Nitrogen is abundant in the Earth’s atmosphere, but it exists primarily as an unreactive form that is relatively inaccessible by most organisms. Although the formation of reactive nitrogen is a natural process, it can be dramatically altered by human activities such as biomass burning, combustion of fossil fuels, and production of synthetic fertilizers, which collectively account for half of the reactive nitrogen in the environment. In Nitrogen Overload, Katz (2020) explores the costs and benefits associated with anthropogenic releases of reactive nitrogen at a global scale.

This 251-page book consists of 11 chapters that are organized in three sections: background information (chapters 1–4), implications (chapters 5–10), and mitigation (chapter 11) for reactive nitrogen in the environment. The first section provides information on the biogeochemistry and scale of nitrogen pollution, with chapter 1 presenting an overview of the main topics covered in the book. Chapter 2 examines the effects of human activities on the preindustrial “natural” nitrogen cycle, which Katz (2020) asserts “has been altered more than the carbon cycle or any other basic element cycle essential to life on earth (e.g., phosphorus, sulfur).” Chapter 3 discusses the major sources of nitrogen pollution to terrestrial and aquatic systems, particularly for North America, Europe, Latin America, and India, and chapter 4 describes techniques for identifying sources of reactive nitrogen with chemical, isotopic, and microbial tracers.

The remaining chapters explore the impacts, sources, and challenges for mitigation of nitrogen pollution. Chapter 5 discusses the human health impacts of reactive nitrogen, including respiratory ailments from NO$_x$ emissions and secondary production of tropospheric ozone, methemoglobinemia from elevated nitrate in drinking water, and respiratory and skin ailments from exposure to harmful algal blooms. Chapter 6 examines the impacts of reactive nitrogen on terrestrial and coastal aquatic ecosystems. Notably, Katz (2020) cites a decline in global seagrass cover by more than 29% during the last century, but also a recovery of aquatic vegetation in portions of Chesapeake Bay (USA) due to more effective management of nutrients since the 1980s. Chapter 7 discusses groundwater contamination from reactive nitrogen with emphasis on the storage of legacy nitrogen in aquifers. In this chapter, the author elucidates a recurring theme in the book: reactive nitrogen applied to the agricultural lands can leach below the root zone of soils, through the unsaturated zone, and into aquifers, where it can be stored and released very slowly over time. Because groundwater residence times can vary from weeks to thousands of years or longer, the contribution of legacy nitrogen stored in aquifers has led to delays in achieving water quality goals in the United States and Europe. Chapter 8 discusses nitrate contamination of springs with specific case studies from Florida, Texas, and the northeast region of Spain. A retired hydrologist with the U.S. Geological Survey, the author has decades of experience investigating the fate and transport of reactive nitrogen in Florida springs, a topic that is featured prominently in this chapter. Chapter 9 discusses with the co-occurrence of nitrate with other contaminants, particularly phosphorus, pathogens, and emerging contaminants (e.g., pharmaceuticals, personal care products) at multiple scales. Chapter 10 discusses the economic costs of consequences associated with excess reactive nitrogen, which the author reports may be as high as $441 billion year$^{-1}$ in the United States. Chapter 11 highlights three strategies for reducing excess reactive nitrogen in the environment: use of enhanced-efficiency fertilizers, reducing consumption of animal proteins, and decreasing emissions from fossil fuel combustion.
Nitrogen Overload is exhaustively researched, but relies primarily on studies conducted by the European Nitrogen Assessment program. Illustrations are clear and depict the main points of each chapter. Although the text is generally well written, a few errors go beyond simple typographical mistakes. For example, the reference for recovery of submerged aquatic vegetation is Lefcheck et al. (2018), not Breitburg et al. (2018, 111), and corn/soybean crops, not atmospheric deposition, represent 52% of nitrogen loads and 25% of phosphorus loads to the Gulf of Mexico (Figure 9.7, 180). Overall, the price of the book ($165 ebook, $200 hardcopy) is justified by the breadth of environmental issues covered, which range from local to global and involve the complex interactions between nature and society. Although the book is particularly well suited to hydrologists, it will be of interest to research scientists working in a variety of different fields, including ecology, environmental science, and biogeochemistry.

References

Breitburg, D., L.A. Levin, A. Oschlies, M. Gregoire, F.P. Chavez, D.J. Conley, V. Garçon, D. Gilbert, D. Gutiérrez, K. Isensee, G.S. Jacinto, K.E. Limburg, I. Montes, S.W.A. Naqvi, G.C. Pitcher, N.N. Rabalais, M.R. Roman, K.A. Rose, B.A. Seibel, M. Telszewski, M. Yasuhara, and J. Zhang. 2018. Declining oxygen in the global ocean and coastal waters. Science 359: eaam7240. https://doi.org/10.1126/science.aam7240

Katz, B.G. 2020. Nitrogen Overload: Environmental Degradation, Ramifications, and Economic Costs. Hoboken, NJ: John Wiley & Sons.

Lefcheck, J.S., R.J. Orth, W.C. Dennison, D.J. Wilcox, R.R. Murphy, J. Keisman, C. Gurbisz, M. Hannam, J.B. Landry, K.A. Moore, C.J. Patrick, J. Testa, D.E. Weller, and R.A. Batiuk. 2018. Long-term nutrient reductions lead to the unprecedented recovery of a temperate coastal region. Proceedings of the National Academy of Sciences of the USA 115: 3658–3662.