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Part I

Introduction

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Climate Change at Sea

Interactions, Impacts, and Governance

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Introduction

Climate change is the greatest challenge facing humanity. But the challenge would be far greater where it is not for the role played by oceans and seas. This is because the oceans have restrained global warming. They have absorbed the vast majority of the heat in global warming and are the largest environmental storehouse or "sink" for the most consequential greenhouse gas (GHG) – humanity's carbon dioxide (CO_2) pollution. Without these buffering services provided by the oceans, global warming, and other manifestations of climate change would be vastly worse – for the atmosphere, for terrestrial ecosystems, and for societies. However, in performing these services, ocean ecosystems themselves are being severely undermined. Indeed, some of the most profound effects of climate change will occur beneath oceans, across seas, and along coastlines. These effects are already being manifested in rising ocean temperatures. As ocean waters warm and land ice melts, sea levels are rising and vast areas are being transformed. What is more, as CO_2 pollution is absorbed by the oceans, seawater is becoming more acidic. Marine biodiversity and ecosystems are suffering the effects. These and many other changes create enormous difficulties for communities that depend upon marine and coastal ecosystems for sustenance, economic wellbeing, and ways of life.

The environmental, social, and economic consequences of *oceanic change* – the changes to seas and oceans arising from broader climate change – present tremendous challenges for governments and other actors. Existing national and international institutions for marine governance, which were created when oceanic conditions were relatively stable and humanity's exploitation of the oceans were much less than they are today, may not be adequate for a future characterized by continuous oceanic change. The impacts of climate change on oceans and seas will have political implications at all levels – local, national, international, and global. Responses to oceanic change will result in winners and losers. This will require politically difficult choices. New and innovative policies for governing oceans and seas, and for managing vital marine resources, have never been more important.

The objective of this book is to explore and understand possibilities for *ocean governance amidst climate change*. We conceive of governance broadly as "a social function centered on efforts to steer societies or human groups away from collectively undesirable outcomes (e.g., the tragedy of the commons) and toward socially desirable outcomes (e.g., the maintenance of a benign climate system)" (Delmas and Young, 2009: 6). Governance is often performed by governments alone, but increasingly involves other actors ranging from international organizations to nongovernmental organizations (NGOs) and businesses. Sometimes those actors work completely independently of governments (Rosenau and Czempiel, 1992). To introduce the topic of climate change and ocean governance, some of the major connections between climate change and oceans (and seas) are briefly described in this chapter. The chapter then highlights some of the international responses to climate change, especially key agreements for climate governance. Finally the case studies presented in subsequent chapters are introduced and summarized.

Climate Change and Oceans: Interactions and Impacts

Science is central to understanding and responding to climate change. This volume is not about the science of climate change per se, so we leave a detailed examination of that to others (see, e.g., IPCC, 2013). However, each of the chapters that follows is necessarily informed by climate science. Similarly, while this volume is not about the science of oceanic change per se, nearly everything that is examined here is intimately connected to that science (see, e.g., IPCC, 2013: 361–484). Governance of the environment without science is impossible. This is not to say that other factors, such as values, preferences, capabilities, and political bargaining are not central to climate governance; rightly or wrongly, they can be more important than science. But to discount science in the governance process virtually assures that governance will fail. To be sure, there are still persons, including those in high office, who wish to deny the realities of climate science, presumably including what it tells us about the oceans. This denial of reality can have real-world consequences, as manifested in the policy decisions of the Trump Administration in the United States. At the time of this writing in 2018, it is working diligently to undermine American and global efforts to address climate change effectively, and indeed it is working equally diligently to shrink dramatically existing marine protected areas and to open up coastal and offshore areas for fossil fuel extraction (Friedman, 2018). These efforts will undermine, or at least delay, effective governance of climate change generally, and governance of oceanic change particularly. Ironically, such actions will make the actual science of climate change, and what it tells us about the future, all that more important.

