

**ENVIRONMENTAL
ISOTOPES**
in the
HYDROLOGICAL CYCLE

Principles and Applications

W. G. Mook
editor

VOLUME III
SURFACE WATER

by

Kazimierz Rozanski Univ. of Mining and Metallurgy, Krakow
Klaus Froehlich previously IAEA, Vienna
Willem G. Mook Groningen Univ., The Netherlands

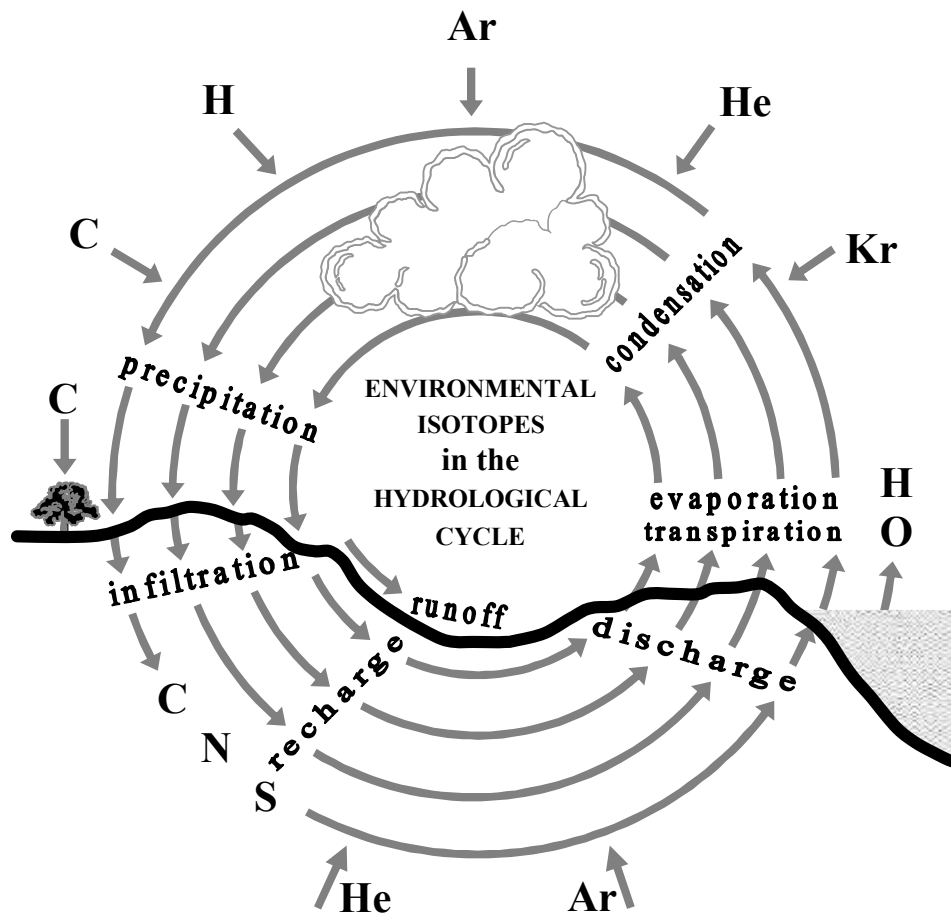
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UNESCO/IAEA Series on

Environmental Isotopes in the Hydrological Cycle
Principles and Applications

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- Volume I Introduction: Theory, Methods, Review
- Volume II Atmospheric Water
- Volume III Surface Water
- Volume IV Groundwater: Saturated and Unsaturated Zone
- Volume V Man's Impact on Groundwater Systems
- Volume VI Modelling



Contributing Author

W. Stichler, GSF-Institute of Hydrology, Neuherberg, Germany

PREFACE

The availability of freshwater is one of the great issues facing mankind today - in some ways the greatest, because problems associated with it affect the lives of many millions of people. It has consequently attracted a wide scale international attention of UN Agencies and related international/regional governmental and non-governmental organisations. The rapid growth of population coupled to steady increase in water requirements for agricultural and industrial development have imposed severe stress on the available freshwater resources in terms of both the quantity and quality, requiring consistent and careful assessment and management of water resources for their sustainable development.

More and better water can not be acquired without the continuation and extension of hydrological research. In this respect has the development and practical implementation of isotope methodologies in water resources assessment and management been part of the IAEA's programme in nuclear applications over the last four decades. Isotope studies applied to a wide spectrum of hydrological problems related to both surface and groundwater resources as well as environmental studies in hydro-ecological systems are presently an established scientific discipline, often referred to as "Isotope Hydrology". The IAEA contributed to this development through direct support to research and training, and to the verification of isotope methodologies through field projects implemented in Member States.

