

Interactions of **LAND, OCEAN AND HUMANS**

A Global Perspective



Chris Maser



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**Interactions of
LAND, OCEAN
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A Global Perspective

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I humbly dedicate this book to the memory of marine biologist Rachel Carson, who saw the wonder of life and, through her love of nature, left this magnificent planet a little better for having been here. This quotation by Rachel is typical of her love of nature: "It is a wholesome and necessary thing for us to turn again to the earth and in the contemplation of her beauties to know the sense of wonder and humility." Thank you, Rachel.

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Foreword

The book you hold in your hands represents the culmination of years of study, travel, observation, analysis, listening, collaboration, and conversation about environmental systems and society by a leader in the field. Chris Maser's courage and originality offer a legacy of experience to absorb and then push further through our own choices, actions, and relationships.

The scope of the book's ambitious vision reminds me of the first time I encountered two forces that are a foundation and springboard for my own work. The first is systems theory (through Fritjof Capra, *The Web of Life*) and the second is ecological resilience (C. S. Holling, *Resilience and the Stability of Ecological Systems*).

From Capra's perspective as a physicist, our worldview, society, and institutions are undergoing a revolution from a hierarchical, top-down model to a system of networked structures. I see this change reflected in the rise and implementation of collaborative, transboundary, ecosystem-based management (a move from solely managing single species for single goals within a single authority, such as a government agency).

From Holling's perspective within ecology, all ecological systems are resilient to disturbance (including, but not limited to, human impacts) unless and until the system's adaptive capacities are overwhelmed. When overwhelmed, systems continue to self-organize but may adopt forms that are starkly different from predisturbance. I see the theory of resilience embedded in restoration of aquatic ecosystems, including rivers and wetlands, and our embrace of adaptive management—learning from empirical observations of the system as we make decisions and take action (or cease actions) to support restoration and management.

Both concepts—systems thinking and ecological resilience—conceive humanity as only one systemic node, not a superior control agent. In my view, these theories evince a powerful recognition and respect of the inherent dynamic and complex nature of systems and the interrelated nature of the whole. Systems thinking and resilience also represent a ground shift toward humility and responsibility. Elaborating humanistically and at length on our place and ethical responsibility from a scientist's perspective is where Chris complements this theoretical lineage.

Chris explains our Earth system components: atmosphere, lithosphere, hydrosphere, and biosphere. Although humanity belongs to the biosphere, this recognition is only recently reflected in environmental law and policy (e.g., considerations of environmental and resource impacts on communities). Sometimes, the realm we occupy is called the sociosphere. Even though this term is more specific, it potentially replicates our persistent self-concept as separate and

apart from the biosphere. Acknowledging and asserting our belonging to the biosphere allows us to be more mindful of the ways in which we are nurtured by the system as a whole and the ways our actions affect the system and may threaten its nurturing benefits.

Regardless of where we live, both our considerable benefits from the ocean and our impacts are abundant. And yet, our awareness of the ocean itself (and implicitly these benefits and impacts) varies widely. In the past decade, two experiences made me aware of the invisibility of the oceans despite the magnitude of their influence on our world. In the first, I opened a child's atlas to discover there was no mention of the oceans or their names. In the second, I attended a public lecture about the oceans in a large, urban auditorium, only to find in the audience one single other person. If we are to adopt new ways of thinking that contribute to long-term sustainability, we need tools to help open our imaginations and our scientific literacy. This book is such a tool; it offers insights about the relationships between the land, sea, and people that could influence us toward better decisions.

Chris defines social-environmental sustainability as a change in consciousness: We embrace the biophysical dynamics (and limits) of the feedback loop of nature-culture and economics for the benefit of all generations. This concept advances the triple-bottom-line sustainability (analysis that requires arriving at decisions that simultaneously achieve all three—ecological, social, and economic sustainability—rather than only one or two aspects) by referencing and incorporating the effect of our decisions on the biophysical system of which we are a part. Such a commitment evolves from more thoughtful decisions at the individual and collective levels, through more holistic (as opposed to disparate) decisions (whether this product or choice is sustainable, via an analysis of the life cycle of the product or decision, instead of a disconnected, short-term, or snapshot view). A practical transformation toward social-environmental sustainability is already beginning all over the world, across industrial sectors, neighborhoods, schools, and institutions, including universities. Traveling all over the world and meeting with community groups, tribes, and governments, speaking to audiences of all ages, and writing, Chris is one of the architects of sustainability for our age.

