 Sustainable Coastal Defense Concords with Life Below Water <i>Martin J. Baptist</i>	59
5 Seaweeds from an Italian Coastal Lagoon: From 'Waste Material' to Commercially Valuable Marine Resources <i>Caterina Pezzola</i>	79
6 Contribution of Biotechnology-Based Valorisation of Forestry By-products to Achieving SDG14 <i>Dominic Duncan Mensah, Jeleel Opeyemi Agboola, Liv Torunn Mydland and Margareth Øverland</i>	97
7 Marine Protected Areas, Coastal and Marine Management <i>Chris de Blok and Richard Page</i>	113
8 Aquaculture Teaching and Research in Higher Education to Advance a Sustainable Industry <i>James Logan Sibley and Matt Elliott Bell</i>	133

9	Realising Sustainable Development: Harmonising People, Planet and Profit in Large-Scale Development Projects <i>Davy van Doren</i>	151
10	Knowledge Hierarchies in Policy-Level Translations of SDG 14: Insights from Human–Salinity Relations in South India and Vietnam <i>Richard Pompoes</i>	171
	<i>About the Editors</i>	191
	<i>About the Contributors</i>	193

PREFACE

Professor Wendy Purcell, PhD FRSA

Higher education (HE) makes an important contribution to the delivery of the Sustainable Development Goals (SDGs). Through high-quality teaching and learning, HE supports the development of responsible citizens as scholars, leaders, entrepreneurs, and professionals. Universities and colleges undertake curiosity-driven and socially impactful research to help advance knowledge frontiers and find solutions for the world's most pressing issues. HE is also active in civic and community settings, often as anchor institutions. Nevertheless, given the fierce urgency of (un)sustainable development, the climate crisis, and widening inequity within countries and across the globe, HE needs to do more and go faster. For HE to deliver fully against the SDGs, it needs to adapt to this shared global agenda and embrace transformative change.

This book series focuses on the role of HE in advancing the SDGs, identifying some successes to date and pointing to opportunities ahead. In sharing the ways and means universities and colleges across the world are engaging with the SDGs, the series seeks to both inspire and enable those in the HE sector and stakeholders beyond to transform what they do and how they do it and hasten progress towards Agenda 2030. Insights gleaned from relevant case studies, innovations, reflective accounts, and student stories can help the HE sector both deepen and accelerate its engagement with the SDGs. Each book seeks to capture examples of how HE institutions (HEIs) are fulfilling the delivery of their academic mission *and* progressing the SDG concerned. Illustrating the work of students, that is undertaken by faculty and staff of the institution and conducted with others, positions HE as a change agent operating at a systems level to help create a world that leaves no one behind.

Taking up this global challenge, SDG14 'Life Below Water' calls on us to 'conserve and sustainably use the oceans, seas, and marine

resources for sustainable development', and thereby safeguard the planet's largest ecosystem. Healthy oceans and seas are essential to life, supplying food, energy, water, and supporting employment. However, ocean warming, acidification, over-fishing, algal blooms, biodiversity loss, and plastic pollution represent an ocean emergency and pose a threat to health and wellbeing. HE is at the forefront of science and education to help tackle these issues. Bringing key assets of curiosity and the pursuit of knowledge and its application to partners seeking solutions and driving innovation, universities, and colleges operate in global networks. Helping realise human potential connects the worlds of learning, work, and entrepreneurship in support of more inclusive economic growth. As place-makers, HEIs can use their convening power to draw stakeholders around a problem in support of the adaptive change needed to tackle the challenges of sustainable development.

This book on HE and SDG14 highlights the work of universities and colleges on sustaining life below water with examples drawn from research, knowledge sharing, and the activities of talented students and faculty. Several chapters reflect on the transformational experience of education, fuelling the desire to explore and discover through research and scholarship, and how personal passions related to the sea-shaped lives and careers. Some of the student stories capture the importance of science in action and being involved in projects that have real-world impact, with student mobility a source of innovation. The book includes examples of HE's work on nature-based solutions, sustainable aquaculture, and building with nature. The wonder of our oceans and the fragility of our relationship with life below water comes through the cases and reflects the dynamic tension between conservation and stewardship on the one hand and development and growth on the other.

