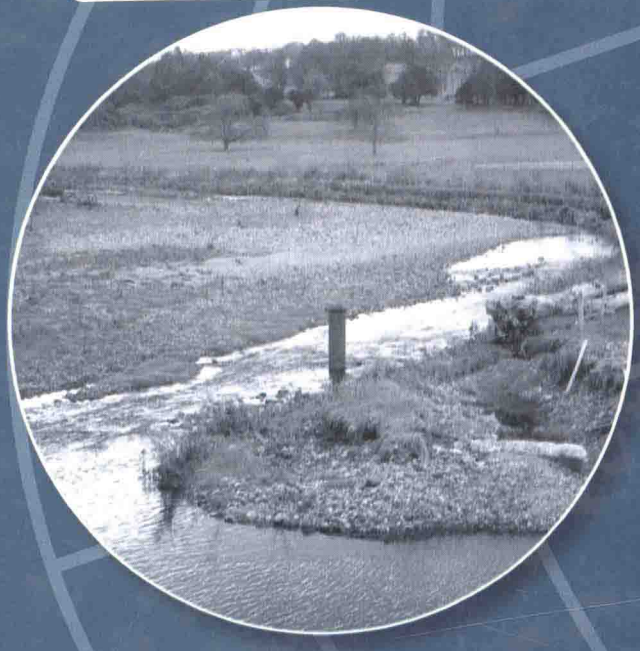
WOODHEAD PUBLISHING IN ENVIRONMENTAL MANAGEMENT



Functional assessment of wetlands

Towards evaluation of ecosystem services

Edited by Edward Maltby

CRC

WP

Functional assessment of wetlands

Towards evaluation of ecosystem services

Edited by
Edward Maltby

CRC Press
Boca Raton Boston New York Washington, DC

WOODHEAD PUBLISHING LIMITED
Oxford Cambridge New Delhi

Published by Woodhead Publishing Limited, Abington Hall, Granta Park
Great Abington, Cambridge CB21 6AH, UK
www.woodheadpublishing.com

Woodhead Publishing India Private Limited, G-2, Vardaan House, 7/28 Ansari Road,
Daryaganj, New Delhi – 110002, India

Published in North America by CRC Press LLC, 6000 Broken Sound Parkway, NW
Boca Raton FL 33487, USA

First published 2009, Woodhead Publishing Limited and CRC Press LLC

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library.

Library of Congress Cataloging in Publication Data
A catalog record for this book is available from the Library of Congress.

Woodhead Publishing ISBN 978-1-85573-834-8 (book)
Woodhead Publishing ISBN 978-1-84569-516-3 (e-book)
CRC Press ISBN 978-0-8493-2600-4
CRC Press order number WP2600

The publishers' policy is to use permanent paper from mills that operate a sustainable forestry policy, and which has been manufactured from pulp which is processed using acid-free and elemental chlorine-free practices. Furthermore, the publishers ensure that the text paper and cover board used have met acceptable environmental accreditation standards.

Typeset by Replika Press Pvt Ltd, India
Printed by CPI Antony Rowe, Chippenham, Wiltshire, UK

Functional assessment of wetlands

Introduction to SWIMMER

The Institute for Sustainable Water, Integrated Management and Ecosystem Research (SWIMMER) is a hub for water-related research within the University of Liverpool, UK. The Institute was established in 2005 to encourage integrated thinking among the water and environmental sciences, to promote interdisciplinary collaboration within the university and with other organisations, and to facilitate both fundamental and applied research through active partnerships with end-users.

Led by Professor Edward Maltby, the Institute has extensive experience in the science and management of wetlands, including scientific understanding of the hydrological, biogeochemical and ecological processes that support sediment and ecosystem functioning, and the consequent provision of ecosystem services and goods to human communities. SWIMMER's international outlook provides a focus for research into climate change, the water cycle, ecosystem functioning, and for pioneering work on the 'ecosystem approach', a methodological framework for achieving sustainability.

Commissioned research on behalf of government, supra-government and non-governmental organisations focuses on the development of tools such as functional assessment and decision-support systems. These facilitate more intelligent environmental management, and help manage urgent societal needs such as poverty alleviation, maintenance of essential ecosystem services and mitigation of climate change impacts. SWIMMER's website can be accessed through www.liv.ac.uk/swimmer/.