Not many authors could so adeptly lead readers on such an intricate, yet accessible, journey illuminating our complex relationships with the sea. The book invites us to investigate the benefits we receive from the ocean (oxygen, rain, marine resources, such as fish and shellfish, to name only a few) and the ocean impacts from our choices (e.g., eutrophication of coastal waters from excess fertilizer, chemical contamination, ocean acidification from CO₂ emissions).

Interactions of Land, Ocean and Humans: A Global Perspective represents an important and unusually rich contribution to the understanding of the human dimensions of the marine environment. This book is to be treasured and shared on our journey.

Holly V. Campbell, JD, LL.M, PhD
Corvallis, Oregon

Preface

But the care of the earth is our most ancient and most worthy and, after all, our most pleasing responsibility. To cherish what remains of it, and to foster its renewal, is our only legitimate hope.

—Wendell Berry¹

Although prehumans (termed *hominids*) and humans have impacted Earth since the beginning of their evolution, the cumulative effects were, at first, minor. (Cumulative effects are the collective changes in the environment instigated by nature's biophysical processes, in this case augmented by the behavior of prehumans and humans.) As evolution progressed, however, and the various groups of hominids multiplied and spread across Earth, the cumulative effects not only became increasingly complex, affecting ever-greater areas of the globe, but also compounded more rapidly with every human innovation, beginning with the use of fire 790,000 years ago.² Then came tools, followed by the domestication of plants and animals, both of which have been accompanied by a continual progression of technological advances. Cohabitation of people and their newly domesticated animals provided the bridge for a variety of diseases to migrate from animals to humans. This relationship brought its own set of issues, which we still face today.

As the human populations fanned out across Earth, the cumulative effects of their interactions with the environment began to spread across the globe from the forest to savannahs, river valleys and deltas, coastlines, and beyond, especially as their populations grew. With the advent of agriculture, which arose in the "Fertile Crescent" of the Middle East, around 8000 BCE, human-influenced land-sea interactions commenced to accelerate, but still in unrecognized ways. The Fertile Crescent refers to a crescent-shaped valley stretching from just south of modern-day Jerusalem, northward along the Mediterranean coast to present-day Syria, eastward through present-day Iraq, and then southward along the Tigris and Euphrates Rivers to the Persian Gulf.

Here, one of the most dramatic developments in human evolution took place—the successful shift from hunter-gatherer subsistence, based on foraging, to one based predominantly on food production derived from cultivated plants and domesticated animals. The ability to grow one's own food was a substantial hedge against hunger and thus proved to be the impetus for settlement that, in turn, became the foundation of civilization. Farming gave rise to social planning as once-nomadic tribes settled down and joined cooperative forces. Irrigation arose in response to the need to support growing populations—and so the discipline of agriculture was born.

Then, around 5000 BCE, the first cities were constructed in the southern part of this long valley, near the Persian Gulf, by an intelligent, resourceful, and energetic people who became known as the Sumerians. Gradually extending their civilization northward over the decades, the Sumerians created the first great empire—Mesopotamia.³

Over time, as the farming population grew, groups of people migrated northwestward out of the Fertile Crescent and colonized much of what is Europe today. As they did so, they replaced the indigenous hunter-gatherers, some of whom may have taken up farming rather than surrender their home territories to the newcomers. Nevertheless, data indicate that the newly arrived farmers bred at a rate sufficient to keep their population expanding northwestward.⁴

The shift from a hunter-gatherer way of life to one of increased sedentism (the term archaeologists use to describe the process of settling down) brought with it the concomitant social interaction and the maintenance of permanent agricultural fields and irrigation. As these populations grew and needed more food, the concept of fertilization was born, with its use increasing over time. So, human activity began to dramatically alter the global cycling of nitrogen.

Today, the majority of industrial farmers not only are addicted to synthetic chemicals, such as nitrogen, but also have addicted the soils they farm. Because too much fertilizer is often applied to agricultural fields, the excess leaches into the soil and is carried by runoff from rain and melting snow into the ditches, streams, and rivers, which ultimately deliver it to the ocean, where it accumulates. Where the accumulation is concentrated enough, it causes a veritable explosion in marine algae, which use up the available oxygen in the water, thus suffocating other marine life.