The health of people, planet, and shared prosperity rely upon the full participation of HE with universities and colleges in turn needing to pursue greater engagement with the SDGs. As organisations that have stood for many centuries in some cases, this demands that they adapt to new models of learning, research partnerships, and leadership and governance frameworks to accelerate progress on delivering the SDGs. Immersive engagement with the SDGs can

catalyse pedagogic innovation, serve to refresh curricula, and stimulate new programme development. It can also open new avenues for research, attract new sources of funding and energise people to deliver on the academic mission. Sustainability is a goal for today and sustainable development is an organising principle. HEIs can play a critical role in developing new systemic and transformative solutions through interdisciplinary and multi-stakeholder collaboration and a purposeful focus on the SDGs. This book illustrates this approach as it relates to HE and SDG14.

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SUSTAINABLE DEVELOPMENT GOAL 14 IN THE 2020s AND BEYOND

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ABSTRACT

The chapter provides an overview of the book and addresses the rationale for the selection of cases reflecting teaching and research in major areas of SDG14. For example, the impact of increasing global sea temperature, ocean acidification, and pollution on aquatic life and biosciences. Fisheries and aquaculture for seafood and marine ingredients and marine protected areas (MPAs) that favour the assemblage of fish, crustaceans, alga, coral, and mussels to enhance and stimulate biodiversity. New products derived from marine biotechnology are viewed to conserve and sustainably use the seas and oceans whilst promoting wealth creation and employment. Marine parks allow scientists to better study the marine environment and explore sustainable balances between tourism, work, and recreation in harmony with the Life Below Water – SDG14 mandate. Finally,

the aspects of governance and roles of stakeholders and societal involvement are advocated in achieving the safe and effective use of marine resources. Throughout, the role of higher education in providing educated scientists and multidisciplinary specialists for future generations to come is highlighted.

Keywords: SDG14; climate change; ocean acidification; fisheries and aquaculture; pollution; offshore energy; biotechnology; governance; higher education

INTRODUCTION

In the first quarter of the 21st century, we witness global climate threats and pollution events. These consist of toxic chemical agents, plastics, and micro/nano plastics, as well as atmospheric rises in carbon dioxide (CO₂), elevating global temperature and leading towards ocean acidification (Hoegh-Guldberg et al., 2017), both tropical and cold-water corals. Almost half of the world's coral reefs have been lost or severely eroded. Scientists predict that all corals will suffer by 2050 and that 75% could face critical threat levels (Eddy et al., 2021). The extensive impact of overfishing worldwide is a fact, with notable consequences for the food chain and associated biodiversity. The Monaco Blue Foundation (as stated in the Monaco Blue Initiative report 2023) has been instrumental for decades in advocating conservation strategies. Life Below Water has clear anthropogenic connections with the global population expected to reach 9.7 billion by 2050 (UN, 2022). Higher education plays a critical role in addressing many important areas and the following topics serve as examples to be highlighted in successive chapters.

Increased Temperatures

Global climate change associated with rising CO₂ and methane emissions is a high priority. Warming oceans cause significant effects on the life cycle of organisms such as phytoplankton and zooplankton. Disruption of the breeding behaviour of pelagic fish species may extend to invertebrates such as *coelenterates* (jellyfish,

corals, and sea anemones) and *mollusks* (e.g. mussels, clams, squid, cuttlefish, octopus). There are also noticeable effects on our fisheries and seafood economy, as described by [Hollowed et al. \(2013\)](#).

Ocean Acidification and Marine Pollution

The 2023 estimate is that nearly 15% of coral reefs have been damaged and impaired over the last decade ([UN, 2021](#)). Between 2009 and 2018, the continuous rise in sea temperature has resulted in a loss of 14% of coral reefs – greater than the size of Australia’s reefs combined ([UN, 2021](#)). There is increased research motivation to include biology and chemistry on the effects of ocean acidification on marine and aquatic fauna. Anthropogenic activities are the primary causes of toxic marine and aquatic pollutants, leading to significant disruption to life below water. Run-off from the land because of herbicides, fertilisers, and industrial chemicals used in the manufacture of products such as paints, pharmaceuticals, flame retardants, (PCB) plasticisers, oils, and heavy metals such as catalysts in the steel industry have been prime areas of concerns ([Hatje et al., 2022](#)).

