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Ecological Climatology: Concepts and Applications, by Gordon B. Bonan

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Tyler acknowledges that he admires the man’s accomplishments and the man himself. Carpenter was an optimistic man who tried to bring together public and private actors to use information and negotiation to honestly resolve water dilemmas. Carpenter’s activities required courage and were exemplified by courtesy to others. While Tyler openly acknowledges his admiration for Carpenter and recognizes the criticism that have been made of interstate compacts, Tyler is silent about environmental damage and social inequities that resulted from the water policies that Carpenter championed. For example, Indians simply were not a consideration when the Colorado River Compact was written despite their need for water resources. Thus, Carpenter was the product of his time and blind to equity concerns that we have today.

Second, the biography gives us an alternative to the litigious and legislative approaches that dominate policy making today. Carpenter firmly believed that those with water interests can resolve problems through openness, honesty, and learning about others’ positions. Carpenter would not have been an advocate of the public comment periods and other participation that we have today, but his views are consistent with some of the more successful decision making by watershed councils. This suggests that his contributions were not as time bound as you might initially expect. Third, the book also tells the story from perspectives that often are neglected: the upper basin states and the supporters of state sovereignty over water. This helps us better understand and deal with questions of water allocation and equity even though we may disagree with Carpenter’s solutions. A broad audience will find this book to be of use in understanding how water and other natural resource policy has been made.

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The interdisciplinary study of Ecological Climatology examines the interactions between two very complicated separate components of Earth’s environment: climate, a chaotic system principally governed by radiation and Newton’s laws of physics, and ecology, grounded in the evolutionary principles of biology. Earth sciences such as climate and ecology really became quantitative endeavors only during the second half of the twentieth century. Before then, these complex fields were described using arbitrary classification criteria (e.g., by defining zones of common vegetation or climate), providing no solid scientific foundations
for connecting the ecosystem with the climate system. In recent decades fundamental principles of physics and chemistry have been applied to observed natural systems. Doing so provides the beginnings of a theoretical framework for assessment of Earth, including its biosphere, and opens new possibilities for predicting changes in these systems.

Applying quantitative analysis to descriptive studies of large-scale Earth systems required, first of all, accumulation of enough observational evidence to test hypotheses. It is still the case that progress on problems in climatology or ecology is limited by the observational database. One cannot understand or explain phenomena that have not been observed, and we are busy observing new phenomena and the connections between them all the time. Most people are surprised to learn just how recently familiar climatic features were described: cold fronts were first identified during World War I, more than a decade after physicists first proposed quantum mechanics and relativity; the jet stream was not properly described before World War II. Both climatology and ecology are very young sciences and the processes that control their interaction on continental scales have been explored with scientific rigor only in the past decade or two.

Gordon Bonan's excellent Ecological Climatology text provides an up-to-date status report on ecosystem-climate interactions. The text is advertised as being directed at "graduate students and advanced undergraduates" in a broad range of disciplines and that statement seems just about right to me. The text is clearly written and little specialized knowledge is required to read it. A slight smattering of calculus is present but is not critical to the book's main points. Readers with a more substantial background in climatology or ecology can read the book at a deeper level. Thus, for classroom usage, I would recommend the book for use by students with some prior knowledge of climatology and ecology despite the readability of the prose.

Conservation laws for energy, momentum, and water are used to assess and simulate the climate system and provide the basis for quantitative dynamical models. Climate in turn modulates the inputs of energy and water into ecosystems. Fundamental constraints on ecosystems are provided by chemical conservation of elements such as carbon and nitrogen, essential nutrients for life. Water vapor and carbon dioxide are the two principal atmospheric greenhouse gases, so analyses of the biogeochemical sources, sinks, and transfer pathways of water and carbon form a key link between the climate system and ecosystems.

It is obvious that climate affects vegetation, although it is far from obvious how to quantify the effects of climate change on vegetation regimes. An individual plant will certainly die if it loses access to water; plant physiologists study the water needs of various plant species. But how severe a drought is required to turn a forested area into shrubland
or grassland? This is a profoundly difficult ecological question. Individual plants can be studied in controlled conditions in a greenhouse, but forests are subject to all sorts of simultaneous stresses (climate, bugs, fire, people with axes) and may slowly proceed through a natural community succession without any external stresses at all. Thus, isolating the effects of any particular influence such as climate on large-scale vegetation regimes is extremely problematic.