On the other hand, systematic fishing of the world's oceans has increased over the last 42,000 years since its apparent beginning in East Timor.⁵ As the numbers and kinds of fish caught and the distances they are transported to continental markets has increased, nitrogen from the ocean has returned to the land through the occupation of marine fishing.

Nevertheless, although the runoff of fertilizer from the land into the ocean and the removal of nitrogen from the ocean through commercial fishing have both increased since the 1970s, the terrestrial input has exceeded that withdrawn from the ocean. That runoff increasingly exceeds the nitrogen returned from the sea through fishing because overfishing greatly reduces the reproductive capacity of the fish to maintain viable populations at sea.⁶ This chemical trade-off represents but a single aspect of the myriad human-influenced complexities that today plague the sustainability of both land and sea through self-reinforcing, increasingly negative, biophysical feedback loops.

Can we arrest this deleterious process? Yes, but it will take a dramatic shift in human behavior worldwide. Why? Just as the collective human behavior and lack of awareness caused the problems in the first place, the level of consciousness that causes the problem is not the level of consciousness that can fix it.

We must shift our thinking from that which is symptomatic to that which is systemic if we are to enjoy a sustainably productive environment through time.

How, you might ask, can we accept responsibility for relationships we do not understand? Thomas Jefferson, the third president of the United States, wrote an eloquent response to this query in a letter to William Charles Jarvis on September 28, 1820: “I know of no safe depository of the ultimate powers of the society but the people themselves; and if we think them not enlightened enough to exercise their control with wholesome discretion, the remedy is not to take it from them, but to inform their discretion by education.”⁷

This said: “The conundrum for the [land-] ocean commons is how to explain to the student, teacher, and broader public, which often lack such a strong attachment to the sea, why they should care about the state of the world’s oceans.”^{8,p.234} It is, therefore, with a great deal of humility, that I accept Jefferson’s wisdom and commit to paper my understanding of the biophysical interactions among the lands, oceans, and peoples of the world. I do this not only to highlight what the global commons means to the quality of our lives through all generations but also that I might leave this magnificent planet spinning miraculously in space a little better for the privilege of having been here amid the untold beauty of its creation.

In this endeavor, I am encouraged by the words of Robert F. Kennedy: “Each time a person stands up for an ideal, or acts to improve the life of others, or strikes out against injustice, they send a tiny ripple of hope; and those ripples, crossing each other from a million different centers of energy, build a current that can sweep down the mightiest walls of oppression and resistance.”⁹

Because of the complexity of the topic herein discussed, it is necessary to reiterate some things now and then to reinforce a concept, principle, or crucial point throughout this book.

NOTES

1. Wendell Berry. *The Unsettling of America: Culture and Agriculture*. Sierra Club Books, San Francisco, 1996.
2. David Robson. Proto-Humans Mastered Fire 790,000 Years Ago. *NewScientist*, October 27, 2008. <http://www.newscientist.com/article/dn15048-protohumans-mastered-fire-790000-years-ago.html#.U1xK2Bwj950> (accessed February 27, 2009).
3. The discussion of the Fertile Crescent is based on (1) Stacey Y. Abrams. The Land between Two Rivers: The Astronomy of Ancient Mesopotamia. *The Electronic Journal of the Astronomical Society of the Atlantic*, 3 (no 2). Georgia State University Press, 1991. (2) The Fertile Crescent. <http://visav.phys.uvic.ca/~babul/AstroCourses/P303/mesopotamia.html> (accessed January 7, 2012).
4. Wolfgang Haak, Peter Forster, Barbara Bramanti, and others. Ancient DNA from the First European Farmers in 7500-Year-Old Neolithic Sites. *Science*, 310 (2005):1016–1018.

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9. Bobby Kennedy. The Ripple of Hope. <http://bobby-kennedy.com/rfkintro.htm> (accessed October 13, 2012).

Acknowledgments

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As always, I am deeply grateful to my beautiful wife, Zane, for her patience with me as I worked on this book and for helping me proof the galley.

All in all, this book has been a team effort—an unconditional gift to all generations. Thank you all!

Editor's Note

In reading this book, keep in mind that our earthscape is composed of three interactive spheres: the atmosphere (air), the litho-hydrosphere (the rock that constitutes the restless continents and the water that surrounds them), and the biosphere (the life-forms that exist within and between the other two spheres). We humans, however, arbitrarily delineate our seamless world into discrete ecosystems as we try to understand the fluid interactions among the nonliving and living components of planet Earth. If you picture the interconnectivity of the three spheres as analogous to the motion of a waterbed, you will see how patently impossible such divisions are because you cannot touch any part of a filled waterbed without affecting the whole of it.

