Scale Problems In Hydrology Runoff Generation And Basin Response

Encyclopedia

of Geology, Second Edition presents in six volumes state-of-the-art reviews on the various aspects of geologic research, all of which have moved on

considerably since the writing of the first edition. New areas of discussion include extinctions, origins of life, plate tectonics and its influence on

faunal provinces, new types of mineral and hydrocarbon deposits, new methods of dating rocks, and geological processes. Users will find this to be a

fundamental resource for teachers and students of geology, as well as researchers and non-geology professionals seeking up-to-date reviews

of geologic research. Provides a comprehensiv e and accessible one-stop shop for information on the subject of geology, explaining methodologies

and technical jargon used in the field Highlights connections between geology and other physical and biological sciences, tackling research

problems that span multiple fields Fills a critical gap of information in a field that has seen significant progress in past years Presents an ideal

reference for a wide range of scientists in earth and environmental areas of study Scale Problems in HydrologyRunoff Generation and Basin ResponseSpringer

Science & Business Media

The last few years have witnessed an enormous interest in application of GIS in hydrology and water

resources. This is partly evidenced by organization of sev eral national and international symposia or conferences under the sponsorship of various

professional organizations. This increased interest is, in a large measure, in response to growing public sensitivity to environmental quality and management.

The GIS technology has the ability to capture, store, manipulate, analyze, and visualize the diverse sets of geo-referenced data. On the

other hand, hydrology is inherently spatial and distributed hydrologic models have large data requirements. The integration of hydrology and

GIS is therefore quite natural. The integration involves three major components: (1) spatial data construction, (2) integration

of spatial model layers, and (3) GIS and model interface. GIS can assist in design, calibration, modification and comparison of models. This

integration is spreading worldwide and is expected to accelerate in the foreseeable future. Substantial op portunities exist in integration of

GIS and hydrology. We believe there are enough challenges in use of GIS for conceptualizing and modeling complex hydrologic processes and

for globalization of hydrology. The motivation for this book grew out of the desire to provide under one cover a range of applications of

GIS technology in hydrology. It is hoped that the book will stimulate others to write more comprehensive texts on this subject of growing

importance. Frequent drought events have recently occurred in different Mediterranean regions. These have highlighted a general

inadequacy of the current strategies applied to mitigate negative impacts of such phenomenon. This book provides various

methods of drought monitoring at different spatial scales, as well as innovative drought forecasting techniques based on stochastic

approaches. Besides common drought indices (i.e. SPI), new agro meteorological indices are proposed.

An Approach Using Copulas Water-Rock

Interaction Parameter Identification and Inverse Problems in Hydrology, Geology and Ecology Rainfall-Runoff Modelling An Approach Based on

Cluster Analysis Hilbert-Huang Transform Analysis of Hydrological and Environmental Time Series

Since the pioneering work of Shannon in

the late 1940's on the development of the theory of entropy and the landmark contributions of Jaynes a decade later leading to the development of the principle of maximum

entropy (POME), the concept of entropy has been increasingly applied in a wide spectrum of areas, including chemistry, electronics and communications engineering,

data acquisition and storage and retreival, data monitoring network design, ecology, economics, environmental engineering, earth sciences, fluid mechanics,

genetics, geology, geomorphology, geophysics, geotechnical engineering, hydraulics, hydrology, image processing, management sciences, operations

research, pattern recognition and identification, photogrammetry, psychology, physics and quantum mechanics, reliability analysis, reservoir engineering,

statistical mechanics, thermodynamics, topology, transportation engineering, turbulence modeling, and so on. New areas finding application of entropy have since continued

to unfold. The entropy concept is indeed versatile and its applicability widespread. In the area of hydrology and water resources, a range of applications of

entropy have been reported during the past three decades or so. This book focuses on parameter estimation using entropy for a number of distributions frequently used in hydrology.

