OCEAN SUSTAINABILITY IN THE 21ST CENTURY

The world's oceans are an essential source of food and other resources, as well as providing an important means of transportation, trade, and recreation. Covering more than two thirds of the Earth's surface, our oceans are intricately linked to our climate system and require careful management to ensure their continued sustainability.

Describing the emerging and unresolved issues related to the oceans and the marine environment, this book presents the developments made in marine science and policy since the implementation of the United Nations Convention on the Law of the Sea (UNCLOS), and implications for the sustainable management of ocean areas and resources. This comprehensive volume also provides a number of scientific, policy, and legal tools to address such issues, and to ensure better science-based management of the oceans. Topics covered include the impacts of human-induced climate change on the oceans, the marine genetic resources debate, the current legal framework for the oceans, and a comparative study of the legal issues associated with outer space.

Including practical examples and worldwide case studies, this book is a valuable resource for policy makers, students, and academics, in marine science and policy, ocean affairs, and the law of the sea.

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Contents

List of contributors *page* vii
Acronyms and abbreviations xi
Foreword by Irina Bokova, Director-General of UNESCO xvii
Foreword by Thomas E. Lovejoy xix
Preface xxiii
Acknowledgements xxvii

1 Issues regarding oceans and opportunities: an introduction to the book 1
SALVATORE ARICÒ

2 Main human uses of ocean areas and resources, impacts, and multiple scales of governance 21
MARJO VIERROS, U. RASHID SUMAILA, AND ROLPH A. PAYET

3 Physical and chemical changes in the ocean over basin-wide zones and decadal or longer time-scales: perspectives on current and future conditions 54
GUNNAR KULLENBERG, EDDY CARMACK, AND KENNETH DENMAN

4 Knowledge and implications of global change in the oceans for biology, ecology, and ecosystem services 84
ROBERTO DANOVARO, CRISTINA GAMBI, AND CINZIA CORINALDESI

5 A new perspective on changing Arctic marine ecosystems: panarchy adaptive cycles in pan-Arctic spatial and temporal scales 109
HENRY P. HUNTINGTON, EDDY CARMACK, PAUL WASSMANN, FRANCIS WIESE, EVA LEU, AND ROLF GRADINGER

6 Ecosystem approach and ocean management 127
MARIO VIERROS, IAN D. CRESSWELL, PETER BRIDGEWATER, AND ANTHONY D. M. SMITH

7 Challenges in using valuation in ecosystem-based management in a marine context: the case of UK Marine Protected Area designation 146
S. SALMAN HUSSAIN

8 The contribution of international scientific cooperation and related institutions to effective governance for the oceans: the cases of regional tsunami early warning systems and the Argo project 174
STEFANO BELFIORE AND AURORA MATEOS

9 Emerging and unresolved issues: the example of marine genetic resources of areas beyond national jurisdiction 198
MARJO VIERROS, CHARLOTTE SALPIN, CLAUDIO CHIAROLLA, AND SALVATORE ARICÒ

10 The assumption that the United Nations Convention on the Law of the Sea is the legal framework for all activities taking place in the sea 232
TULLIO SCOVAZZI