So it is that rivers of air carry water from the oceans to every location on Earth; thus, not only are they the nonsubstitutable source of our potable water but also they give life to the soil and all that grows therein—our food. In turn, how we treat the land ultimately protects the purity of the world's air, water, and soil *or* degrades them with pollution. In like measure, the way in which we treat the oceans determines the long-term sustainability of their biophysical services, which we rely on for a good-quality life, as opposed to a desperate struggle for mere survival. And, finally, how we act toward the air determines whether the world breathes freely or suffocates in pollution, which ultimately controls how the global climate reacts to the choices we make.

Together, these three spheres form myriad interactive, self-reinforcing feedback loops that affect all life on Earth. And, it is the reciprocity of these feedback loops that form the legacy we leave—one that either liberates or progressively constrains all generations. The choice of how we, the adults of the world, behave is ours—either with psychological maturity and sacred humility or self-indulgence and monetary arrogance. How will you choose?

Finally, this CRC series of books on the various facets of social-environmental sustainability is a forum wherein those who dare to seek harmony and wholeness can struggle to integrate disciplines and balance the material world with the spiritual, the scientific with the social, and in so doing expose their vulnerabilities, human frailties, and hope, as well as their visions for a viable future.

As the title of this book implies, the human component of the world is a critically important—but often overlooked or blatantly ignored—dimension of social-environmental sustainability. Yet, it is the integrity of the relationships among the diverse elements in any system that both defines the system

through its functional processes and confers sustainability to the system in its functioning. *Interactions of Land, Ocean and Humans: A Global Perspective* examines this notion in terms of nature, culture, and the irrevocable relationships between them.

Chris Maser
Series Editor



Water's Journey from the Mountaintop to the Sea

Learning about Water's Journey

1

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INTRODUCTION

I learned about the interactions of the land, oceans, and people over many years as I traveled and worked in North America, Europe, North Africa, and Asia. In the process, I crossed the Atlantic twice by ship and spent time on its shores in Canada, New York, and Florida. I conducted research along the Pacific Coast of the northwestern United States and the Red Sea in Egypt.



I have spent time along the Pacific in southern Chile, California, Washington, Canada, and Alaska; the Gulf of Mexico in Texas; the Mediterranean in Italy, Lebanon, and Egypt; the Sea of Japan; and the Indian Ocean off the coast Malaysia. And, it became clear to me, as I flew various routes around the world and visited different ocean shores, just how immense the ocean really is and how varied its surrounding landscapes are.

The vastness of these waters makes it difficult for people living in various regions of the world to comprehend that the world's oceans are in fact a single entity that recognizes no human boundaries. Nevertheless, humanity has divided this great body of water into segments, each with a different name and myriad proclaimed ownerships. Consequently, industrial humanity dismisses the fact that the combined oceans of the world constitute a major part of the global commons, and as such, their bounty is everyone's birthright, and their care is everyone's responsibility. Moreover, every person for generations to come will pay for the abuse and avarice with which "economic man" (*Homo economicus*) has treated the oceans since the beginning of the industrial age—a behavioral pattern of deep unconsciousness that continues unabated, thereby spawning the growing oceanic extinctions to the increasing detriment of each succeeding generation.

Is this the inevitable outcome? It does not have to be. But, that depends on the conscious choices we, the adults of the world, make from this day forward.

To find the alternatives to our current actions requires greater understanding of the ocean as a dynamic system entrained within the three interactive spheres of our earthscape: the atmosphere (air), the litho-hydrosphere (the rock that constitutes the restless continents and the water that surrounds them), and the biosphere (the life-forms that exist within the other two spheres). We humans, however, arbitrarily delineate our seamless world into discrete biophysical systems as we try to understand the fluid interactions between nonliving and living components of planet Earth. If you picture the interconnectivity of the three spheres as analogous to the motion of a filled waterbed, you will see how patently impossible such divisions are because you cannot touch any part of a waterbed without affecting the whole of it. (I incorporate *biophysical system* throughout this book because it denotes the interactions of the three spheres mentioned.)