In the entropy-based parameter estimation the distribution parameters are expressed in terms of the given information, called constraints. Thus, the method lends

itself to a physical interpretation of the parameters. Because the information to be specified usually constitutes sufficient statistics for the

distribution under consideration, the entropy method provides a quantitative way to express the information contained in the distribution. Since the greenhouse

effect emerged as a predictable threat, necessitating the evalu ation of its future impact on the environment in the various parts of the globe, interest in the climate

changes during the Holocene has gained momentum. The background can be summarized by the sentence: The past is a key to the future. As a matter of fact, this sentence is in

the opposite direction, on the dimension of time, to the principle adopted by the founders of the science of geology. They proposed that geological processes in the present

should be used as a key for understanding the past. Another reason for the interest in the history of the climate of the Holocene can be described as the renaissance of a modified

deterministic approach to the inter relation between physical and human geography. This relates in the first place to the fact that various investigations, especially as

carried out by Hubert Lamb, showed that the sequence of climate changes previously suggested by Blytt and Sernander for Europe and adopted by most Holocene climatologists

was far too general, and that there were more climate changes during recent history than previously taken account of. In the second place it was found out that these changes had had

an impact on the history of human communities. Thus, one can conclude that once the taboo on geographical determinism (i. e. Modeling of the rainfall-runoff process is of

both scientific and practical significance. Many of the currently used mathematical models of hydrologic systems were developed a genera tion ago. Much of the effort

since then has focused on refining these models rather than on developing new models based on improved scientific understanding. In the past few years, however, a renewed

effort has been made to improve both our fundamental understanding of hydrologic processes and to exploit technological advances in computing and remote sensing. It is against

this background that the NATO Advanced Study Institute on Recent Advances in the Modeling of Hydrologic Systems was organized. The idea for holding a NATO ASI on this topic grew out

of an informal discussion between one of the co-directors and Professor Francisco Nunes-Correia at a previous NATO ASI held at Tucson, Arizona in 1985. The Special Program

Panel on Global Transport Mechanisms in the Geo-Sciences of the NATO Scientific Affairs Division agreed to sponsor the ASI and an organizing committee was formed. The

committee comprised the co directors, Professor David S. Bowles (U.S.A.) and Professor P. Enda O'Connell (U.K.), and Professor Francisco Nunes-Correia (Portugal), Dr.

Donn G. DeCoursey (U.S.A.), and Professor Ezio Todini (Italy). The Brahmaputra River represents nearly 30% of India's water resources potential and 41% of its

total hydropower. No sustainable future for this underdeveloped region can occur without a plan combining social, political, economic, cultural, and legal

considerations with scientific paradigms. This book pools the talent, knowledge and experience of a wide range of water resource professionals to provide an exhaustive study of the

Brahmaputra River basin, present and future.

The Rio Chagres, Panama Observations, Models and Analysis

Volume 4: Effective Environmental Management for

Sustainable Development Water Supply Management

The Brahmaputra Basin Water Resources

Water-Quality Hydrology

To face the threats to the water supply and to maintain

sustainable water management policies, detailed knowledge is needed on the surface-to-subsurface transformation link in the water cycle. Recharge flux is covered in this book as well as many other groundwater

issues, including a comparison of the traditional and modern approaches to determine groundwater recharge. The authors also explain in detail the fate of groundwater recharge in the subsurface by

hydraulic and geologic means, in order to stimulate adapted groundwater-management strategies.

R. S. GOVINDARAJU and ARAMACHANDRA RAO School of Civil Engineering Purdue

University West Lafayette, IN. , USA Background and Motivation The basic notion of artificial neural networks (ANNs), as we understand them today, was perhaps first formalized by McCulloch and Pitts

(1943) in their model of an artificial neuron. Research in this field remained somewhat dormant in the early years, perhaps because of the limited capabilities of this method and because there was no clear

indication of its potential uses. However, interest in this area picked up momentum in a dramatic fashion with the works of Hopfield (1982) and Rumelhart et al. (1986). Not only did these studies place artificial neural

networks on a firmer mathematical footing, but also opened the dOOf to a host of potential applications for this computational tool. Consequently, neural network computing has progressed rapidly along all fronts:

theoretical development of different learning algorithms, computing capabilities, and applications to diverse areas from neurophysiology to the stock market. . Initial studies on artificial neural

networks were prompted by adesire to have computers mimic human learning. As a result, the jargon associated with the technical literature on this subject is replete with expressions such as excitation and

inhibition of neurons, strength of synaptic connections, learning rates, training, and network experience. ANNs have also been referred to as neurocomputers by people who want to preserve this

analogy.

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Linsky National Water Research Institute Fountain Valley, California, United States Gina Melin National Water Research Institute Fountain Valley, California, United States 1. What is Riverbank Filtration? The

purpose ofthis book is to show that riverbank filtration (RBF) isa low-cost and efficient alternative water treatment for drinking-water applications. There are two immediate benefits to the increased use of

RBF: Minimized need for adding chemicals like disinfectants and coagulants to surface water to control pathogens. Decreased costs to the community without increased risk to human health.