Registration details

It is anticipated that *Functional assessment of wetlands* will be both updated and expanded in the future. If you would like to know more about updates, please register with SWIMMER by contacting us at: swimmer@liv.ac.uk. Updating will be greatly enhanced by feedback from readers using the functional assessment procedures for themselves. We look forward to hearing your comments and suggestions.

Foreword

Wetlands perform functions that deliver benefits to society, often referred to as *ecosystem services*, as a result of the interactions that take place among natural processes within the structure of these ecosystems. However, wetlands do not all perform the same functions, nor is any one function carried out to the same extent or intensity among different wetland types. A functional approach to wetland assessment enables a holistic view to be taken of the wide range of services wetlands can provide. Some of these may be mutually exclusive, or else one service may be optimised only by reducing the effectiveness of another. The functional assessment procedures (FAPs) can be used to determine the likelihood of particular functions occurring, and how this may vary with changing environmental conditions and management. Questions can be addressed such as 'what are the implications for biodiversity or water quality regulation if water levels are raised by a given level?' The method can be used to indicate the potential and priorities for management options, and at what point further studies are required to improve the knowledge necessary for strategic land-use or site-specific management decisions to be made with more confidence.

The FAPs provide a methodology, which can be used by both experts and non-experts to assess wetland functioning relatively rapidly. Primarily this is achieved by the identification of key characteristics or predictors, which can be related to functions without the need for detailed studies. The most effective performance of some key functions, such as nitrate removal by denitrification, is sometimes focused on small discrete areas of the landscape. To cater for this, assessments are made of distinctive, often small areas of the wetland, characterised by features of hydrology and landform. Better understanding of such variation can lead to improved management and more satisfactory resolution of planning and land-use conflicts, offering options for alternative uses and addressing development pressures.

Previous development of sufficiently robust, science-based tools for wetland functional assessment has been impeded by the lack of integration of the wide range of specialised scientific and geographical perspectives necessary. However, a sequence of EC-funded research projects undertaken since 1991 was targeted largely to overcome this impediment through international and inter-disciplinary collaboration.

It is anticipated that the FAPs will be used by a range of individuals or organisations concerned with wetland management who wish to gain a better understanding of the processes, functions, services or benefits and potential of the wetlands for which they have responsibility or interests. The FAPs are a first step in providing guidance for on-site management and decision making by presenting information on how a wetland is likely to be functioning and the key processes operating within it. On a different level, the FAPs can assist strategic planners at local and catchment scales to make decisions on wetland management and land-use through assessment of overall wetland functioning and the contribution of wetlands to ecosystem services such as water quality, water quantity and biodiversity. Knowledge of functioning can be used to assist with the implementation of national and wider policy, such as the Water Framework Directive, where they can assist with decisions such as the location, type, number and area of wetland buffer zones required to deliver desired water quality benefits, or the risks to the integrity of water bodies and contiguous wetlands resulting from activities such as abstraction that affect water resources.

The modular structure of the package facilitates its expansion to include additional functions to meet the requirements of other specific users, such as the develop-

ment of a module for wetland archaeologists. The heritage value of wetlands derives mainly from the ability of waterlogged anoxic environments to preserve organic and associated archaeological evidence, which is otherwise rapidly destroyed by biological decay processes under the oxidised conditions that prevail when drying out takes place.

Assessment outcomes from the FAPs can be used in conjunction with other information relating to, for example, societal priorities, costings and policy limitations to assist and support environmental decision making. The FAPs translate best available scientific knowledge into reasonable predictions of how component parts of wetlands function in different landscape contexts. FAP outcomes are linked to societal priorities such as flood control, pollution reduction and biodiversity conservation. The FAPs recognise and emphasise the 'natural capital' of healthy wetland ecosystems, and reinforce the fact that wetland management is a question of choice: for individuals as well as society.

There have been at least three major developments over the gestation period of the FAPs, which underlie their potential significance and points of relevance to operational application:

1. elaboration of the Ecosystem Approach as the primary instrument for delivery of the objectives of the UN Convention on Biological Diversity (http://www.biodiv.org);
2. the UN Millennium Ecosystem Assessment (MA: http://www.maweb.org), which assesses the links between ecosystems and human wellbeing, governmental support through the Millennium Development Goals and the Plan of Implementation following the World Summit of Sustainable Development (http://www.un.org/events/wssd/);
3. in Europe, the development of a more integrated and holistic approach to water management through implementation of the Water Framework Directive (2000/60/EC).