Climate Change Science and Ocean Interactions

The science of climate change is not new. The idea that carbon emissions from human activities could warm Earth's atmosphere and lead to unnatural global warming was first hypothesized in the nineteenth century. However, it was only in the 1970s that the problem started to become prominent on an international agenda, and it took another decade before governments agreed to create a global organization to study it – the Intergovernmental Panel on Climate Change (IPCC). Since 1990, the IPCC has produced a number of reports examining the science of climate change and describing its causes, environmental impacts, and socioeconomic consequences (see, most recently, IPCC, 2013, 2014). As time has passed, the scientific understanding of climate change has increased markedly, as have the predictions of dire consequences. Indeed, the harmful consequences that were seen as relatively unlikely possibilities a quarter century ago are now viewed as virtual certainties. What is more, climate change has gone from being perceived as mostly a future problem to be avoided, to a problem that is being experienced today. As highlighted in a number of the chapters in this volume, the world is now getting a taste of things to come.

The primary causes and major consequences of climate change will be familiar to most readers of this volume. To recap, in simple terms, climate change involves long-term and large-scale anthropogenic change to Earth's climate system, including global warming – the "Greenhouse Effect" – and follow-on changes to other Earth systems. For our purposes, this includes unnatural changes in Earth's oceanic systems. Global warming and other manifestations of climate change are by-products of global CO_2 emissions produced during humanity's burning of fossil fuels – coal, oil, and natural gas – since the start of the Industrial Revolution more than two centuries ago, as well as emissions of other climate-effecting pollutants, often referred to as "greenhouse gases." These pollutants have a number of effects, among the most prominent for the oceans being ocean warming – a major aspect of *global* warming – and chemical reactions between CO_2 and seawater that lead to ocean acidification. These and other changes in oceans and seas associated with climate change are referred to here as oceanic change.

One cannot understate the importance of the oceans in the wider global *problematique* of climate change. Perhaps the most profound example of this is the role that the oceans play both as sinks for CO_2 pollution and for the global heat that results from that pollution. The oceans have absorbed at least one-third of the CO_2 emitted into the atmosphere since the Industrial Revolution (Khatiwala et al., 2013) and more than 90 percent of the heat resulting from humanity's CO_2 emissions (Wijjfels et al., 2016). However, the capacity of the oceans to absorb CO_2 pollution may decline and their ability to absorb the extra heat of global warming will have its limits. Indeed, it is possible that the oceans may switch from absorbing the heat of global warming to releasing that heat back into the atmosphere. This could happen on timescales that will have very real consequences for humanity (Tollefson, 2016).

In essence, the oceans have been a planetary dump for the much of the negative environmental externalities of global industrialization and modernization. If a stable global climate is what we value, then we owe an enormous debt of gratitude to the oceans. Without their role in mitigating climate change, and global warming in particular, environmental changes would be far greater and more rapid than they have been and will be in the future. However, much as every other environmental sink has its limits, the oceans will not be able to continue to buffer climate change forever. The impacts of climate change on the oceans themselves are profound. The consequences for societies will be – are already, in many places – equally profound.

Impacts of Oceanic Change

The effects of climate change at sea are probably as varied as the oceans themselves. Among the biggest effects are ocean warming, sea-level rise, and acidification. These effects have associated direct and indirect impacts that are of consequence to human societies. Ocean warming arises when oceans absorb the heat of global warming. Ocean warming is largely a function of ocean circulation among the sea surface and deep oceans, and among different regions via major currents. Worryingly, the ocean circulation that enables the transfer of heat from the atmosphere into the deep oceans may result in changes to those very circulation systems, with potentially paradoxical consequences, such as substantial cooling of Europe's climate (Struzik, 2017). Among the major consequences of ocean warming are mortality of coral reefs, typified by coral "bleaching" events (see Chapters 17 and 22). In combination with acidification and other environmental stressors such as river runoff containing agricultural pollution, warming seas have resulted in dramatic declines in corals in most areas where they traditionally thrive (Langlais et al., 2017). Just as dramatic are the consequences of ocean warming for the Arctic Ocean (see Chapters 12, 14, and 15). Warming there has resulted in radical reductions in the thickness and total area of ice coverage, with consequential major effects for Arctic marine ecosystems. What is more, reduced ice coverage is opening new areas of the Arctic to exploitation of oil, gas, and minerals, potentially exacerbating climate change still further. Frighteningly, warming in the Arctic could result in the release of seabed methane, substantially contributing to total global GHG emissions and creating a "positive feedback loop" to drive additional global warming (Wadhams, 2016).