Butwhat,exactly, isRBF? In humid regions, river water naturally percolates through the ground into aquifers (which are layers of sand and gravel that contain water underground) during high-flow conditions. In arid

regions, most rivers lose flow, and the percolating water passes through soil and aquifer material until it reaches the water table. During these percolation processes, potential contaminants present in river water are filtered

and attenuated. If there are no other contaminants present in the aquifer or ifthe respective contaminants are present at lower concentrations, the quality of water in the aquifer can be ofhigher quality

than that found in theriver. In RBF, production wells — which are placed near the banks ofrivers —pump large quantities ofwater.

The chemical interaction of water and rock is one of the most fascinating

an d multifaceted process in geology. The composition of surface water and groundwater is largely controlled by the reaction of water with rocks and minerals. At elevated temperature, hydrothermal

features, hydrothermal 0 re deposits and geothermal fields are associated with chemical effects of water-rock interaction. Surface outcrops of rocks from deeper levels in the crust, including exposures

of lower crustal and mantle rocks, often display structures that formed by interaction of the rocks with a supercritical aqueous fluid at very high pT conditions. Understanding water-rock

interaction is also of great importance to applied geology and geochemistry, particularly in areas such as geothermal energy, nuclear waste repositories and applied hydrogeology. The extremely wide-ranging research

efforts on the universal water-rock interaction process is reflected in the wide diversity of themes presented at the regular International Symposia on Water-Rock Interaction (WRI). Because of the large and

widespread interest in water-rock interaction, the European Union of Geosciences organized a special symposium on "water-rock interaction" at EUGI0, the biannual meeting in Strasbourg 1999

convened by the editors of this volume. In contrast to the regular WRI symposia addressed to the specialists, the EUG 10 "water-rock interaction" symposium brought the subject to a general platform This very successful

symposium showed the way to the future of water-rock reaction research. Proceedings of an International Conference Held at the Technical University of Braunschweig, Germany, 10-14 March 1997

Capillary Flows in Heterogeneous and Random Porous Media

Chaos in Hydrology

A Multidisciplinary Profile of a Tropical Watershed

Extremes in Nature

Papers from the Symposium "Understanding of

Hydrologic Processes at the Basin Scale"

Water is vital to life, maintenance of ecological balance, economic development, and sustenance of civilization. Planning and

management of water resources and its optimal use are a matter of urgency for most countries of the world, and even more so for India with a huge population. Growing population and

expanding economic activities exert increasing demands on water for varied needs--domestic, industrial, agricultural, power generation, navigation,

recreation, etc. In India, agriculture is the highest user of water. The past three decades have witnessed numerous advances as well as have presented intriguing

challenges and exciting opportunities in hydrology and water resources. Compounding them has been the growing environmental consciousness. Nowhere are these challenges

more apparent than in India. As we approach the twenty first century, it is entirely fitting to take stock of what has been accomplished and what remains to be accomplished,

and what accomplishments are relevant, with particular reference to Indian conditions.

It is well known that the interactions between land surfaces and the

atmosphere, and the resulting exchanges in water and energy have a tremendous affect on climate. The inadequate representation of land-atmosphere interactions is a major weakness

in current climate models, and is providing the motivation for the HAPEX and ISLSCP experiments as well as the proposed Global Energy and Water Experiment (GEWEX) and the

Earth Observing System (EOS) mission. The inadequate representation reflects the recognition that the well-known phys ical relationships, which are well described at

small scales, result in different relationships when represented at the scales used in climate models. Understanding this transition in the mathematical relationships with

increased space-time scales appears to be very difficult, and has led to different approaches; at one extreme, the famous "bucket" model where the land-surface is a simple one layer

storage without vegetation; the other extreme may be Seller's Simple Biosphere Model (Sib) where one big leaf covers the climate model grid. Given the heterogeneous nature of

landforms, soils and vegetation within a climate model grid, the development of new land surface parameterizations, and their verification through large scale experiments is

perceived to be a challenging area of research for the hydrology and meteorology communities. This book evolved from a workshop held at Princeton University to explore the

status of land surface parameterizations within climate models, and how observa tional data can be used to assess these parameterizations and improve models.

