Environmental problems in the humid tropical regions, where the focus is on the fate and management of the surviving rainforest and climate change, are attracting increasing international attention. The distribution of tropical rainfall is highly variable, and in many regions the supply of potable water is inadequate. By the end of the century one-third of the world’s population will be living in the humid tropics. This book considers all aspects of hydrology in the humid tropics.

The first four parts of the book cover the physical basis of hydrology in the humid tropics: climatology, meteorology, process hydrology, sedimentation, water quality and freshwater ecology. This is followed by extensive treatment of the human and societal issues: land-use changes, water resource management, and rural and urban water supply in the tropical regions. The book is a uniquely integrated summary of hydrology in the tropics.
Hydrology and water management in the humid tropics
Hydrological research issues and strategies for water management
INTERNATIONAL HYDROLOGY SERIES

Hydrology and Water Management in the Humid Tropics

Hydrological research issues and strategies for water management

Edited by
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Foreword

It is widely recognized that water is going to be one of the major issues confronting humanity at the turn of the century and beyond. We are already facing a crisis as regards the quantity and quality of water supply, but we have yet to experience the full social and political impact of that crisis. Water is the life-blood of living organisms, and a very potent factor in human behaviour. Where plentiful, water is accepted unreflectively as a gift of nature. But when scarcity makes it a precious commodity, it can become a source of dispute and even conflict between its users. We know that civilization has always been crucially dependent on water. It is essential to remember that the converse is also true: vital water resources depend upon civilization, or more precisely on the "civilized" use of a finite and vulnerable resource. Culture and tradition are therefore important dimensions to be taken into account in water conservation.

The interdependence of water and civilization highlights the need for close co-operation among all players in the water game, extending from the local through the regional right up to the global level. At the international level, one of the most important needs is for co-ordinated efforts to understand the processes occurring in the water cycle, to assess surface and ground water resources, and to promote attitudes conducive to maintaining the quality and quantity of water resources for generations to come. Recognition of the importance of these objectives led to the launching of the International Hydrological Decade (IHD) in 1964, the first truly international scientific and educational effort ever made in hydrology.

IHD proved a truly remarkable example of international co-operation and, despite the formidable political and ideological barriers that existed at the time, yielded unique results in assessing the world’s water resources. Yet important gaps remain, particularly in the application of scientific advances to the solution of practical problems. Economic and social activities tend to aggravate difficulties arising from the natural fluctuations in the hydrological regime, and the human impact on water resources increases with population growth and the spread of urbanization. Such problems, it was felt, could best be tackled by further strengthening international and regional co-operative efforts. In 1974, UNESCO decided to set up the long-term International Hydrological Programme (IHP) with the aim of finding solutions to the specific problems of countries with different geographical and climatic conditions and at various levels of technological and economic development. IHP was thus launched as an intergovernmental programme and today constitutes, together with the Man and the Biosphere (MAB) programme, the Intergovernmental Oceanographic Commission (IOC) and the International Geophysical Correlation Programme (IGCP), the scientific backbone of UNESCO’s environmental activities.

The general objective of the IHD, and later of the IHP, was to improve the scientific and technological basis and the human resource base for the rational development and management of water resources, including the protection of the environment. The pursuit of this objective is closely bound up with the search for solutions to such crucial problems as the lack of reliable water supplies and sanitation, shortage of food and fibre, inadequate supplies of electrical energy, pollution of surface and ground waters, erosion and sedimentation, floods, drought and desertification. Attaining the general objective presupposes advances in knowledge and their effective application in a number of fields. In particular, a better understanding is required of the hydrological cycle as affected by man in terms of both quantity and quality under various climatic conditions.

The water resource situation in the developing countries will present a serious challenge to water management well into the twenty-first century. The challenge for water users, educators, planners, managers, policy-makers and politicians is how to devise policies that will be environmentally sound yet will contribute effectively to meeting social and economic goals. World leaders meeting at the Earth Summit in Rio de Janeiro in June 1992 acknowledged that protecting our rapidly changing and increasingly vulnerable environment will call for the deployment of our best legal, organizational and scientific efforts. A continued focus on satisfying short-term needs is a recipe for disaster. Greater attention must be given among other things to providing a scientifically valid basis for integrated resource development which takes into consideration both socio-cultural factors and the safeguarding of our natural heritage for future generations. The need for hydrological...
science as a foundation for integrated water management can thus only increase, and this is what the International Hydrological Programme of UNESCO has set out to satisfy, with the overriding goal of helping nations to help themselves.

It is great pleasure to launch the International Hydrology Series as a joint undertaking of UNESCO’s International Hydrological Programme and Cambridge University Press, and I hope that this first volume concerned with the humid tropics will prove useful in the context of addressing the hydrological and water resources problems with which our planet is confronted.

Federico Mayor
Director-General of UNESCO

May 1993
Preface

The humid tropics are a treasure-house of natural resources. Beside making up twenty-two per cent of the globe’s land area or 29.4 million km², these warm and humid areas hold most of the world’s uncut forest, most of the unexploited hydroelectric power and most of the world’s genetic riches among their estimated 30 million species of plants and animals. They may also contain vast, untapped supplies of minerals.