A manifestation of oceanic change that is particularly evident to many people is that of sea-level rise (see especially Chapters 5, 8, and 18). As the oceans warm, they expand, resulting in some of the rise in sea levels that has already been experienced and will be much more so in the future. Furthermore, as oceans warm, they contribute to the melting of glaciers on land at the edge of the sea, thereby adding to sea-level rise. Rising seas are also a consequence of the melting of inland and mountain glaciers due to atmospheric warming. Estimates of sea-level rise are on the order of one meter or more by the end of this century, and potentially multiples of that in later centuries, with actual rises depending on location (see, for example, IPCC, 2013: 285–91; DeConto & Pollard, 2016). Roughly one-third of sea level rise is attributed to thermal expansion, with the remainder mostly the consequence of melting of glaciers and ice sheets on land (National Research Council, 2012: 33–53). Rising seas have myriad adverse consequences for coastlines and shallow seas (see the chapters in Part II). They inundate estuaries, which are vital nurseries for many fish and other marine species, and they can rise too quickly for coral reefs to adapt, in turn harming entire reef ecosystems.

Even if global warming were, by some cosmic intervention, to stop suddenly, the oceans and countless species that live within them would be threatened. That is because ocean acidification – the decrease in the pH of seawater resulting from absorption of CO_2 – is affecting seawater itself: the very chemistry of the oceans is undergoing quite a rapid change. Ocean acidification is contributing to coral bleaching and making survival difficult for other marine species dependent on calcification, such as many species of plankton and shellfish (Tynan, 2016). Ocean waters are changing in other ways as a consequence of climate change. For example, due to glacial runoff and intensified rain, salinity is undergoing significant change, affecting ocean ecosystems and circulation, thereby impacting the distribution of marine life and even weather phenomena (Balaguru et al., 2016; Lange and Marshall, 2017).

Taken together, oceanic change is already resulting in substantial deviations in marine species and habitats from longstanding historical norms. The impacts will be felt by people who live, often precariously, along coastlines, and by those who rely on vital resources from the sea. Rising seas are already major threats to some of the world's poorest countries, most obviously many vulnerable small-island states (see Chapters 8 and 18). Fish species are disappearing from their normal habitats, sometimes being lost altogether or migrating to new areas where regulatory protections are weaker (see the chapters in Part III). Other impacts include loss of inhabited areas along and near coasts, damage to infrastructure and loss of agricultural land to the sea, impacts from more powerful storms, and threats to coastal and high-seas fisheries (see the chapters in Parts II and III). Some island communities and entire nation-states face the existential threat of becoming uninhabitable within decades (Storlazzi, Elias, and Berkowitz, 2015). The chapters that follow explore these impacts in detail, in the process demonstrating the importance of climate change for the oceans and, in turn, the importance of oceanic change – and the importance of effective governance of it – for people and societies.