Supply of

sufficient clean drinking water is often taken for granted, but it requires a considerable technical and financial effort to ensure reliable and economic water supply. This volume

presents an up-to-date overview of water supply management and aims at efficient management of water supply schemes rather than design of new works. Various chapters of the book are

devoted to water demands, management of reservoirs and conjunctive use of alternative sources. Asset management and loss control are also considered. Water quality and provision of

water to developing communities are also discussed. Water supply management is of concern to developed urban environments as well as developing communities. The

book will be equally valuable to the practising water engineer and the newcomer or graduate student in the subject. During the past decade many countries in the world have

experienced droughts, with severe impacts on water urban supply systems. Because droughts are natural phenomena, water utilities must design and implement

drought management plans. This topic was selected for the International Course on Drought Management Planning in Water Supply Systems, which took place in Valencia,

Spain, on 9-12 December 1997, and was hosted by the Universidad Internacional Menéndez y Pelayo (UIMP). The contributions in this book have been carefully selected and

presented in four sections: Introduction Water Supply Systems Modernization Drought Management in an Urban Context Practical Cases (Israel, USA, Italy, Spain) To achieve

a well-balanced approach, authors were invited from academia as well as from consultancies and water utilities, and have wide experience in the subject. The book is

mainly aimed at water supply engineers, working in utilities and consultancies. Monday, 17 June-Thursday, 20 June 1996, Hotel Schloß, Krumbach, Near Vienna, Austria

Commemorating the 150th Anniversary of the American Society of Civil Engineers

The Primer

Selected Water Resources Abstracts

Scale Problems in Hydrology

Distributed Hydrologic Modeling Using GIS

Africa, the cradle of many old civilizations, is the second largest world continent, and the homeland of

nearly one-eighth of the world population. Despite Africa's richness in natural resources, the average income per person, after excluding a few

countries, is the lowest all over the world, and the percentage of inhabitants infected with contagious diseases is the highest. Development of Africa to help accommodate the

ever-increasing population and secure a reasonable living standard to all inhabitants, though an enormous challenge is extremely necessary. Water is the

artery of life, without it all living creatures on earth cannot survive. As such, a thorough knowledge of the meteorological and hydrological

processes influencing the yield and quality of the water resources, surface and subsurface, and their distribution and variability in time and space is

unavoidable for the overall development of any part of the world. It is highly probable that the said knowledge is at present a top priority to Africa, a continent that has been for so

long-and probably still-devastated by the endless ambitions of colonial powers not to forget the corruption and destruction practiced by the internal powers, at least in some

countries. The present book “Hydrology and Water Resources of Africa” is written with the aim of bringing together in one volume a fair amount of knowledge any professional

involved in hydrology and water resources of Africa needs to know.

This report contains 27 papers that serve as a testament to the state-of-the-art of civil

engineering at the outset of the 21st century, as well as to commemorate the ASCE's Sesquice ntennial. Written by the leading practitioners, educators, and researchers of

civil engineering, each of these peer-reviewed papers explores a particular aspect of civil engineering knowledge and practice. Each paper explores the development of a particular

civil engineering specialty, including milestones and future barriers, constraints, and opportunities. The papers celebrate the history,

heritage, and accomplishments of the profession in all facets of practice, including construction facilities, special structures, engineering mechanics,

surveying and mapping, irrigation and water quality, forensics, computing, materials, geotechnical engineering, hydraulic engineering, and transportation

engineering. While each paper is unique, collectively they provide a snapshot of the profession while offering thoughtful predictions of likely developments in

the years to come. Together the papers illuminate the mounting complexity facing civil engineering stemming from rapid growth in scientific knowledge, technological

development, and human populations, especially in the last 50 years. An overarching theme is the need for systems-level approaches and consideration from

undergraduate education through advanced engineering materials, processes, technologies, and design methods and tools. These papers speak to the need for

civil engineers of all specialties to recognize and embrace the growing interco nnectedness of the global infrastructure, economy, society, and the need to work for more

sustainable, li fe-cycle-oriented solutions. While embracing the past and the present, the papers collected here clearly have an eye on the future needs of ASCE and the

civil engineering profession. Hydrogeology of Crystalline Rocks deals with deep groundwater in the granite and gneiss basement of the continents. It has become

evident during the past years that highly mineralized water is present in an interconnected fracture network of the basement. Thus, the upper part of the crust of the continents

can be viewed as an aquifer and investigated with tools common in hydrogeology. This book presents accounts on wat er-conducting features of crystalline