11 The legal regime of outer space in light of the Law of the Sea 249
VIVIANA IAVICOLI

12 Towards sustainable oceans in the 21st century 275
SALVATORE ARICÒ, GUNNAR KULLENBERG, AND BILIANA CICIN-SAIN

Index 293
Colour plate section between pages 132 and 133

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Acronyms and abbreviations

ABE-LOS	Advisory Body of Experts on the Law of the Sea
ABNJ	Areas Beyond National Jurisdiction
ABS	Access and Benefit-Sharing
ACIA	Arctic Climate Impact Assessment
AFMA	Australian Fisheries Management Authority
Antigua Convention	Convention for the strengthening of the Inter-American Tropical Tuna Convention
APEC	Asia-Pacific Economic Cooperation
ATCM	Antarctic Treaty Consultative Meeting
Barcelona Convention	Convention for the protection of the marine environment and the coastal region of the Mediterranean
BAU	Business as usual
Cartagena Convention	Convention for the protection and development of the marine environment of the wider Caribbean region
CBA	Cost–benefit analysis
CBD	Convention on Biological Diversity
CBS	Convention on the conservation and management of pollock resources in the central Bering Sea
CCAMLR	Convention for the Conservation of Antarctic Marine Living Resources
CCN	Cloud condensation nuclei
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CEs	Choice experiments
CHM	Common heritage of mankind
CITES	Convention on International Trade in Endangered Species of wild fauna and flora
CLCS	Commission on the Limits of the Continental Shelf

CMS	Convention on Migratory Species of wild animals
CoC	International Code of Conduct for outer space activities
COFI	Committee on Fisheries of the Food and Agriculture Organization of the United Nations
COMEST	World Commission on the Ethics of Scientific Knowledge and Technology
COPUOS	Committee for Peaceful Uses of Outer Space
COSPAR	Committee on Space Research
CPR	Continuous plankton recorder
CPUCH	Convention on the Protection of the Underwater Cultural Heritage
CTBTO	Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization
CVM	Contingent valuation method
DHABs	Deep hypersaline anoxic basins
DIC	Dissolved inorganic carbon
DMS	Dimethyl sulfide
DSWC	Dense shelf water cascading
EAF	Ecosystem Approach to Fisheries
EBA	Ecosystem Based Approach
EBFM	Ecosystem Based Fisheries Management
EBM	Ecosystem Based Management
EBSAs	Ecologically and Biologically Significant Areas
EC	European Commission
EEZs	Exclusive Economic Zones
EIA	Environmental Impact Assessment
EPC	European Patent Convention
EPOCA	European Project on Ocean Acidification
FAO	Food and Agriculture Organization of the United Nations
GCOS	Global Climate Observing System
GCRMN	Global Coral Reef Monitoring Network
GEF	Global Environment Facility
GFCM	General Fisheries Commission for the Mediterranean
GHGs	Greenhouse gases
GLOSS	Global Sea Level Observing System
GMDSS	Global Maritime Distress Safety System
GOOS	Global Ocean Observing System
GPA	Global Programme of Action for the protection of the marine environment

GTOS	Global Terrestrial Observing System
GTS	Global Telecommunications System
HELCOM	Helsinki Commission
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Convention for the Conservation of Atlantic Tunas
ICG/CARIBE EWS	Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and adjacent regions
ICG/IOTWS	Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System
ICG/NEAMTWS	Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean, and connected seas
ICG/PTWS	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System
ICJ	International Court of Justice
ICM	Integrated Coastal Management
ICP (or UNICPOLOS)	United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea
ICSU	International Council for Science
ICZM	Integrated Coastal Zone Management
IDOE	International Decade of Ocean Exploration
IGBP	International Geosphere–Biosphere Programme
IGOS	Integrated Global Observing Strategy
IGY	International Geophysical Year
IHO	International Hydrographic Organization
IIOE	International Indian Ocean Expedition
IMCAM	Integrated Marine and Coastal Area Management
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange Programme
IOTC	Indian Ocean Tuna Commission
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPY	International Polar Year
ISBA (or ISA)	International Seabed Authority