Fisheries and Aquaculture

Aquaculture can provide a source of protein for human consumption, meeting the growing demand for seafood and reducing the pressure on wild fish populations. By providing an alternative source of seafood, aquaculture can help to reduce the demand for wild-caught fish, which can help support sustainable fishing practices and protect marine ecosystems ([Naylor et al., 2021](#)). However, marine ingredient allocation in the context of empirical net aquaculture biomass production of fish and shrimp from marine resources (Fish In: Fish Out [FIFO] ratio) was comprehensively evaluated by [Kok et al. \(2020\)](#). Sustainable and responsible fisheries minimise negative impacts on the environment and maximise the social and economic benefits to local communities. [Haas et al. \(2019\)](#) provided an insight into how large-scale commercial fishing operations, with a focus on the harvest industry, can articulate with

the seven primary targets of SDG14, providing specific examples for several of the targets (REF to SDG14 targets needed). Four key fisheries areas meeting SDG14 targets are presented in [Table 1](#).

Offshore Energy Generation

Wave energy systems are typically located away from sensitive coastal habitats and wind farms can be sited in areas with low biodiversity to minimise their impact, thus reducing the need for coastal development and habitat destruction. The progress and achievements of wave energy development in the UK towards achieving net zero for the UK industry by 2030 are reviewed and described by [Jin and Greaves \(2021\)](#). This may stimulate local economies and support sustainable development in coastal communities. Wind farms are good for fisheries as they will create no-take areas that may work as pseudo-protected areas and favour the aggregation of organisms like algae, corals, and mussels, creating a suitable environment that attracts fish ([Michler-Cieluch and Kodeih, 2008](#)).

Table 1. The Sustainable Fisheries Agenda for Meeting SDG14.

Protecting marine ecosystems	By adopting sustainable fishing practices, such as using selective fishing gear and setting catch limits, responsible fisheries can help to protect marine ecosystems and preserve the diversity of marine life.
Responsible fisheries	Responsible fisheries can provide a sustainable source of food for human consumption, helping to meet the growing demand for seafood in a way that does not harm the environment.
Providing economic benefits	Responsible fisheries can benefit local communities economically, particularly in coastal areas where fishing is an essential source of livelihood.
Promoting sustainable development	By adopting sustainable and responsible practices, fisheries can contribute to the overall goal of SDG14 to conserve and sustainably use marine resources for sustainable development.

Importance of Marine Biotechnology

Marine biotechnology refers to using marine resources, such as microorganisms, plants, animals, and other marine-derived natural materials, to develop products and technologies that benefit society, as recently defined by [Rotter et al. \(2021\)](#). Marine biotechnology has the potential to support SDG14, which aims to conserve and sustainably use the oceans for sustainable development.

Marine Protected Areas

Marine parks are areas of the ocean set aside for protecting and conserving marine life and ecosystems, which was described in scientific terms as a primary mechanism for the guardianship and restoration of marine ecosystems by [Turnbull et al. \(2021\)](#). As [Davies \(2023\)](#) stated recently, they can play crucial roles in the conservation of the environment, including protecting a wide range of marine species and habitats, helping to stimulate and enhance the diversity of life in the ocean. Marine parks serve as a place for scientists to research marine life and ecosystems, which helps inform conservation efforts and can benefit local communities economically through tourism and recreation.

Governance and Societal Involvement

Effective governance is essential for coordinating and aligning the efforts of various stakeholders, including governments, businesses, non-governmental organisations (NGOs), and local communities, to achieve SDG14. This can involve setting targets and indicators to measure progress, and providing resources and support for implementation, as explained by [Haward and Haas \(2021\)](#). It is essential to characterise projected changes in the scale and size of the ocean economy and the part that observations, measurements, and forecasts contribute towards supporting the safe, effective, and equitable use of the ocean's resources ([Rayner et al., 2019](#)). [Sumaila et al. \(2021\)](#) provided a strategic assessment of financing a sustainable ocean economy.

THE ROLE OF HIGHER EDUCATION

Higher education institutions can offer courses that focus specifically on marine biology, oceanography, and other disciplines related to studying Life Below Water. They can also support and conduct research on issues related to SDG14, such as the impacts of climate change on marine ecosystems or the management and conservation of marine resources. These programmes can provide students with the knowledge and skills needed to understand the complex relationships between humans and the ocean whilst appreciating the challenges and opportunities ahead.

Here, the role of higher education in helping to meet the targets of SDG14 is presented as case studies that show how the sector provides opportunities and enrichment for students and researchers to highlight their originality, enterprise, and innovation. We have endeavoured in our selection to present interesting and timely work in leading universities and colleges that can be amplified by others. These examples reflect the current contribution of universities and colleges to SDG14 and signal where more progress can be made. The chapters are carefully sequenced to provide a logical flow from the riverine to coastal areas transitioning to our seas and ocean environment providing a comprehensive journey.