Climate Governance: Key Objectives and Agreements

Climate change has been on the global policy agenda for the better part of half a century. The climate change regime complex consists of formal international treaties, notably a framework convention and a protocol, associated nonbinding agreements, ongoing conference negotiations, and a variety of implementation mechanisms at regional, national, and local levels. Furthermore, the climate regime is intimately connected to, and arguably not complete without, agreements associated with other issues. For example, one major tool for reducing GHG pollution has been to use the Montreal Protocol on Substances that Deplete the Ozone Layer. The pollutants controlled by that agreement are powerful GHGs, so action in the context of the Montreal Protocol is effectively action on climate change. The climate regime also comprises commonly accepted overarching goals and standards. For example, it is now widely accepted by governments and most major industries that climate change demands action. Acceptance does not automatically translate into action, but it helps. This section briefly highlight some of the steps that have been taken internationally to craft the international regime for climate governance (see Harris, 2018, from which this section is adapted, for a more detailed description).

In response to concerns among scientists about the global implications of climate change, the United Nations Framework Convention on Climate Change (UNFCCC) was signed at the 1992 UN Conference on Environment and Development. The objective of the framework convention was the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC, 1992: art. 2). The UNFCCC called on the world's developed states to reduce their emissions of GHGs to 1990 levels by 2000. That "soft" objective – there were no real penalties for noncompliance – was not achieved. However, the agreement of the UNFCCC was the start of a decades-long series of negotiations to find ways to formulate international objectives and rules for addressing climate change. The first UNFCCC "Conference of The Parties" (COP) was held in 1995, with COPs soon becoming annual (or nearly so) international meetings of diplomats and others to debate and negotiate implementation of the framework convention.

At the first COP, held in Berlin, diplomats agreed that the principle of "common but differentiated responsibilities" ought to guide responses to climate change. According to this principle, all of the world's states have common responsibility for climate change, but the developed states have more responsibility to do so. At the 1996 second COP, diplomats called for a legally binding protocol to the UNFCCC that would have specific targets and timetables for limiting GHG pollution coming from developed states. Toward that end, the Kyoto Protocol was agreed at the third COP in 1997. The protocol required developed states to reduce their collective GHG emissions by 5.2 percent below 1990 levels by 2012. The Kyoto Protocol was designed to provide flexibility in implementing its objectives. However, much as they failed to do what they promised in the UNFCCC, many developed states did not do what the Kyoto Protocol demanded. One contentious issue among all states was whether the use of carbon sinks, such as planting forests and making other land-use changes to remove GHGs from the atmosphere, should be counted alongside concrete reductions in greenhouse emissions (see Chapter 22). The effectiveness of such an approach is still subject to debate.

Subsequent international climate negotiations have been tortuous. They have resulted in incremental steps toward action on climate change, but in the process they have highlighted recurring differences among states about how best to achieve the fundamental objective of the UNFCCC to "prevent dangerous anthropogenic interference with the climate system." Many states have been unwilling to accept internationally mandated cuts in their GHG pollution. As with most other international collective action problems (not least those associated with governing the oceans), states that are required to take action frequently try to avoid doing so if there are significant financial or political costs involved (see Harris, 2013). At the seventeenth COP in 2011, diplomats affirmed an informal objective of limiting global warming to less than 2°C above the pre-industrial norm. At the same time, however, they admitted that twice that much global warming was likely without new national commitments to cut global emissions of GHGs far more aggressively. By the time of the twentieth COP in 2014, the UN Environment Program was making it clear that *urgent* action was necessary to limit GHG emissions, specifically *halving* them almost immediately and eliminating them completely later this century (UNEP, 2014). The “top-down” approach of dealing with climate change, whereby GHG limitations were decided internationally, was not working.

A shift in the approach to climate governance was agreed at the 2015 Paris COP. In the Paris Agreement on climate change, governments accepted that overall climate objectives could be agreed internationally, but that the commitments of each state – how much each country should be required to cut or otherwise limit its GHG emissions – would be determined nationally – by individual states themselves (United Nations, 2016). Perhaps as a consequence, unlike in previous international agreements on climate change, in the Paris Agreement developing states agreed to join developed ones in limiting their GHG emissions. As part of the Paris Agreement, all states accepted the common objective of limiting global warming to less than 2°C, and they acknowledged that it would be preferable to go further and aim for a target of 1.5°C. As part of the agreement, each state pledged to limit its national emissions in some way, although not necessarily to *reduce* them. The idea was that these pledges – formally known as “nationally determined contributions” – would become baselines for more action in the future (see Chapter 16). This approach garnered nearly universal participation. That said, this new “bottom-up” approach has so far resulted in pledges that will *not* achieve the objective of the UNFCCC to prevent “dangerous anthropogenic interference” in Earth’s climate. Even if all of the Paris pledges were to be fully implemented, global warming would surpass 3°C (UNEP, 2016).