ITIC	International Tsunami Information Center
ITLOS	International Tribunal for the Law of the Sea
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
ITSU	International Coordination Group for the Tsunami Warning System in the Pacific
ITU	International Telecommunications Union
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported, and Unregulated fishing
IWRM	Integrated Water Resources Management
JNCC	Joint Nature Conservation Committee
JRC	Joint Research Centre
Lima Convention	Convention for the protection of the marine environment and coastal area of the South-east Pacific
LMEs	Large Marine Ecosystems
LOMAs	Large Oceans Management Areas
London Convention	Convention on the prevention of marine pollution by dumping of wastes and other matter
LOS Convention (or UNCLOS)	United Nations Convention on the Law of the Sea
MA	Millennium Ecosystem Assessment
MARPOL 73/78	International convention for the prevention of pollution from ships
MCZs	Marine Conservation Zones
MPAs	Marine Protected Areas
MSP	Marine Spatial Planning
MSR	Marine Scientific Research (in the context of the United Nations Convention on the Law of the Sea)
NADW	North Atlantic Deep Water
NAFO	Convention on future multilateral cooperation in the North-west Atlantic fisheries
NAO	North Atlantic Oscillation
NASCO	North Atlantic Salmon Conservation Organization
NEAF	Convention on future multilateral cooperation in the North-east Atlantic Fisheries
NOAA	National Oceanic and Atmospheric Administration
Noumea Convention	Convention for the protection of the natural resources and environment of the South Pacific region
NPAFC	North Pacific Anadromous Fisheries Commission
NPGO	North Pacific Gyre Oscillation

NTWC	National Tsunami Warning Centres
OBIS	Ocean Biogeographic Information System
OCB	US Ocean Carbon and Biogeochemistry Program
OECD	Organisation for Economic Co-operation and Development
OMZs	Oxygen Minimum Zones
OSPAR	Convention for the protection of the marine environment of the North-east Atlantic
OST	Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (or Outer Space Treaty)
PDO	Pacific Decadal Oscillation
PEMSEA	Regional programme on building partnerships in environmental management for the seas of East Asia
PES	Payment for Ecosystem Services
PIC	Prior Informed Consent
POC	Particulate organic carbon
PSSAs	Particularly Sensitive Sea Areas
PTWS	Pacific Tsunami Warning System
RBM	River Basin Management
RFMOs/As	Regional Fisheries Management Organizations/ Arrangements
ROVs	Remotely Operated Vehicles
SACs	Special Areas of Conservation
SBSTTA	Subsidiary Body on Scientific, Technical and Technological Advice of the Convention on Biological Diversity
SDGs	Sustainable Development Goals
SEAFO	Convention on the conservation and management of fishery resources in the south-east Atlantic Ocean
SIDS	Small Island Developing States
SIOFA	Southern Indian Ocean Fisheries Agreement
SMTA	Standard Material Transfer Agreement of the International Treaty on Plant Genetic Resources for Food and Agriculture
SOLAS	International Convention for the Safety of Life at Sea
SPAMIs	Specially Protected Areas of Mediterranean Interest
SPAs	Special Protected Areas

SPRFMA	South Pacific Ocean Regional Fisheries Management Agreement
SST	Sea Surface Temperature
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total Economic Value
TOWS-WG	Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems
TRIPs Agreement	Trade Related Aspects of Intellectual Property Rights Agreement
TWS	Tsunami Warning System
UKOA	UK Ocean Acidification Research Programme
UNCLOS (or LOS Convention)	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
UNICPOLOS (or ICP)	United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea
UNU	United Nations University
VMEs	Vulnerable Marine Ecosystems
WCPFC	Convention on the conservation and management of the migratory fish stocks in the western and central Pacific Ocean
WHC	World Heritage Convention
WIPO	World Intellectual Property Organization
WMO	World Meteorological Organization
WTO	World Trade Organization
WTP	Willingness to pay

Foreword by Irina Bokova, Director-General of UNESCO

Our planet is mainly ocean, our survival depends on the ocean, and our capability to thrive in the future will depend on a healthy ocean.

We are the stewards of the world's ocean, and it is our moral obligation and responsibility to pass on a healthy ocean to future generations and to ensure that ocean benefits can be enjoyed by humanity as a whole in an equitable manner.

The ocean is essential to life and well-being. We need blue carbon to help store CO_2 emissions. We need blue economies to benefit from the enormous and diverse opportunities offered by the marine environment – from tourism, transportation, fishing and recreation, to communication, scientific research, as well as the commercial applications of scientific findings in health and industry. We need the ocean also to support peaceful exchanges between countries which share transboundary waters and resources, and as a basis for scientific cooperation and global trade.