A significant proportion of the world’s developing countries lie within the humid tropics and adjacent areas, and estimates suggest that by the year 2000 some 33% of the global population or more than two billion people will inhabit the humid regions.

The environmental and social problems found in the humid tropics are particularly complementary – and nearly all are related to water in some way. They are a result of population and land-use pressures and the failure to consider water resource management adequately within the context of general development plans for the region.

Until recently, little coordinated attention was paid to studying the hydrology of the humid tropics. With plentiful rainfall, apparently endless forests, and major rivers – like the Mekong, the Irrawaddy, the Ganges–Brahmaputra of East and South Asia, the Congo and Niger of Africa, and the Amazon and its South American tributaries – dominating the landscapes, it did not seem that water could be a problem.

UNESCO’s International Hydrological Programme (IHP) has for several years realized the importance of the humid tropics and has organized projects to study various aspects of its hydrology and managing its water. In April 1987, the IHP-III Working Group connected with Project 4.2 (Hydrology of Humid Tropical Areas) met at the University of Hawaii’s Water Resources Research Center. In recognition of the escalation in socio-economic problems of the humid tropics and the urgency of the need to address the associated water management issues, it was proposed that a more comprehensive programme needed to be developed under the auspices of the IHP. An international meeting was suggested to formulate the directions of this programme.

In October 1987, the planning process for such a meeting was started at UNESCO headquarters (Paris) by Dr. John S. Gladwell and Dr. Michael Bonell. This included identifying from a diverse range of literature what was perceived to be the most critical water management issues and the formulation of a proposed structure for the meeting. An Organizing Committee was later established and met at the Environment and Policy Institute, East-West Center, Honolulu, Hawaii in February 1988 to consider existing planning proposals and the terms of reference for the international meeting. The Committee also addressed the scope of a major programme for action.

The result was a decision to hold an international meeting during July 1989 under the title of the “International Colloquium on the Development of Hydrologic and Water Management Strategies in the Humid Tropics.” The offer of the James Cook University of North Queensland, Townsville, Australia to serve as the site of the Colloquium was also accepted. Dr. Michael Bonell agreed to serve as Chairman of the Organizing and subsequently Co-ordinating Committees, and to work closely with the Project Officer, Dr. John S. Gladwell, in the preparations for the colloquium.

Plans were then made for some 70 experts from around the world to be invited to the colloquium, with a number to prepare papers for discussion. Four workshops were scheduled to follow the general sessions at which recommendations for follow-up actions would be developed. It was made clear that the important output of the colloquium would be the recommendations for action – not just what needed to be done, but equally important, how needed action should be implemented. (Many of the workshop recommendations are now in the process of being put into action.)

Following the colloquium, it was decided that the papers that had been produced, and the workshop results, should be considered for publication. On the other hand, simply publishing a proceedings of the colloquium would not suffice. As a result, an Editorial Committee was constituted in February 1990. The members of that group carefully reviewed the existing material and concluded that the basis for a book existed, but that considerable editorial work would be needed. All authors who contributed to the colloquium were requested to revise (in some cases very extensively) their manuscripts over...
the 1990–92 period. It was also decided that several additional topics should be included and invitations to additional authors were initiated.

The result of these actions and the contributions of many people are represented in this book. However, while this book is a very important contribution to the humid tropics programme of the IHP, it is necessary that the total programme be understood. In addressing the water resource problems in the humid tropics, the International Hydrological Programme has chosen a three-pronged approach. First, there is the scientific component stressing hydrological research as the basis for all other actions. Then there is a management component, by which water managers, technicians and policy planners are exposed to the demands – and the rewards – of taking a broader view of natural resources and development. Finally, there is the information and training component, which distributes knowledge by building networks for the exchange of information. A major effort to produce documents suitable for the higher level decision-makers and for the public is also underway.

In order to accomplish the various activities foreseen as needed (and this book explores many, if not most, of them), networks of water and water-related experts and research organizations involved in warm humid region hydrology and water management studies are being established. Three regional centres (Latin America and the Caribbean, Africa, Asia) and a fourth on the special problems of small islands of the warm humid tropics are being established. The centres are intended to serve within each of their assigned areas as focal points for networks of research programmes, knowledge and technology transfer activities, including the development of literature, symposia, seminars and workshops. In addition, they will serve for the coming together of established and younger scientists for short periods of study on specific subjects.

The International Hydrological Programme, of which the Humid Tropics programme is a part, also works through a number of networks, one of which is that of the national committees for the IHP. These networks will be used in implementing regionally-coordinated cooperative studies and capacity-building that is deemed to be essential for the development and maintenance of programmes leading to the rational management of water resources.

This book, which the IHP is very pleased to present to the scientific and water management community of the humid tropics, will serve in defining the future of its own programme. It is considered that this is one of the few monographs to integrate scientific and management aspects in a comprehensive way such that the problems and water-related issues of the humid tropics might be better understood. As such, it is hoped that it will be accepted by the professional community as a contribution to the solution of the many difficulties that have been identified in the region.

We wish to express our appreciation and indebtedness to the many individuals – authors, participants in the colloquium, editors, and other contributors – for their major effort that went into the preparation of this volume.

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UNESCO, Division of Water Sciences
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In the event we have omitted any persons or institutions who should be recognized, please accept our apologies and thanks.

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