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VALIGURA, R. A., R. B. ALEXANDER, M. S. CASTRO, T. P. MEYERS, H. W. PAERL, P. E. STACEY, AND R. E. TURNER [EDS.]. 2001. **Nitrogen loading in coastal water bodies: An atmospheric perspective.** American Geophysical Union. viii + 254 p. US$56. ISBN 0-87590-271-5.

Over the last 40 yr, understanding how nutrients get into estuaries and coastal waters has evolved in three stages. First, the most obvious point sources (e.g., sewage treatment plants) were considered. Next, inputs of diffuse sources—agricultural runoff, stormwater runoff, residential fertilizer use, leakage from septic tanks, and other groundwaters—were quantified. Most recently, scientists have been grappling with the problem of assessing the importance of atmospheric sources. Although the effects of atmospheric deposition (acid rain) on terrestrial and freshwater ecosystems have been studied since the 1960s, the first papers dealing specifically with their effects on estuarine and coastal waters appeared only in the 1980s. This book deals with the current status of this important topic.

Seven editors and 32 authors contributed to the eight chapters in this book. Major topics include the ecological and biogeochemical effects of atmospheric nitrogen loading, the estimated rates of atmospheric deposition to 40 estuaries, and an evaluation of several models of nitrogen loading to estuaries. In spite of egregious presentation problems (*see below*), this is a good synthesis of our understanding of the magnitude and effects of atmospheric nitrogen loading on the coastal zone. People already familiar with the literature on atmospheric nitrogen loading or watershed nitrogen modeling will be particularly interested in what it offers. Three chapters compare estimates of nitrogen loading to 42 U.S. estuaries obtained with a variety of techniques: the SPARROW (SPAtially Referenced Regressions On Watershed Attributes) model, watershed models (SWAT/HUMUS [Soil and Water Assessment Tool/Hydrologic Unit Model of the United States] and Chesapeake Bay HSPF [Hydrologic Simulation Program—Fortran]), and NOAA's regional estimates, as well as independently derived estimates from the published literature. SPARROW is a statistical and empirical model that uses watershed inputs and hydraulic characteristics to fit water quality data and estimate loadings; the watershed models use watershed inputs and uptake processes to estimate export, and the NOAA regional estimates were based on discharge and water quality data. Unfortunately, the terminology used to refer to any particular model is not consistent throughout the book, which makes it difficult to compare results. It appears, however, that the various models produced mixed results. Several explanations related to the basics of model building and defining boundary conditions are given for this unsatisfactory outcome; viz. the various models did not use the same watershed areas or data from the same time periods, and some models included groundwater loading and estimated nitrogen inputs from ungauged streams and from below the fall line (the transition between upland and lowland portions of a river, normally the limit of navigation), whereas others did not. Hopefully, future research will repeat these comparisons using identical boundary conditions and will particularly address the role of attenuation (uptake processes) below the fall line.

Despite these uncertainties, the bottom line is clear: Under some circumstances, atmospheric nitrogen deposition can be a significant fraction of the total loading to coastal ecosystems. Specifically, it is a high percentage of the total load to estuaries whose drainage basin areas are small in relation to their water surface areas. This suggests that comparative studies of estuaries that vary widely in the ratio of drainage basin area to water surface area would give valuable insight into whether it matters how nitrogen gets into an estuary (i.e., by atmospheric deposition, surface runoff, or groundwater). I suspect that it does, because atmospheric deposition to the water surface should alter nitrogen concentration gradients by increasing concentrations in polyhaline zones, where they are typically low.

Although this book provides convincing evidence that atmospheric deposition is a significant nitrogen source to some estuaries and other parts of the coastal zone, a lot of work remains to be done before we will be able to regulate atmospheric nitrogen inputs. Regulation of nutrient inputs to the coastal zone began with the Clean Water Act of 1972, which has been quite successful at reducing inputs from large, well-defined point sources such as sewage treatment plants. We are currently in the midst of the second phase of regulation—controlling diffuse sources (agricultural runoff, septic tanks, stormwater runoff, residential fertilizers, etc.). The U.S. EPA is developing guidelines that will allow states to set scientifically justifiable total maximum daily loads (TMDLs) for nutrients, focusing on best management practices to reduce agricultural runoff, municipal stormwater runoff, residential fertilizer use, and leakage from septic tanks; every successful program is a major effort that brings together varied interest groups and mobilizes public support to protect a particular estuary. Regulating atmospheric nutrient inputs will be even more difficult because it will require the cooperation of people distant from the estuaries and coastal zones at risk. Controlling NO_x emissions from internal combustion engines and power stations will increase costs for basic commodities like electricity and transportation, and controlling NH_4^+ emissions associated with animal production will increase the costs of pork, beef, and poultry. Higher costs are never popular with the public, and scientists, managers, and educators will have to work together to make a convincing case that clean estuaries and coastal waters are a necessity and that these costs are justified.

As an afterthought, it is sad that this scientifically valuable book is marred by poor production values, which at times completely distracted me. Several chapters were inadequately proofread prior to publication. Graphs were misplaced or poorly labeled and the fonts in some tables were too small to be legible. Although I commend the AGU for attempting to publish books inexpensively and in a timely manner, they cut far too many corners in this case.

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