rocks and summarizes the hydraulic properties of the basement. The volume includes reviews, new data and research on the often remarkable chemical

composition of deep groundwater. Microbial processes in the deep basement aquifer are probably more important than previously thought. Two contributions

focus on this recent extension of research of the biosphere to greater depth in the Earth. This book represents the first multidisc iplinary and integrated account of deep

groundwater hydrology in crystalline basement. It is of interest to hydrologists and hydrogeologists working with water in crystalline rocks, but also to solid earth

geophysicists, geochemists and petrologists with an interest in fluids in the crust. Scientists involved in nuclear waste disposal programs and geothermal

energy development will find a wealth of stimulating ideas in this volume. Capillary phenomena occur in both natural and human-made systems, from equilibria in

the presence of solids (grains, walls, metal wires) to multiphase flows in heterogeneous and fractured porous media. This book, composed of two volumes, develops fluid

mechanics approaches for two immiscible fluids (water/air or water/oil) in the presence of solids (tubes, joints, grains, porous media). Their hydrodynamics are typically

dominated by capillarity and viscous dissipation. This first volume presents the basic concepts and investigates two-phase equilibria, before analyzing two-

phase hydrodynamics in discrete and/or statistical systems (tubular pores, planar joints). It then studies flows in heterogeneous and stratified porous media,

such as soils and rocks, based on Darcy's law. This analysis includes unsaturated flow (Richards equation) and two-phase flow (Muskat equations). Overall, the

two volumes contain basic physical concepts, theoretical analyses, field investigations and statistical and numerical approaches to c apillary-driven equilibria and flows in

heterogeneous systems

Geographical Information Systems in Hydrology

Managing Urban Water Supply

Improving Efficiency and Reliability in Water Distribution

Systems Methods and Tools for Drought Analysis and Management Regionalization in Hydrology Proceedings from the UIMP International Course held in Valencia,

December 1997

We, the editors, have long believed that a strong knowledge of relatively simple economic and engineering concepts is valuable in solving water management problems. The lack of such knowledge

has been apparent to us in some of the journal articles, research proposals and books we have reviewed. The articles which have been written concerning specific local water economies and management issues are scattered over a

wide variety of journals, making them hard to access. Most of the extensive water resources literature is concerned with large regional water projects or with narrow technical and regional issues. This book was written to make

practical economic and engineering concepts readily available to urban water supply managers, thereby filling a gap in the available literature. It is concerned with decisions made daily, monthly, or annually by managers of urban

water supply systems. The book includes basic chapters presenting supply and cost concepts, calculation of demand elasticities, use of marketing concepts, public goods analysis, water markets, industrial water

demand and the use of price in water conservation. The authors have included multiple examples of how these concepts can aid in managing urban water supply. The water provider is generally a governmental entity or regulated private

utility. Most books on public utilities and their management emphasize gas, electricity, or telephone rather than water. Water is different because of m~or variations in quality by source and the necessity for proper disposal

of waste water. Clustering techniques are used to identify groups of watersheds which have similar flood characteristics. This book, the first of its kind, is a comprehensive reference on how to use these techniques for

regional flood frequency analysis. It provides a detailed account of several recently developed clustering techniques, including those based on fuzzy set theory. It also brings together formerly scattered

research findings on the application of clustering techniques to RFFA. The Hilbert-Huang Transform (HHT) is a recently developed technique used to analyze nonstationary data. This book uses methods based on

the Hilbert-Huang Transform to analyze hydrological and environmental time series. These results are compared to the results from the traditional methods such as those based on Fourier transform and other classical statistical

tests.

The Workshop on Parameter Identification and Inverse Problems in Hydrology, Geology and Ecology, Karlsruhe, April 10-12, 1995, was organized to bring to gether an interdisciplinary group drawn from

the areas of science, engineering and mathematics for the following purposes: - to promote, encourage and influence more understanding and cooperation in the community of parameter identifiers from various disciplines, -

to forge unity in diversity by bringing together a variety of disciplines that attempt to understand the reconstruction of inner model parameters, un known nonlinear constitutive relations,

heterogeneous structures inside of geological objects, sources or sinks from observational data, - to discuss modern regularization tools for handling improperly posed pro blems and strategies of incorporating a

priori knowledge from the applied problem into the model and its treatment. These proceedings contain some of the results of the workshop, representing a bal anced selection of contributions from the various groups of participants. The

reviewed invited and contributed articles are grouped according to the broad headings of hydrology, non-linear diffusion and soil physics, geophysical methods, mathematical analysis of inverse and ill-posed

problems and parallel algorithms for inverse problems. Some of the issues adressed by the articles in these proceedings include the rela tion between least squares and direct formulations of inverse problems for partial

differential equations, nonlinear regularization, identification of nonlinear consti tutive relations, fast parallel algorithms for large scale inverse problems, reduction of model structures, geostatistical inversion

techniques.