We commence with an assessment of water quality criteria within a river system in Southwest England, with significance to aquatic life and biodiversity. Vera Cirina, a student in the UK evaluates anthropogenic activities with an emphasis on the catchment of Nitrogen and metals on water quality by efficient monitoring to build a model. Her report includes recommendations and mitigation strategies needed to improve the environmental quality of the system.

Matt Bell, a Marine Biology and Oceanography student from the UK describes his work on surveying the local marine biodiversity in the possible preparation of the installation of a subsea tidal generator in Southwest England. He depicts how underwater marine engineering for renewable energy schemes served as the basis for a full diving and technical experience, as part of his assignment to assess various potential factors and criteria that may affect the benthos fauna.

Martin Baptist from the Netherlands examines challenges in safeguarding its low-lying coastline against rising sea levels and the consequences of coastal defence strategies on marine life, particularly in relation to SDG14. The use of hard structures for coastal protection contributes to the loss of natural coastal habitats, raising biodiversity concerns.

Caterina Pezzola from Italy describes the vital importance of seaweeds in marine ecology and algal bloom issues in Tuscany. Re-purposing the biomass to produce seaweed-derived commercial goods would provide benefits for the environment and local economic activities while promoting a sustainable business within a circular bio-economy framework.

Dominic Duncan Mensah (PhD student) from Ghana and with colleagues from his university in Norway explored a group of highly promising emerging novel ingredients known as microbial ingredients (MIs), means of producing them, and how they can help achieve sustainable aquaculture and SDG14 targets. This chapter interestingly connects Life on Land SDG15 with SDG14 showing overlap and synergy offering novel solutions and bioeconomical considerations.

Richard Page, an academic from the USA based in the Pacific Island State of Palau and college student Chris de Blok present a case study of Palau, one of the first countries to use marine protected areas (MPAs) as a tool to develop biodiversity within its Exclusive Economic Zone (EEZ). Pacific MPAs impact on ecosystems and fisheries are compared with European MPAs, with examples such as wind turbine arrays, artificial reefs, and ecosystem and fisheries impacts.

An overview of Sustainable Development Goal 14 in relation to aquaculture and fisheries is given by American, James Sibley from Boston, Massachusetts with contributions from Matt Bell and Simon J. Davies. They address feed from sustainable sources and highlight advances in marine biotechnology and molecular genomics to produce healthy viable farmed ocean fish like Atlantic salmon. Aquaculture is a major seafood contributor and Sibley brings this into focus.

Davy van Doren of MatureDevelopment (Voorburg, the Netherlands) provides an insight into the higher education basis for his

work on Building with Nature – an initiative towards sustainable hydraulic engineering. This chapter assesses how issues in relation to nature conservation and social wellbeing are being addressed in practice and their effectiveness on voluntary green behavioural and operational changes, particularly in relation to challenges and benefits associated to the enforcement of corporate responsibility. This was mainly a case study situated in Abu Dhabi, and the construction of Khalifa Port, UAE.

Finally, Richard Pompoes a doctoral student from Germany and the Netherlands examines how diverse actors in the Cauvery Delta, India, and the Mekong Delta, Vietnam, understand and live with water salinity. This chapter addresses some of the SDG14 targets, i.e. SDG14.2 ('Protect and restore ecosystems') and 14.5 ('Conserve coastal and marine areas') with changing delta profiles and the effects on local stakeholders and societal involvement. It includes how his research articulates teaching and student interactions and learning outcomes integral to SDG14.

We can be optimistic for the future of how we can preserve and protect our aquatic and marine bioresources via our younger educators and scientists and their efforts to pass on this message to future generations. This book and its constituent chapters not only give prominence to a selection of topics but also serve as a platform for successive generations in Higher Education to lead and uphold such values as stewardship, ownership, and entrepreneurship to value our planet's unique water ecosystem.

REFERENCES

Davies, S.J. 2023. Utilizing marine protected areas to support aquaculture operations, *International Aquafeed*, September Issue.

Eddy, T.D., Lam, V.W.Y., Reygondeau, G., Cisneros-Montemayor, A.M., Greer, K., Palomares, M.L.D., Bruno, J.F., Ota, Y. and Cheung, W.W.L. 2021. Global decline in capacity of coral reefs to provide ecosystem services, *One Earth*, 4(9), 1278–1285, ISSN 2590-3322. doi: 10.1016/j.oneear.2021.08.016

Haas, B., Fleming, A., Haward, M. and McGee, J. 2019. Big fishing: the role of the large-scale commercial fishing industry in achieving