In 2000, the world agreed on a set of visionary Millennium Development Goals, inspired by the lessons of the Declaration of Principles and Agenda 21, the Plan of Action of the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992. Much progress has been achieved across the world, but this is insufficient and uneven. As countries accelerate towards the deadline of 2015, we must shape a new global sustainable development agenda, with the ocean at its heart.

The stakes are high and time is against us. The climate system has already been significantly altered by human activities. During Earth's history, the ocean has ensured the planet's resilience against climate variability – it is still assisting us today, but there is a mismatch between the pace of human-driven carbon emissions and the ability of the ocean to respond to alterations of the climate system. The alarm bell is ringing – we must take immediate steps to allow the world ocean to continue acting as a life-support system.

Everywhere, there are signs that we are crossing the boundaries of the planet. This is evident in the depletion of the capacity of the ocean to provide food and fibre in the form of fish proteins and other proteins, as well as the decreased water quality and related impacts on seaweed farming. We see this in the increased acidity of the ocean, which leads to vulnerability and the eventual disappearance of coral species on which the livelihood systems of many coastal peoples and populations depend. The rise in sea level is having a direct impact on small island systems and coastal areas, as well as on human settlements all around the world. These are just a few signals of deep distress.

This context is a call to action – to protect and use sustainably the ocean areas beyond national jurisdiction and to cherish them through collective stewardship and also greater scientific research. We need to take steps today to ensure that a healthy and productive ocean can continue assisting people and economies to thrive around the globe.

Ocean science is essential for this. In 1960, states created the Intergovernmental Oceanographic Commission, entrusting UNESCO with the responsibility of hosting the Commission and assisting in its mission in relation to ocean observation and forecasting. The role of the Commission has included risk reduction, marine sciences and capacity-building, and it is extending to informing policy and reinforcing the science–policy interface. To respond to current challenges, I am convinced that we need a strong, dynamic, and effective Intergovernmental Oceanographic Commission, to help states to strengthen the sustainability of the ocean and to derive shared benefits from healthy and resilient marine ecosystems.

This is also why it is important to respect the spirit of the 1982 United Nations Convention on the Law of the Sea. This landmark convention is designed to provide a significant contribution to fostering peace, justice, and equitable development for all peoples, especially for developing countries most in need.

This book is an important contribution to UNESCO's commitment to support and the sharing of knowledge to ensure a healthy and productive world ocean for the benefit of all. I wish to thank all of the authors for their engagement with these tasks. This matters for every society, today and tomorrow, in the run-up to 2015 and well beyond.

Foreword by Thomas E. Lovejoy

Elizabeth Kolbert, in *Field Notes from a Catastrophe*, paints a vivid picture of an oceanographic sample of sea butterflies or pteropods (tiny snails with 'feet modified like little flapping wings to keep the animals from sinking in the water column'). Held overnight, by the morning the CO_2 exhaled by the tiny animals had rendered the seawater in the container sufficiently acid that it etched their shells. This was one of the first inklings of ocean acidification, now recognized as a major consequence of global change, and an indication of the sensitivity of the marine environment.

Picture if you will, a coral reef submerged in a pleasant tropical sea. It is a colourful blend of multiple stakeholders: the coral itself, the aquatic organisms that feed from it, their waste that adds in time to the cycle of life, and the local human communities which have relied on the reef's productivity from time immemorial. It lies in delicate balance, where the alteration of one of these aspects leads to the collapse of the system. Even a change in the composition of the water itself can bring the whole system down.

This picture is an appropriate metaphor for the complex environmental and ecological change that characterizes the oceans today. The future of the planet's oceans involves diverse constituencies, from indigenous fishermen to UN lawyers, global tourists, and developing world policy makers. If each of these actors were asked how they saw the ocean, their answers would be quite different. The chapters in this book illuminate our knowledge of the oceans today, while reflecting the aspirations and expectation of these diverse constituencies.