The world-wide programme of the International Hydrological Decade (1965-1974) and the subsequent long-term International Hydrological Programme (IHP) of UNESCO have been an essential part of the well recognised international frameworks for scientific research, education and training in the field of hydrology. The International Atomic Energy Agency (IAEA) and UNESCO have established a close co-operation within the framework of both the earlier IHD and the ongoing IHP in the specific aspects of scientific and methodological developments related to water resources that are of mutual interest to the programmes of both organisations.

The first benchmark publication on isotope hydrology entitled "Guidebook on Nuclear Techniques in Hydrology" was realised in 1983 through the activity of the joint IAEA/UNESCO Working Group on Nuclear Techniques established within the framework of IHP, and it has been widely used as practical guidance material in this specific field.

In view of the fact that the IHP's objectives include also a multi-disciplinary approach to the assessment and rational management of water resources and taking note of the advances made in isotope hydrology, the IAEA and UNESCO have initiated a joint activity in preparation of

a series of six up-to-date textbooks, covering the entire field of hydrological applications of natural isotopes (environmental isotopes) to the overall domain of water resources and related environmental studies.

The main aim of this series is to provide a comprehensive review of basic theoretical concepts and principles of isotope hydrology methodologies and their practical applications with some illustrative examples. The volumes are designed to be self-sufficient reference material for scientists and engineers involved in research and/or practical applications of isotope hydrology as an integral part of the investigations related to water resources assessment, development and management. Furthermore, they are also expected to serve as “Teaching Material” or text books to be used in universities and teaching institutions for incorporating the study of "isotopes in water" in general into the curriculum of the earth sciences. Additionally the contents can fulfil the need for basic knowledge in other disciplines of the Earth Sciences dealing with water in general.

These six volumes have been prepared through efforts and contributions of a number of scientists involved in this specific field as cited in each volume, under the guidance and co-ordination of the main author/co-ordinating editor designated for each volume. W.G.Mook (Netherlands), J.Gat (Israel), K.Rozanski (Poland), M.Geyh (Germany), K.P.Seiler (Germany) and Y.Yurtsever (IAEA, Vienna) were involved as the main author/co-ordinating editors in preparation of these six volumes, respectively. Final editorial work on all volumes aiming to achieve consistency in the contents and layout throughout the whole series was undertaken by W.G.Mook (Netherlands).

Mr.Y. Yurtsever, Staff Member of the Isotope Hydrology Section of the IAEA; and Ms. A. Aureli, Programme Specialist, Division of Water Sciences of UNESCO, were the Scientific Officers in charge of co-ordination and providing scientific secretariat to the various meetings and activities that were undertaken throughout the preparation of these publications.

The IAEA and UNESCO thank all those who have contributed to the preparation of these volumes and fully acknowledge the efforts and achievements of the main authors and co-ordinating editors.

It is hoped that these six volumes will contribute to wider scale applications of isotope methodologies for improved assessment and management of water resources, facilitate incorporation of isotope hydrology into the curricula of teaching and education in water sciences and also foster further developments in this specific field.

Paris / Vienna, March 2000

PREFACE TO VOLUME III

The third volume in the series of textbooks on the environmental isotopes in the hydrological cycle deals with surface water. From man's perspective, this is perhaps the most visible and most accessible part of the global hydrological cycle. Indeed, development of human civilisation over the past millennia was always intimately linked to availability of water; civilisations flourished and died in the rhythm of climatic cycles controlling availability and abundance of freshwater in many parts of the world.

The industrialised world brought new dimensions into ever-persisting relationship between man and water. Particularly this century saw dramatic impact of man's activities on surface water systems in a form of massive and widespread pollution of these systems with numerous pollutants of various nature: organic compounds, heavy metals, oil products, agrochemicals, etc. In many instances natural cleaning capacities of those systems were surpassed with the resulting conversion of numerous rivers and lakes into biologically dead sewage channels and reservoirs. Although growing concern has led in many parts of the world to gradual control of this impact, pollution of surface water systems still remains one of the central problems related to management of global water resources.

This series of 6 volumes are meant to be in first instance textbooks helping young people to apply environmental isotope methodologies in addressing various practical problems related to the hydrological cycle. Practical approach was adopted also throughout Volume III. Three core chapters of this volume (Chapter 2, 3 and 4) deal with rivers, estuaries and lake systems, respectively. Systematic presentation of possibilities offered by various isotope tracers in addressing questions related to the dynamics of surface water systems, their interaction with groundwater and vulnerability to pollution is pursued throughout those two chapters. Practical hints and suggestions are given how to carry on environmental isotope investigation. The volume closes with an outlook to future of surface water systems in the light of anticipated global warming induced by greenhouse gases.

Krakow, Vienna, Groningen

K. Rozanski
K. Froehlich
W. G. Mook

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