Drought Management

Planning in Water Supply Systems

Recent Advances in the Modeling of Hydrologic Systems

Bridging Determinism and Stochasticity

Contributions from an International

Workshop within the framework of International Hydrological Program (IHP) UNESCO, held at Ben-Gurion University, Sede Boker, Israel from 7–12 July 1996 Perspectives in Civil Engineering Stochastic and

Statistical Methods in Hydrology and Environmental Engineering

This is the first book of its kind to focus on the geochemistry of the lanthanide series

elements in groundwater/aquifer environments. The contributors are leading researchers in the study of low-temperature geochemistry of rare earth

elements. Individual chapters address analytical techniques, water-rock interactions, aqueous complexation, and the reactions and

processes that influence these heavy metals along groundwater flow paths. This book examines one of the most important and complex of the world's

tropical rainforest regions: the greater Panama Canal Watershed. The Rio Chagres is the primary water source for operating the Canal, and supplies

potable water for municipal use and electricity generation, but science has left this important national resource largely unstudied. The

text promotes understanding of the physical and ecological components of an isolated and largely pristine tropical rainforest. This

authoritative book presents a comprehensive account of the essential roles of nonlinear dynamic and chaos theories in understanding,

modeling, and forecasting hydrologic systems. This is done through a systematic presentation of: (1) information on the salient ch aracteristics

of hydrologic systems and on the existing theories for their modeling; (2) the fundamentals of nonlinear dynamic and chaos theories,

methods for chaos identification and prediction, and associated issues; (3) a review of the applications of chaos theory in hydrology; and

(4) the scope and potential directions for the future. This book bridges the divide between the deterministic and the stochastic schools in

hydrology, and is well suited as a textbook for hydrology courses. Conventionally, time series have been studied either in the time domain or the frequency

domain. The representation of a signal in the time domain is localized in time, i.e . the value of the signal at each instant in time is well defined .

However, the time representation of a signal is poorly localized in frequency , i.e. little information about the frequency content of the

signal at a certain frequency can be known by looking at the signal in the time domain . On the other hand, the representation of a signal in the frequency

domain is well localized in frequency, but is poorly localized in time, and as a consequence it is impossible to tell when certain events occurred in time. In

studying stationary or conditionally stationary processes with mixed spectra , the separate use of time domain and frequency domain analyses is

sufficient to reveal the structure of the process . Results discussed in the previous chapters suggest that the time series analyzed in

this book are conditionally stationary processes with mixed spectra. Additionally, there is some indication of nonstationarity, especially in longer time series.

Nonstationarities in Hydrologic and Environmental Time Series Artificial Neural Networks in Hydrology Hydrology and Water Resources of

Africa Runoff Generation and Basin Response Proceedings of the Hydrogis'96 Conference Held in Vienna, Austria, from 16 to 19 April

1996 Improving Source-Water Quality

Partial contents: Relative role of hillslope and network geometry in hydrologic response;

Nonlinearity and time-variance of the hydrologic response of a small mountain creek; Runoff simulation model based on hillslope topography; Geomorphologic approach to

synthesis of direct runoff hydrograph from the Upper Tiber River Basin, Italy; Spatial heterogeneity and scale in the infiltration response of catchments; Runoff

production and flood frequency in catchments of order n: an alternative approach; Study of scale effects in flood frequency response; Scales, gravity and network structure in

basin runoff; Averaging properties of channel networks using methods in stochastic branching theory; Incorporation of channel losses in the geomorphologic

IUH. (Instantaneous Unit Hydrograph).

Keywords: Watersheds; Runoff measurement.