Although 'global warming' is but one element of 'global environmental change', the warming of the oceans is nonetheless important in its own right. The warming is pervasive and goes 2000 metres deep and yet deeper. There will be dramatic effects on moisture flux, nutrient supply, and climate variability. Thermal expansion of water, in addition to melting ice on land and glacier retreat

worldwide, will cause dramatic sea-level rise. About 600 million people live within 10 metres of sea level.

There will be drastic effects on ocean biodiversity as well. It appears that this has already caused a global fall of 6% in primary production. Were agricultural production to fall by a similar amount there would be instant alarm. This is similarly grave.

The impacts observed are the initial consequences of a 0.75 °C global increase. They pale in comparison with those that would ensue with a number of degrees Celcius increase, exacerbated by declining efficiency of carbon sinks and accelerating carbon–climate feedbacks.

Since 1950, the pH of the oceans has decreased by 0.1 pH unit (a logarithmic scale). This amounts to a 30% increase in acidity over a handful of decades. In contrast the oceans have been nurtured by the same 10,000 years of stable climate that brought forth human civilization.

In 2009 I had the honour of moderating the Expert Panel on Ocean Acidification in the New York UN Headquarters – an event that was organized by the UN Department of Economic and Social Affairs, the UN Division on Ocean Affairs and the Law of the Sea, and the UN foundation. Since 2009, the situation has, of course, only worsened and continues to do so with serious implications for the marine biota and for humanity.

The projected ocean acidification is not only higher than at any time in the last 120 million years, it is also increasing faster than anything documented over that time. It is accompanied by disruption of biogeochemical cycles, most notably that of nitrogen. Land run-off and nitrogen deposition from the air have the effect of nitrifying coastal and estuarine regions such as the Baltic Sea and the Gulf of Mexico. The consequent 'dead zones' have major deleterious effects on productivity and economic sustainability. Globally, they have doubled in number every decade for the past four decades.

Smaller and often forgotten organisms may seem trivial compared with such big issues. While pteropods may seem to be an evolutionary curiosity they constitute a critical base for food chains in northern oceans.

Mangroves in coastal and estuarine regions provide substantial ecosystem services. Their dense wall of biomass blocks storm surges and erosion of coasts, and blunts tsunamis. They are nurseries for fisheries, provide local communities with fishing hot-spots, and shelter countless organisms. They are also an important 'blue carbon' player in sequestering carbon. In spite of this, mangrove extent is expected to fall by 10 to 15% by 2100 (and has already fallen by 35% in the past 25 years, according to the Millennium Ecosystem Assessment).

Viewing Earth systems collectively, marine ecosystems can be shown to provide around two-thirds of ecosystem services globally. In addition to the obvious

bounty of seafood and other resources, which account for trillions of dollars every year in the global economy, the role of the ocean in climate regulation, biogeochemical modulation, transport, and communications provides a large underpinning contribution.

This volume makes a very good case for determining the economic and non-economic value of biodiversity-dependent ecosystem services at multiple scales. Without question, the cost of inaction would be much higher than adopting a long-term approach of economic investment in ecosystem restoration and maintenance of existing ecosystem services.

One of the main findings of the Third Global Biodiversity Outlook (GBO3) (presented in Nagoya, Japan, in 2010 under the auspices of the Convention on Biological Diversity) was that continued overfishing would damage marine ecosystems to the point of collapse of fish populations. UN Secretary-General Ban Ki-Moon put it forthrightly in GBO3: '... conserving biodiversity cannot be an afterthought once other objectives are addressed – it is the foundation on which many of these objectives are built'. Restoration of ecosystems is essential to bring such services back to full force and value.

This is more than good science. It involves communication, international relations, politics, and law (e.g. national jurisdictions). For example, questions of national legal rights to genetic resources from the deep seabed and the high seas are essential to resolving possible subsequent public–private sector transfer. This newly recognized global gene pool is likely to re-open the debate on the law of the sea. Some fresh ideas about the evolving legal framework of the oceans are discussed with respect to biodiversity/bioprospecting.

Nonetheless, operational oceanography and international scientific cooperation on ocean-related matters should proceed and not wait for the legal and policy framework to be sorted out. If we can measure the ocean's influence on weather, a common good indeed, why can we not agree on measures to deal with other such common goods?