However, because of our limited perceptions of scale, we often separate the oceans from the land that surrounds them. Despite our worldview, the universe is a single, all-inclusive relationship constituted of an ever-expanding web of biophysical feedback loops, each of which is perpetually dynamic, novel, and self-reinforcing. Each feedback loop is a conduit whereby energy is moved from one place, one dimension, and one scale to another. This said, keep in mind as you read that we *do not destroy* biophysical systems; *we alter them*. What we destroy is their ability to produce the goods and services necessary for our survival and a good quality of life.

Seventy-five percent of the surface of Earth is covered with water, but more than 97 percent of it is salt water that makes up the oceans. The remaining 3 percent is in the form of water vapor in the air and freshwater on land, of which two-thirds is locked up in ice caps and glaciers and the other one-third is in liquid form either underground (in aquifers and rocks) or aboveground in lakes, soil, wetlands, rivers, and living organisms. Thus, bear in mind that only 1 percent of Earth’s water is in a form usable by humans, of which a mere 4/10 of 1 percent is accessible in the form of lakes and rivers.¹

Water, like everything else in the universe, is cyclical in nature wherein water becomes a “shape shifter” among liquid (water), gas (vapor), and solid (ice). It works like this: Liquid water on the ocean’s surface is heated by the sun and consequently evaporates into the air, where winds carry it throughout the global atmosphere as a vapor that ultimately *condenses* into *precipitation* and is scattered over the surface of Earth as rain, snow, or ice, depending on where and when it falls.

Hydrology, from the Greek *hydro* “water” and *logos* “study,” is the scientific study of the properties, distribution, and effects of water on Earth’s surface, in the soil and underlying rocks, and in the atmosphere. Surface water is stored over the short term in lakes, swamps and other wetlands, streams, and rivers. Other precipitation is absorbed and stored at various depths within the soil or deeper in the ground as subsurface or groundwater in subterranean aquifers and lakes.

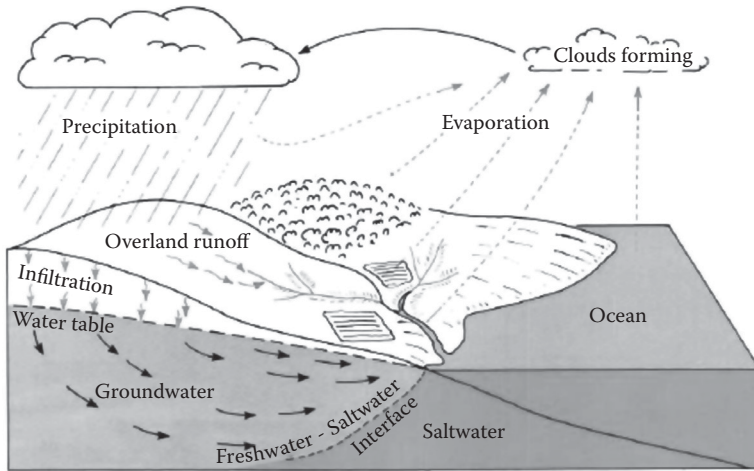


FIGURE 1.1 Hydrological cycle. (Illustration by Ralph C. Heath, U.S. Geological Survey. http://commons.wikimedia.org/wiki/File:Hydrologic_cycle.png)

Surface water is stored over the long term in snowpack (the accumulation of snow), glaciers, and ice caps, which recharge lakes, swamps and other wetlands, streams, and rivers, as well as belowground aquifers and lakes. Regardless of where or in what form water is stored, it ultimately returns to the sea directly or in the air as it evaporates from lakes, swamps and other wetlands, streams, and rivers or through transpiration (the evaporation of water into the atmosphere from the leaves and stems of plants) to fall as precipitation onto the oceans only to once again evaporate from the seas of the world to ride the winds, condense, and descend on the land in a continuous cycle—the *hydrological cycle* (Figure 1.1).

Regardless of where the precipitation originates, the location of mountains and other topographic features has a profound effect on where it falls, when it falls, and how much. Ultimately, however, all water comes from the oceans of the world, even if today it appears to be “landlocked.” Thus, every time you take a bath or a shower or merely wash your hands, no matter where you are, you are, metaphorically, cleansing yourself in the ocean.

WATER: A CAPTIVE OF GRAVITY

Water is a nonsubstitutable, uncompromising requirement of life. Its source and capacity for storage are finite in any given landscape. Fresh, usable water, once thought by nonindigenous peoples in the United States to be inexhaustible in supply, is now becoming scarce in many parts of the world. In the western United States, for example, water pumped from deep underground