The relationship going the other way, with vegetation affecting the global climate system significantly, has been convincingly developed only very recently. Biology mattered very little in early models of the climate system, and not until the 1980s were global climate models shown to be sensitive to changes in the amount of moisture available for evaporation on continental land surfaces. Some measure of climate, which is most often characterized by surface temperature and precipitation, can change due to "external" influences like fluctuations of solar brightness and volcanic activity. In the early days of climate modeling, the principal "internal" factors influencing climate change that were intensively studied were fluctuations of snow/ice cover (which are an important component of understanding ice age cycles), and slow changes in ocean temperatures. The El Niño phenomenon and its effect on global and regional climates is a prominent example of an oceanic climate driver.

So, while ecologists have always been concerned about the climate, mid twentieth century climatologists generally ignored the complexities of ecosystems because other processes seemed more important. This oversimplified view is changing rapidly. As always happens in the Earth sciences, access to better data led to more sophisticated ideas. Decades of satellite observations show obvious large-scale changes in vegetation across parts of the globe, and these can be related to climate variability. Desertification in regions like the African Sahel provoked consideration of the causes and effects of widespread vegetation change. Estimates of the vast expanses of Amazonian rainforest clearing prompted questions about the climatic consequences of such clearing.

The Sahel, the savanna region at the southern edge of the Sahara Desert, offers an example of the mutual interactions between shifts in climate and changes in vegetation that lie at the heart of interdisciplinary research in ecological climatology. Rainfall in this marginal land decreased sharply starting in the 1950s. To begin with this may have been due to a change in weather patterns associated with a change in ocean surface temperatures in the tropical Atlantic. Such droughts are the subject of "pure" climatology. The combination of drought and overgrazing stressed vegetation in the Sahel. Ecologists study how this process works.
If that were the whole story, then presumably ocean temperatures would shift back and the Sahelian ecosystem would recover. However, the Sahel remained stuck in ever worsening drought with widespread desertification for more than three decades, much longer than could be attributed to ocean temperature fluctuations. The prolonged drought seems to have triggered a positive feedback, such that the decrease in vegetation caused by climate fed back upon the climate system itself. Desert sand is more reflective than vegetation and therefore absorbs less sunlight than a green surface. When evapotranspiration decreases, the near-surface energy that feeds thunderstorm activity is decreased, and the local water supply to the atmosphere is reduced. Both factors act to reduce precipitation further: a positive feedback. Instead of passively being affected by climate, the ecosystem actively reinforced drought conditions in the Sahel.

Is this sort of vegetation feedback applicable to other semiarid regions? How severe or prolonged must a drought be to affect vegetation so severely that the drought becomes self-perpetuating? Are there identifiable “stress points” in ecosystems that would allow us to identify when such vegetation feedbacks will take place? What other climatic forcings—global warming, for example—or land use changes, such as deforestation, might trigger such behavior in the coupled climate-vegetation system? These are the kinds of questions that are being addressed by a growing cadre of interdisciplinary scientists using new data sets and improved models.

Bonan devotes five initial chapters of his text to Earth’s physical environment: three chapters to climatology, one to hydrology, and one to soils. Climate science is split into chapters on physical fundamentals, climate change, and climate variability. In the argot of climatology, “climate variability” refers to relatively short (seasonal-decadal) fluctuations that are controlled mostly by natural oceanic variability, modulated by land surface processes such as snow cover or growth of individual plants; “climate change” is slower, associated with wholesale changes in large-scale vegetation communities, and covers the realm of possible anthropogenic effects due to land use change and greenhouse gas increases. Three subsequent chapters cover local topographic effects on climate and the fundamentals of plant physiology and ecology most directly connected to the climate system: the exchanges of energy, water, and nutrients between air, soil, and plants, how these exchanges are controlled by leaves, and the basic types of plants and plant communities.