This international cooperation requires the best of interdisciplinary and synergistic science. Such a process has led to improvements in effective tsunami detection and preparation. Perhaps lessons might be learned from the legal framework drawn up for outer space or for Antarctica of the value to management of the high seas and deep seabed.

The oceans cry out to be managed in a holistic manner, such as applying an ecosystem approach that is inherent in the Convention on Biological Diversity. Perhaps there is some value or inspiration in emerging theory such as *Panarchy* (as applied to the study of the Arctic system in Chapter 5 of this book). Tools such as marine spatial planning show that some solutions to problems of the oceans already exist.

This volume highlights urgent ocean issues derived from established and developing science, and then presents some possible international legal and policy frameworks which offer sound solutions. The contents are relevant to policy makers, students, the private sector, and, indeed, any stakeholder. Examples range from local to subregional to global. It discusses the reciprocal nature of the effect of climate change on the oceans and the biodiversity therein.

Humanity tends to think locally as well as in the very short term. In fact we are disturbing global systems and the way the planet actually works. Why should near future cost–benefit outweigh that of the distant future when we are discussing such large and long-term problems? The good news is that there is great potential for better management of the oceans and a more complete oceans policy for the Ocean Planet.

Thomas E. Lovejoy

Preface

Humans are generally conscious of the value of the world ocean: no ocean, no life; a thriving ocean, a thriving humankind. Yet, when it comes to acting in a sustainable manner in our relationship with the ocean, we are often at a loss; it appears that the scale and pace of human action do not match the pace and scale of ocean processes well enough for the two to counterbalance and act synergistically. It appears that, from a lack of consciousness about what is right and what should be done, we prefer not to act. And it also appears that because of shortsightedness in terms of the human print on the ocean environment and life therein – and really 'shortsightedness' is the word, because the ocean is often out of sight – we comfortably (or less comfortably) hide behind our incapacity to see fully and to understand how increasingly modified and degraded the world ocean is, and we hope that it will recover by itself.

The world's oceans cover approximately 71% of the planet's surface, with an estimated volume of 1,335 billion cubic kilometres (Eakins and Sharman, 2010).[1] It is difficult to grasp the meaning of such immense figures. Intuitively, however, we all realize that such a large surface and volume must contribute substantially to the Earth's climatic balance. We also now know that life in the oceans is present all the way from the surface to its deepest areas. Evolutionary biology has demonstrated that the oceans have played a major role in the origin and shaping of life on Earth. Over historical time, humans have always depended greatly on the oceans for food, health, transportation, trade, and recreation – among other uses (Independent World Commission on the Oceans, 1998;[2] cf. also Chapter 2 of this book). In turn, a healthy ocean cannot be without proper management in light of the fact that over seven billion humans live on the planet today. In today's globalized economy and in an era characterized by global climate change and a global biodiversity crisis, the interdependence of humans' survival and ocean health is stronger than ever.

What are the key processes in the ocean that we cannot afford to alter without altering our own chances of a sustainable future for humankind? In which direction is human dynamics evolving and what are its consequences for the world ocean? And how can we match, as best we can, our knowledge (as well as our ignorance) with the tools – scientific, observational, management, policy, normative, educational – which we have developed in our long-standing relation with the ocean? These are the main questions which this book attempts to tackle. And by addressing itself to a mixed constituency of decision and policy makers, specializing students, and expert practitioners from multiple sectors, this book attempts to provide solutions to these questions in an integrated manner.

Building on the active efforts of the scientific and policy communities over the past 20 years aimed at solving issues related to the implementation of the law of the sea regime since the enactment of the Convention on the Law of the Sea, in 1994, this book describes the main known, emerging, and unresolved issues related to the oceans and the marine environment in general with which we are faced today and are likely to be faced with in the near future.

