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Review of: Wetlands- Nutrients, metals, and mass cycling. Edited by J. Vymazal

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This book, *Wetlands – nutrients, metals and mass cycling*, is the result of a workshop held at Trebon, Czech Republic, entitled “Nutrient Cycling and Retention in Natural and Constructed Wetlands IV”. It is the third edited volume resulting from a series of such workshops; previous proceedings include a volume of the same name, *Nutrient Cycling and Retention in Natural and Constructed Wetlands* (Backhuys Publishers 1999), as well as *Transformations of Nutrients in Natural and Constructed Wetlands* (Backhuys Publishers 2001). Like the earlier meetings, this one was organized to provide a forum for scientists working on constructed wetlands for wastewater treatment to meet with those working on biogeochemical cycles in natural wetlands. The result is a compendium of 21 chapters derived from 30 presentations made at the workshop, including some by leaders in the field of engineering constructed wetlands.

The essential focus of the book is to develop our understanding of biogeochemical cycles in constructed and natural wetlands as a means to increase the efficacy of wetlands constructed for wastewater treatment. Chapter topics vary widely, from very specific topics (“Removal of linear alkylbenzene sulphonate in constructed wetlands” by Rhian Thomas and colleagues) to much broader ones (“Efficacy of periphyton-dominated wetlands for phosphorus removal in the Florida Everglades” by Robert Knight). Chapters have not been organized into thematic sections (e.g., constructed and natural wetlands and the cycling of metals), which would have helped organize the information and guide the reader to topics of most interest.

All chapters are quite data rich, and many present very specific information on design considerations for wetland treatment systems. At its best it is akin to a “how to manual” on the engineering of efficient wastewater treatment, with full disclosure of system specifications. For example, in a chapter dealing with the questions of the optimum recirculation ratio for nitrogen removal from highly concentrated animal waste, the authors (Kantawanichkul and Naemkam) detail how small experimental tanks, only 1.2 m on each side and planted with *Cyperus*, were able to reduce Total Kjeldahl Nitrogen (TKN) from 242 mg l\(^{-1}\) in the raw wastewater with no recirculation, to 3.5 mg l\(^{-1}\) in the effluent (amounting to a 98.5% reduction); at the same time ammonia levels dropped from 156.4 mg l\(^{-1}\) to 3.1 mg l\(^{-1}\). When effluent was recirculated (thus diluting the influent) efficiency rates increased slightly, and also helped reduce levels of nitrate (NO\(_3\)), which tended to increase through the system. Enough detail is provided that the avid reader could recreate this system based on information provided in the chapter.

Other chapters focus on the capacity of wetland treatment systems to remove nutrients in order to...

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restore natural ecosystems. This is one approach being used by the state of Florida (USA) to removed phosphorus (P) from water before it enters the Everglades ecosystem. In this case periphyton-dominated stormwater treatment areas (PSTAs) are being employed, and the challenge is to remove P when it is at very low influent concentrations (<50 μg l⁻¹) to levels needed to protect the South Florida wetlands (the target is 10 μg l⁻¹). The PSTAs are designed as low-maintenance systems based entirely on solar energy inputs, and are therefore more land-intensive than some other treatment system designs. Many design permutations are discussed here, but the periphyton-based design has the capability to remove P at very low levels, achieving effluent concentrations lower than 12 μg l⁻¹.

Several chapters demonstrate the capacity of aquatic macrophytes to remove both N and P at high concentrations. One of the most interesting of these describes N and P removal kinetics using the Michaelis–Menton model in a wastewater system planted with water hyacinth (*Pistia stratiotes*). Still other chapters explore issues of which macrophyte species maximizes system performance, the role of substrate or rooting medium on nutrient removal efficiency and the mineral content of plant tissues, and the influence of microbial activity in the plant rhizosphere on nutrient cycling. In this way nearly every aspect crucial to the design of wastewater treatment systems is addressed at some point in the volume.

Like most edited volumes on this topic, the focus is on the removal of nutrients from wastewater and, although the title of the books suggests otherwise, the space devoted to wetlands constructed for metal removal is slim, receiving full attention in only one (the final) chapter in the book. While trace metals (such as iron, cadmium, or lead) are not often problematic in domestic wastewater or stormwater runoff, they may accumulate in sediments or even plant tissues, making an understanding of their dynamics important, particularly if harvested plants or dredged sediments must be disposed of. This chapter, by J. Vymazal, provides a comprehensive review of metals in wastewater and presents data on the distribution of iron, cadmium, nickel and lead in soils and plant tissues in a 3-year-old constructed wetland near Prague (Czech Republic). This chapter is an extremely valuable, comprehensive review summarizing data from numerous studies on the movement and accumulation of metals in wetland systems, both natural and constructed, with multiple tables of data summarized from the literature. For anyone interested in the biogeochemistry of metals, this chapter provides an excellent current review of the topic. Unfortunately, this is essentially the only treatment of this topic in the book.

Most studies on constructed wetlands are site-specific in their approach, so it was refreshing to see that several of the chapters in this volume deal with landscape form and processes that affect the placement of wetland treatment systems. T. Mauring and colleagues make the important point that landscape analysis, in this case through development of a suitability model for wetland construction, is crucial to the successful restoration or creation of wetlands on a catchment basis. They demonstrate a method of complex landscape analysis that allows a regional synthesis of water quality issues. It is a spatially sophisticated approach that moves us beyond site-specific concerns to a full integration of wetlands designed to benefit watershed health, a welcome perspective! Another chapter by L. Pechar and colleagues provides a review of the environmental history of fishponds in the Trebon Basin, and the improvement in water quality that has resulted as agricultural practices in the basin have become less intense. Many readers interested in wetland management will be familiar with the work conducted in the Trebon Basin over the past 20 years, this chapter provides a landscape-based understanding to their ecosystem management.

All of the chapters end with a transcript of the discussion that followed the presentation of the paper at the original workshop. These provide an interesting insight into the kinds of questions that experts in the field have on the topics presented, and will also answer some of the questions that readers may have as they move through the material. One editing weakness was a surprising number of typographical errors noted in the volume.

The great strength of this book is the incredible wealth of technical information that is presented. Of particular note are the diagrams and schematics of the various treatment wetland designs that are described. These are wonderfully comprehensive with details on size and dimensions, plumbing and drainage ways, substrate composition, planting strategies, and
sampling stations. An abundance of data is also presented, documenting nearly every aspect of wetland ecosystem mass cycles, and in many cases, mathematical models derived from the data area also presented. One particularly detailed case study by R. Kadlec even includes cost information. For those interested in the nuts and bolts of constructed wetland system engineering this book is a must have as it will be an invaluable resource. For others with perhaps a more general interest in the subject, the highly technical nature of the subject matter makes the reading a bit dry.

In sum, *Wetlands – nutrients, metals and mass cycling* is a collection of technically strong chapters detailing work to improve the engineering of wetlands for wastewater treatment. At a time when resources for environmental protection are becoming more scarce, tapping into this promising technology is more important than ever. This book has a place in guiding the way.