

Vymazal, J., Brix, H., Cooper, P.F., Green, M.B., Haberl, R. (ed.): **Constructed Wetlands for Wastewater Treatment in Europe**. - Backhuys Publishers, Leiden 1998. 366 pp. NLG 250.00. ISBN 90-73348-72-2.

This book is devoted to the European experience with constructed wetlands used for wastewater treatment. Such human-made wetlands, planted mostly with marsh plants such as *Phragmites australis*, *Typha* spp. or *Phalaris arundinacea*, came into wider use in Europe some two decades ago. Since then, many wetland systems for wastewater treatment, mostly with subsurface water flow, have been constructed in a number of European countries, despite unjustified criticism by some water technologists and managers. The most widespread are constructed wetlands planted with helophytes rooted in a bed filled with gravel or sand, or some composed soil, sometimes also called root-zone wastewater treatment plants. They are called so because the wastewater purification occurs in the helophytes' rhizosphere. Microorganisms associated with the plant roots and receiving oxygen from them, are assumed to mineralize organic substances and, to some extent, to remove nitrogen from the system through a combination of organic nitrogen mineralization, nitrification and denitrification, in a mosaic of anoxic and oxic microhabitats within the wetland bed. Mineral nutrient uptake by the plants plays an unimportant role in the wastewater treatment. The design and functioning of constructed wetlands should facilitate the deposition and immobilization of such nutrients as phosphorus or iron. Heavy metals should also be immobilized in the bed, but most of the constructed wetlands nowadays process municipal or agricultural wastewater, which is hardly ever excessively loaded with heavy metals. The functioning of a constructed wetland depends on two energy sources: *a)* organic matter contained in the treated wastewater, and *b)* photosynthates transported to the plant roots and eventually used by the rhizosphere microorganisms. In this respect, constructed wetlands are ecosystems depending, also, on solar energy input and thus requiring a relatively large area. The European Union recommends an area of about 5 m² per 1 PE (person equivalent of water pollution) and hence considers the use of constructed wetlands as purposeful for treating wastewater from sources polluted up to the level of about 1000 PE.

The idea of bringing together the European experience with constructed wetlands was conceived in 1994, and eventually altogether 34 authors from 15 countries contributed to this project. The respective countries, each represented by one chapter in the book, are: Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Norway, Poland, Portugal, Slovenia, Sweden, Switzerland, The Netherlands and the United Kingdom. Though the bulk of the book is occupied by these 15 chapters, two introductory chapters set the general framework for the book's topic. The first chapter is the

Introduction by J. Vymazal, briefly describing the principles of the design and functioning of constructed wetlands and their history, starting from Kaethe Seidel's experiments in 1952. It also provides a rich list of references. The second chapter, by J. Vymazal, H. Brix, P.F. Cooper, R. Haberl, R. Perfler and J. Laber, deals in considerable details with the removal mechanisms and types of constructed wetlands. The mechanisms of absorption, cation exchange, transformation, and other processes occurring in the wetland bed are explained. The survey of types of constructed wetlands includes not only root-zone treatment plants of various kinds, but also systems employing aquatic plants, especially free-floating ones (e.g., *Lemna* spp., *Eichhornia crassipes*), in which nutrient uptake by the plants becomes more important. The hydrological and hydrodynamic requirements on the materials used for filling the wetland bed are also outlined, and so are the structural and functional adaptations of aquatic and wetland plants used in different types of constructed wetlands. In Europe, the most widely used plant is *Phragmites australis*, so the techniques of its propagation and cultivation are briefly described as well. This comprehensive chapter (49 pp.) also includes an ample list of references.

The national contributions to this book naturally vary in size and scope, but each of them provides a survey of different types of constructed wetlands in use or under construction in the respective country. Highly useful, too, are the references to important papers and reports published in each country. Moreover, each national contribution gives essential information on the principal aspects of the design and functioning of various constructed wetlands in the respective country. Some examples of these wetlands are described and analysed in considerable detail, which makes each of the national contributions even more interesting. Each national contribution is well furnished with figures and tables, many of them contain a map of the sites with constructed wetlands. The numbers of constructed wetlands in operation are quite high (relative to the size of each country and its population density) in Austria, Bavaria (Germany) Czech Republic, Denmark, Slovenia, Switzerland and the United Kingdom. The Belgian contribution describes the design and operation of the largest constructed wetland in Europe, which is in northern France, but was designed by Belgian scientists from Arlon. The Dutch contribution tells us about completely newly made wetlands in the reclaimed IJsselmeer polders.

Apart from a rich subject index, the book is supplemented with a list of macrophyte species potentially useful in constructed wetlands, giving their

scientific Latin as well as vernacular English names. The book, as a whole, is a worthy counterpart to earlier North American books dealing with natural systems of wastewater treatment, also including constructed wetlands, *e.g.*, Dinges, R. (Natural Systems for Water Pollution Control. - Van Nostrand Reinhold Company, New York 1982), Reddy, K.R., Smith, W.H. (Aquatic Plants for Water Treatment and Resource Recovery. - Magnolia Publishing Inc., Orlando 1987), and Kadlec,

R.H., Knight, R.L. (Treatment Wetlands. - CRC Lewis Publishers, Boca Raton - New York 1996).

This book proves that Europe is going its own and carefully considered way in the design and use of constructed wetlands for wastewater treatment. The editors and contributing authors deserve our thanks for producing this book. It would be most useful if it were followed, in some 5 to 10 years, by another similar volume, describing the latest development.

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