The common philosophy underpinning the rationale behind these initiatives is the recognition that ecosystem functioning is directly or indirectly responsible for the delivery of goods and services that are essential to human welfare. The value of such benefits is sometimes recognised as the 'natural capital' of the world's ecosystems. There is considerable interest from the policy community in the development of methodologies for the assessment of ecosystem services as support to improved decision making in the management of natural resources. Wetlands deliver a wide range of ecosystem services that contribute to human wellbeing, such as water supply, flood regulation, water purification, climate regulation, biodiversity and productivity (e.g. of fish and grazing land) and amenity.

Functional assessment enables the user to predict the functioning of a wetland area without the need for comprehensive empirical research. This provides indicators for the quality and degree of delivery of specified ecosystem services. The link to specific ecosystem services has been developed subsequently through a geographical information system (GIS) mounted decision support tool called the Wetland Ecosystem Decision Support System (WEDSS; http://www.liv.ac.uk/swimmer/research/past_projects.html).

Application of the FAPs enables the user to make more informed and rational decisions about wetlands, based on the better understanding of how they work and what they are contributing, or could contribute, to various sectoral interest groups and to society as a whole.

Edward Maltby

Key contributors

Many individuals in institutions across Europe have contributed material to these procedures, both as scientific researchers and editorial contributors.

Core editorial team:
C. J. Baker
T. Barker
U. Digby
D. V. Hogan
E. Maltby
R. J. McInnes

Lead scientific authors:
K. H. Bishop
M. S. A. Blackwell
B. Clément
E. Maltby
D. Papadimos
M. Scholz
C. Schulz-Zunkel
M. Seferlis
J. Tellam
J. T. A. Verhoeven
M. L. Verhoeven
The Functional Assessment Procedures CD-ROM was programmed by A. Aidoud.

Contributing research personnel:

Wetland Ecosystems Research Group (now located at SWIMMER: Institute for Sustainable Water, Integrated Management and Ecosystem Research, University of Liverpool)
Principal Investigator: E. Maltby
Researchers: C. J. Baker, T. Barker, P. Cheesman, U. Digby, D. V. Hogan, A. Hooijer, M. Hutchins, C. P. Immirzi, E. C. Jewkes, I. Jones, J. N. Kellett, C. Linstead, R. J. McInnes, N. Melville, O. Paramour, F. Sgouridis, R. Thorne, J. E. Tollervey, M. D. Wood
Research students: M. S. A. Blackwell, M. J. Everington, N. J. Mockler, G. A. Oliver, M. A. Russell, M. Simpson

Free University of Amsterdam
Principal Investigator: B. Engelen
Researcher: A. Hooijer

University of Birmingham
Principal Investigator: J. W. Lloyd
Researchers: J. H. Tellam, K. S. J. Massey
Research student: K. Papatolios

University of Glasgow
Principal Investigator: K. J. Murphy
Researchers: C. Allan, T. H. Flowers, I. D. Pulford
Research students: V. Abernethy, J. M. Hills

Complutense University, Madrid
Principal Investigator; J. J. Sanz Donaire
Researchers: M. R. Llamas Madurga, J. Cruces de Abia, D. Díaz Alvarez, A. Sánchez Pérez de Evora
Research students: J. M. Fornés Azcoiti, M. García Rodríguez, E. Perez Gonzalez

Automonous University, Madrid
Researchers: C. Montes del Olmo, F. G. Bernáldez, C. Levassor, C. Guerrero,
Research student: M. Florín Beltrán

University of Rennes
Principal Investigator: B. Clément
Researchers: A. Aidoud, C. Faribault,
Research students: I. Gilles, B. Touzard, S. David

University of Utrecht
Principal Investigator: J. T. A. Verhoeven
Researchers: M. L. Verhoeven, A. Spink, R. Aerts
Research students: M. M. P. van Oorschot, M. J. van der Peijl, I. J. J. van den Wyngaert

Auen Institute, Rastatt
Principal Investigator: P. Obrdlik
Researchers: E. Castella, E. Schneider

The National Parks and Wildlife Service, Office of Public Works, Dublin
Principal Investigator: J. B. Ryan
Researchers: M. C. D. Speight, B. Healy, P. Galvin.