A special workshop on scale problems in hydrology was held at

Princeton University, Princeton, New Jersey, during October 31-November 3, 1984. This workshop was the second in a series on this general topic. The proceedings of the first

workshop, held in Caracas, Venezuela, in January 1982, appeared in the Journal of Hydrology (Volume 65:1/3, 1983). This book contains the papers presented at the second

workshop. The scale problems in hydrology and other geophysical sciences stem from the recognition that the mathematical relationships describing a physical

phenomenon are mostly scale dependent in the sense that different relationships manifest at different space-time scales. The broad scientific problem then is to identify and

for mulate suitable relationships at the scales of practical interest, test them experimen tally and seek consistent analytical connections between these relationships

and those known at other scales. For example, the current hydrologic theories of evaporation, infiltration, subsurface water transport and water sediment

transport overland and in channels etc. derive mostly from laboratory experiments and therefore generally apply at "small" space-time scales. A rigorous extrapolation

of these theories to large spatial and temporal basin scales, as mandated by practical considerations, appears very difficult. Consequently, analytical formulations of

suitable hydrologic theories at basin wide space-time scales and their experimental verification is currently being perceived to be an exciting and challenging

area of scientific research in hydrology. In order to successfully meet these challenges in the future, this series of workshops was initiated. This book

presents multi-disciplinary analyses of the environmental effects and implications in Bangladesh and India of the Ganges water diversion. The analyses demonstrate that the

downstream part of the Ganges River basin in Bangladesh, which has a sensitive ecosystem, has become very vulnerable to water diversion and as a result it has caused significant

damage to many economic sectors and ecosystems. Areas upstream of the Farakka Barrage in India have become more vulnerable to floods and riverbank erosion. The

Kolkata Port has marginally benefited from the water diversion. In the Hooghly River estuary, populations of flora and fauna have thrived. In the downstream areas of

Bangladesh costly adaptation measures have been adopted and in many cases damages are irreparable. A regional cooperative framework is presented to

foster water resources and environmental development in the Ganges River basin. This book contains the lectures given in the International Course "Improving

efficiency and reliability in water supply systems", hosted and sponsored by the Menendez Pelayo International University (U.I.M.P.) and co-sponsored by Aguas de

Valencia, the British Council and the EC Cornett and Erasmus programmes. The short course took place in Valencia (Spain) in November 1994, with an attendance of

more than one hundred delegates. We must not only acknowedge and thank Dr. Joaquin Azagra, as UIMP Director, but also his collaborators D. Luis Moreno and Lidia Lopez

for their support in the preparation of the Course and during the course taking place. UIMP sponsorship allowed us to assemble in Valencia an eminent cadre of lecturers

coming from all over the world, that covered in an ordered and precise fashion some of the more relevant aspects on efficiency and reliability in water supply systems. We are very thankful

to all these leading lecturers for their invaluable cooperation. The publication of this book and the Spanish edition as well, have been made possible thanks to the

sponsorship of both Polytechnic University of Valencia througout its Chancellor, Justo Nieto, and Aguas de Valencia throughout its General Director Alvaro

Aguirre. We must also thank Kluwer Academic Publishers and especially their Publisher Petra van Steenbergen for her assistance, careful presentation and production of the book.

Rare Earth Elements in Groundwater Flow Systems

Application of Geographic Information Systems in Hydrology and Water Resources Management

Hydrogeology of Crystalline

Rocks
The Ganges Water Diversion
Encyclopedia of Geology

Rainfall-Runoff Modelling: The Primer, Second Edition isthe follow-up of this popular and authoritative text, firstpublished

in 2001. The book provides both a primer for the noviceand detailed descriptions of techniques for more advancedpractitioners, covering rainfall-runoff models and their practicalapplications. This new edition extends these aims to includeadditional

chapters dealing with prediction in ungauged basins,predicting residence time distributions, predicting the impacts ofchange and the next generation of hydrological models. Giving acomprehensive summary of

available techniques based on establishedpractices and recent research the book offers a thorough andaccessible overview of the area. Rainfall-Runoff Modelling: The Primer SecondEdition focuses on predicting

hydrographs using modelsbased on data and on representations of hydrological process.Dealing with the history of the development of rainfall-runoffmodels, uncertainty in mode predictions, good and bad practice andending with a

look at how to predict future catchment hydrologi calresponses this book provides an essential underpinning ofrainfall-runoff modelling topics. Fully revised and updated version of this highly populartext Suitable for both novices in

the area and for more advancedusers and developers Written by a leading expert in the field Guide to internet sources for rainfall-runoff modellingsoftware 1. 5 REFERENCES 127 7 DIGITAL TERRAIN 129 1. 1 INTRODUCTION 129 1. 2

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