Interdisciplinary science texts inevitably involve endless tradeoffs between rigor and breadth. In my academic department (Earth & Planetary Sciences), at least one separate semester-long course is offered in the separate subjects of large-scale climatology, micro-
climatology, hydrology and pedology (soil science). Bonan’s treatment of these topics is necessarily limited. Thus, the chapters on climatology describe the global distribution of precipitation, and how zones of precipitation have changed with time, but the actual physical processes that generate precipitation are not covered in significant detail.

The grand interdisciplinary climax to all this introductory material comes in three long chapters covering ecosystems, vegetation dynamics, and climate-ecosystem interactions. These chapters could not have been written ten years ago and they will need to be rewritten in five years, but I do not intend this statement in a derogatory way. These chapters are the best in the book, and provide an excellent survey of the rapidly evolving state of the science. Anthropogenic influences on ecosystems and climate are covered in chapters on agriculture and urban effects. Bonan’s canvass of these subfields is up to date and informative.

Ecological climatology is an interdisciplinary science in its infancy. There are many exciting new ideas being tested but few of them are time-tested—most of the concepts driving ecological climatology have the status of “working hypotheses” rather than “theories” or “laws.” New climate models incorporating interactive vegetation changes can reasonably “hindcast” the precipitation decreases observed during the Sahelian drought period when provided the observed time-varying ocean temperatures. Of course, a fully coupled Earth system model capable of predicting Sahelian drought would need to accurately simulate the evolution of ocean temperatures too. But coupled ocean-atmosphere models are only slightly more advanced than coupled vegetation-atmosphere models, and no models are yet capable of predicting long-term drought with any reliability.

Perhaps this situation will change in time for a second edition of Ecological Climatology. Meanwhile, the combination of new global data sets new models and cheap computers makes the field wide open for anyone with the sort of interdisciplinary background provided by this book. Are there significant climatic consequences associated with our choices about land use and water management? In many cases the answer must be affirmative, but we are just reaching the point at which educated conjecture can start to be supplanted by quantitative guidance, including realistic estimates of the uncertainties in our guidance. What ecosystem changes can be expected to occur as part of observed and future climate change? The answer to this question would contribute tremendously to assessment of the impacts of the current global warming trend.

Ecological Climatology clearly outlines the scope of possibility for integrating the physics of climate, the biological principles of ecology, and the biogeochemical pathways that link atmosphere and land surface. Gordon Bonan’s book can be thought of as a natural philosophy text,
providing a welcome prospectus for synthesizing the principles of two new Earth sciences to examine a host of issues of profound social and economic importance.

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In the International Law of Water Resources, Slavko Bogdanovic examines the work of three committees—the Rivers Committee (1965–1966), the Committee on International Water Resources Law (1966–1986), and the Committee on International Water Resource (1990–present)—within the International Law Association. The parent International Law Association is one of the most influential non-governmental organizations involved in international law. These three committees, the Association’s progeny, contributed in the creation of an authoritative statement of law governing international watercourses, the black-letter law governing water resources. Their work has spanned nearly half a century and has significantly contributed to the development of water law including their most significant accomplishment, the 1966 Helsinki Rules. Their rules on water law are recognized as the foundation for the peaceful resolution of disputes over shared watercourses. In this succinct volume, Bogdanovic has consolidated the work of the International Law Association (ILA) and provided valuable insight into the creation of those water laws.

A series of international river disputes, including the conflicts between India and Pakistan over the Indus, Egypt and the Sudan over the Nile, Israel and its neighbors over the Jordan, and Canada and the United States over the Columbia, caused the International Law Association to create laws governing water resources. In International Law of Water Resources, Bogdanovic gathers the ILA’s work into a single document and complements it with background information. The book examines current international water law in great detail and provides valuable insight into its development. The volume is essentially a textbook. While Bogdanovic’s work would be useful for teaching international water law, it is not particularly entertaining.

Bogdanovic provides insight into the evolution of water law that distinguishes this book from a mere compilation of international laws. He draws a common thread between the three committees by describing them as entities that promote the reasonable and equitable sharing of waters of an international drainage basin. According to Bogdanovic, the principle of equitable utilization is the starting point for rational