Swedish University of Agricultural Sciences
Principal Investigator: K. H. Bishop
Researcher: M. Nilsson
Research student: S. J. Köhler

Trinity College, Dublin
Principal Investigator: P. Johnson
Research student: O. Dubois

Station Biologique de la Tour du Valat, France
Researcher: P. Grillas

UFZ – Helmholtz Centre for Environmental Research
Principal Investigator: K. Henle
Researchers: C. Schulz-Zunkel, V. Eisenmann, O. Brandt, K. Henle, S. Geyer, H. Potesta, M. Scholz

Greek Biotope Wetland Centre (EKBY)
Researcher: M. Seferlis
Researchers: D. Papadimos, M. Anastasiadis

University of Bucharest
Principal Investigator: A. Vadineanu
Researcher: S. Christofor

Acknowledgements

We would like to acknowledge the following funding sources:

FAEWE I (Functional Analysis of European Wetland Ecosystems I), Contract STEP CT90 0084

FAEWE II (Functional Analysis of European Wetland Ecosystems II), Contract EV5V-CT95-0060

PROTOWET (Procedures for the Operationalisation of Techniques for the Functional Analysis of European Wetland Ecosystems), Contract ENV4-CT95-0060

EVALUWET (European Valuation and Assessment Tools supporting Wetland Ecosystem Legislation), Contract EVK1-CT-2000-00070

TECWET (Techniques and Procedures for the Functional Analysis of Wetland Ecosystems), Contract EVK1-2001-80001

ECOFLOOD (Towards Natural Flood Reduction Strategies), Contract EVK1-2002-00579

Euro-limpacs (Integrated Project to evaluate the Impacts of Global Change on European Freshwater Ecosystems), Contract GOCE-CT-2003-505540

Special acknowledgement is due to Dr Hartmut Barth, Scientific Programme Officer at the Directorate General Research of the European Commission, for his sustained support of the interdisciplinary scientific group contributing to this effort. Lastly to my wife, Rosemary Maltby, for forbearance and taking on many other unreasonable tasks whilst I indulged in the numerous international meetings leading eventually to this publication.

For
Rosemary, Alistair, Peter, Geoffrey and Penny

Preface

This document is a guidance manual and explanatory methodology for the procedures for functional assessment of wetlands, known commonly through its development as the FAPs. The FAPs process information entered by the user and transform the data into outputs that can assist in management decisions based on best available knowledge.

The paper version contains full instructions and supplementary guidance to enable a user to make an effective functional assessment of a wetland. The Functional Assessment Procedures CD-ROM takes much of the more tedious aspects out of the assessment once the initial recording stage is completed. It provides a full record of wetland processes, the functioning resulting from them, and their assessment. This information is stored electronically for future reference.

The essence of the FAPs is the conversion of documented and observable information into an interpretive picture of functioning in the wetland. It begins with desk-based studies, local knowledge and field observations of the characteristics and variables controlling processes that determine the functional characteristics of the wetland. This information constitutes a database against which to measure supplementary information obtained by examination of key variables that have important influences on specific aspects of wetland functioning.

The outputs of the assessment exercises can be used directly in order to evaluate a specific process or function in a defined part of the wetland, or can be combined to assess the overall performance of functions in part or all of the wetland area. This capability can be used to compare wetland areas for functional performance, for monitoring performance before and after management activities, or predicting the possible outcomes of different scenarios related to policy or environmental (such as climate) change. Outputs can be fed directly into the GIS-based computer programme Wetland Evaluation Decision Support System (WEDSS, downloadable free from the WEDSS page on the SWIMMER website http://www.liv.ac.uk/swimmer/research/past_projects.htm), which offers the option of asking 'what if' type questions about potential management strategies.

Both the FAPs and WEDSS provide practical methods of assessing and managing wetlands for optimal delivery of one or more of the important ecosystem services that they provide. The FAPs is an on-going project and future editions will greatly benefit from user feedback. The authors welcome your comments and suggestions.

Contents

Appraisal sheets and Look-up tables

Appraisal sheets are used to keep a record of answers to process-specific questions about the wetland area under study. The procedures select the appropriate description of wetland process performance using look-up tables. Wetland interactions are complex, sometimes involving more than one process to perform a single function.