

INTERNATIONAL HYDROLOGY SERIES



Hydrology and Water Management in the Humid Tropics

Hydrological research issues and strategies for water management

Edited by

Michael Bonell (*Department of Geography, James Cook University of North Queensland, Australia*)

Maynard M. Hufschmidt (*Program on Environment, East-West Center, Honolulu*)

John S. Gladwell (*Hydro Tech International Consultants, Vancouver and formerly UNESCO, Division of Water Sciences, Paris*)



 **CAMBRIDGE**
UNIVERSITY PRESS

G 12600

Contents

List of Authors	xi
Foreword by Federico Mayor, Director-General, UNESCO	xv
Preface	xvii
Cartographic Credit	xix
Acknowledgements	xx
 <i>SECTION I – INTRODUCTION</i>	
<i>1. The Objectives and Structure of this Book</i>	3
M. Bonell, M.M. Hufschmidt and J.S. Gladwell	
 <i>SECTION II – HUMID TROPICS SETTING</i>	
<i>2. Climate and Rainfall Variability in the Humid Tropics</i>	13
M.J. Manton and M. Bonell	
<i>3. Operational Hydrology Problems in the Humid Tropics</i>	34
R.E. Manley and A.J. Askew	
<i>4. The Problems of the Humid Tropics – Opportunities for Reassessment of Hydrological Methodology</i>	45
V. Klemeš	
 <i>SECTION III – REGIONAL HYDROLOGY</i>	
<i>5. Hydrology in Humid Tropical Asia</i>	55
J-H. Chang	
<i>6. The Hydrology and Water Resources of Humid Northern Australia and Papua New Guinea</i>	67
B.J. Stewart	
<i>7. Hydrology and Water Resources of Tropical Latin America and the Caribbean</i>	84
B. Griesinger and J.S. Gladwell	
<i>8. Amazonia Rainfall and Its Variability</i>	99
L.C.B. Molion	

<i>9. Regional Hydrology and Water Resources in the African Humid Tropics</i>	112
N.B. Ayibotele	
<i>10. Review of Hydrology and Water Resources of Humid Tropical Islands</i>	135
A.C. Falkland and J.P. Brunel	
 <i>SECTION IV – PHYSICAL PROCESSES</i>	
<i>11. Recent Scientific Developments and Research Needs in Hydrological Processes of the Humid Tropics</i>	167
M. Bonell with J. Balek	
<i>12. Groundwater Systems in the Humid Tropics</i>	261
S.S.D. Foster and P.J. Chilton	
<i>13. Perspectives on the Hydrology and Water Resource Management of Natural Freshwater Wetlands and Lakes in the Humid Tropics</i>	273
A. Bullock	
<i>14. Erosion and Sedimentation</i>	301
C.W. Rose	
<i>15. Water Quality Issues in the Humid Tropics</i>	344
M-A. Roche	
<i>16. Ecological Characteristics of Tropical Fresh Waters: An Outline</i>	367
H.L. Golterman, M.J. Burgis, J. Lemoalle and J.F. Talling	
 <i>SECTION V – PHYSICAL PROCESSES – HUMAN USES: THE INTERFACE</i>	
<i>17. Challenges in Agriculture and Forest Hydrology in the Humid Tropics</i>	395
R. Lal	
<i>18. The Impact of Land-Use Change on Water Resources in the Tropics: An Australian View of the Scientific Issues</i>	405
P.M. Fleming	
<i>19. Urban Water Management Problems in the Humid Tropics: Some Technical and Non-Technical Considerations</i>	414
J.S. Gladwell	
<i>20. The Management of Water Resources, Development and Human Health in the Humid Tropics</i>	437
A. Prost	
<i>21. Water Supply and Health in the Humid Tropics with Particular Reference to Rural Areas</i>	454
P. Wurzel	
 <i>SECTION VI – MANAGEMENT ISSUES</i>	
<i>22. Water Resource Management</i>	471
M.M. Hufschmidt	
<i>23. Water Management Issues: Population, Agriculture and Forests – A Focus on Watershed Management</i>	496
K.G. Tejwani	
<i>24. Urban Water Resources in the Humid Tropics: An Overview of the ASEAN Region</i>	526
K.S. Low	
<i>25. Urban Water Problems in the Humid Tropics</i>	535
G. Lindh and J. Niemczynowicz	

<i>Contents</i>	ix
<i>26. Rethinking Urban Water Supply and Sanitation Strategy in Developing Countries in the Humid Tropics: Lessons from the International Water Decade</i>	547
Y-S. F. Lee	
<i>27. Water Resource Management Issues in the Humid Tropics</i>	556
G. Le Moigne and U. Küffner	
 <i>SECTION VII – APPENDICES</i>	
 <i>Appendix A Definition of the Humid Tropics</i>	571
J-H. Chang and L.S. Lau	
<i>Appendix B Workshop Reports</i>	
Hydrological Processes Workshop	575
A. Bullock	
Erosion and Sedimentation Workshop	576
V. Nogueira	
Water Quality Control Workshop	577
B.J. Stewart	
Water Resource Management Workshop	580
D.S. McCauley and E. van Beek	
<i>Appendix C Committees for the ‘International Colloquium on the Development of Hydrologic and Water Management Strategies in the Humid Tropics’</i>	584
Organising Committee	584
Coordinating Committee	584
<i>Appendix D Organizations Supporting UNESCO and UNEP in the presentation of the Colloquium</i>	586
Place index	587

Published by the Press Syndicate of the University of Cambridge
The Pitt Building, Trumpington Street, Cambridge CB2 1RP
40 West 20th Street, New York, NY 10011-4211, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia
and United Nations Educational, Scientific and Cultural Organisation
7 Place de Fontenoy, Paris, France

© UNESCO 1993

First published 1993

Printed in Great Britain at the University Press, Cambridge

A catalogue record for this book is available from the British Library

Library of Congress cataloguing in publication data applied for

Cambridge University Press ISBN 0 521 45268 6 hardback
UNESCO ISBN 92 3 102854 5

The designations employed and the presentation of material throughout this publication do not imply the expression of any opinion whatsoever on the part of the UNESCO Secretariat concerning the legal status of any country, territory, city or area or of its authorities, or the delimitations of its frontiers or boundaries.