Because the international climate change agreements have been informed by science, the role of the oceans in governing climate change has been implicit from the start of negotiations. That said, for the most part the oceans have seldom played a major role in international policy making on climate change. After all, getting governments to agree to take climate change seriously, and specifically to actually limit and then cut their use of fossil fuels – to “decarbonize” their economies – is difficult enough. For most of them to also focus on the role of oceans is quite a lot to ask. However, recently this has started to change, as a number of the chapters in this volume point out. The oceans are now increasingly part of the official climate regime and a central feature of related governance initiatives, whether those be about the oceans per se – for example, fisheries agreements (see chapters in Part III) – or about other issues – for example, the UN’s Sustainable Development Goals (see Chapters 16 and 19).

Governance of Threatened Seas: Case Studies

Scientific literature on the role of oceans and seas in climate change is now substantial. In contrast, the body of literature looking at the *governance* of oceanic change is relatively small. Through the chapters that follow, this volume aims to help address this shortfall in the literature. It brings together research findings from political science and cognate disciplines to examine the political and policy dimensions of climate change for the oceans. Collectively, the chapters give a snapshot of the current state of knowledge and portray a cross-section of research and analyses being conducted in this nascent and vital area of climate-related scholarship. All of the chapters make explicit connections between climate change, oceans (or seas), and questions of governance, particularly politics, policy formulation, and policy implementation at all levels, from the global to the local. Taken together, the chapters in this volume provide a comprehensive look at the state of climate change and ocean governance in its relative infancy.

Before the case studies begin, Part I of this volume continues with a chapter by Elizabeth Mendenhall. In Chapter 2, Mendenhall constructs some scaffolding that is useful for understanding subsequent chapters. She does this by surveying the most important international conventions and institutions for ocean governance. Mendenhall notes that the basic principles of ocean governance have evolved over many centuries. By the middle of the last century, increasing exploitation of the oceans had prompted unilateral claims by coastal states for control of resources well offshore. This increased the need for more effective rules for ocean governance. Toward that end, under the auspices of the United Nations, starting in the 1970s, the international community negotiated a framework for ocean governance: the UN Convention on the Law of the Sea (UNCLOS). The convention simultaneously nationalized, regionalized, and internationalized ocean governance (see the chapters in Part V). National zones of ownership and jurisdiction, and particularly exclusive economic zones, gave coastal states rights to the fish and other resources that could be found in a large proportion of the oceans (see Chapter 18). The Law of the Sea convention created new instruments for the resolution of maritime disputes, particularly those related to delimitation of national jurisdictions. The convention also contained several provisions to facilitate international cooperation, with one result being the emergence of regional bodies to manage fisheries and pollution (see the chapters in Part III). The UNCLOS reaffirmed the status of the high seas as a global commons area and designated the deep seabed as "common heritage" of humanity. As examined in subsequent chapters, especially those in Part V, while UNCLOS has established institutional mechanisms for governing the oceans in many ways, not all of these mechanisms have been successful. It is therefore of great importance to ask whether and how the current oceans regime can be deployed to govern the world's oceans as they grow warmer, higher, and more acidic (see, especially, Chapter 20).

Vulnerable Islands and Coasts

Our analyses begin with several chapters on the vulnerabilities of islands and coasts. The first case study, by Lisa Benjamin and Adelle Thomas, examines climate-related challenges for island states of the Caribbean. Small island developing states (SIDS)