This book also attempts to provide options, supported by a thorough rationale, for a better science-based management of the oceans, for taking into account other relevant knowledge than scientific knowledge, and for enhancing the relevance and effectiveness of the legal and policy regimes governing the oceans. In fact, while the oceans are facing multiple problems, we already have available to us now a number of relevant scientific, policy, and participatory tools to implement solutions and, thus, we can render the oceans sustainable in this century.

The book targets graduate and postgraduate university students, policy makers, private sector operators, and other non-governmental stakeholders active in the area of ocean affairs. The intention of this book is to provide them with a comprehensive overview of ocean-related issues today and to point them towards approaches and tools needed to tackle these issues. The choice of targeting multiple audiences is justified by the assumption that the problems faced by the oceans today are complex because they are multifold and interconnected in nature. A comprehensive book in this area must speak to all constituencies concerned with ocean-related issues. The book also aims at building bridges between such diverse stakeholders.

In fact, the sustainable development of the oceans can only be achieved through the collective and coordinated action of multiple stakeholders, based on a common understanding of the problems and of the possible solutions available to us. Some of these solutions also point to possible opportunities, both in terms of the sustainability of the world's oceans as part of the life-support system on Earth, and of new areas for research and development, green growth, and proper governance.

Throughout the book, a major effort has been made to provide a variety of perspectives in disciplines and to connect, whenever appropriate and possible, these disciplines. It is also the intention of this book to present a balanced perspective between theory and practice, and the reader will be able to refer to the many practical examples and case studies around the world that are bridging multiple scales (global, regional, national, and sub-national) in relation to the questions raised in the book.

Overall, the book endeavours to provide a reference work and, therefore, major effort has been concentrated on synthesizing information available in the already published peer-reviewed literature and providing the reader with a comprehensive bibliography for her or his perusal. The book also attempts to bring added value to existing literature in the area of the oceans by bringing new evidence, while relying on a more narrative style, and using the opportunity to articulate at length complex notions, as opposed to the more technically complex prose style that characterizes scientific journals. Whereas, in this context, it is unavoidable that some chapters may use more technical language than others, an overall effort has been made to keep the language relatively accessible, and highly technical remarks have been presented in the chapter endnotes whenever possible.

Each chapter in the book addresses a set of specific issues and can therefore be read as a stand-alone contribution for those interested in those issues; for example, the impacts of human-induced climate change on the oceans; the various dimensions of the marine genetic resources debate; or, the adequacy of the current legal and policy regime for the oceans. Depending on the reader's interest and background, these parts can be read in isolation, in that they represent coherent separate units (albeit interlinked) within the book.

The chapters in the book present the following elements for study and reflection: an introduction to the main issues and opportunities facing the oceans today; the main human uses of the oceans and consideration of the current governance framework; perspectives on changes in the oceans and implications of such change, seen from a physical, and from a biological and ecological perspective; a specific case in point of the implications of these changes as exemplified by the emergence of a new ocean in the current generation's life span: the Arctic; implementing the ecosystem approach in the oceans; an introduction to the use of integrated economic valuation for marine ecosystems; institutions and governance for the oceans from the perspective of the role of international scientific cooperation; the main dimensions of the issue of deep-sea genetic resources – scientific and legal – as an example of a no longer emerging and yet major unresolved issue at the policy level; a reflection on whether the current regime on the law of the sea should be seen as the legal framework for all activities in the sea; possible analogies between problems and solutions of the law of the sea regime and the legal regime of outer

space; and conclusions on possible ways forward so as to attain a more sustainable relationship of peoples with ocean areas and resources.

The editor's hope is that, ultimately, the contents of this book will assist in a concrete manner the process of decision-making related to ocean affairs at the international as well as multiple levels, with a view to agreeing on a bold agenda in relation to the contribution of the oceans to sustainable development.

Notes

1 Eakins, B.W. and Sharman, G.F. (2010). *Volumes of the World's Oceans from ETOPO1*. Boulder: NOAA National Geophysical Data Center.
2 Independent World Commission on the Oceans (1998). *The Ocean: Our Future*. Cambridge University Press, 248 pp.

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