

# **ENTROPY THEORY<sup>IN</sup> HYDROLOGIC SCIENCE<sup>AND</sup> ENGINEERING**

**Vijay P. Singh**

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# Entropy Theory In Hydrologic Science And Engineering

**Lan Zhang, V. P. Singh**



## **Entropy Theory In Hydrologic Science And Engineering:**

*Entropy Theory in Hydrologic Science and Engineering* Vijay Singh, 2015-01-05 A THOROUGH INTRODUCTION TO ENTROPY THEORY AND ITS APPLICATIONS IN HYDROLOGIC SCIENCE AND ENGINEERING This comprehensive volume addresses basic concepts of entropy theory from a hydrologic engineering perspective The application of these concepts to a wide range of hydrologic engineering problems is discussed in detail The book is divided into sections preliminaries rainfall and evapotranspiration subsurface flow surface flow and environmental considerations Helpful equations solutions tables and diagrams are included throughout this practical resource Entropy Theory in Hydrologic Science and Engineering covers Introduction to entropy theory Maximum entropy production principle Performance measures Morphological analysis Evaluation and design of sampling and measurement networks Precipitation variability Rainfall frequency distributions Evaluation of precipitation forecasting schemes Assessment of potential water resources availability Evaporation Infiltration Soil moisture Groundwater flow Rainfall runoff modeling Streamflow simulation Hydrologic frequency analysis Streamflow forecasting River flow regime classification Sediment yield Eco index

**Entropy Theory in Hydrologic Science and Engineering** Vijay P. Singh, 2014-09-22 A THOROUGH INTRODUCTION TO ENTROPY THEORY AND ITS APPLICATIONS IN HYDROLOGIC SCIENCE AND ENGINEERING This comprehensive volume addresses basic concepts of entropy theory from a hydrologic engineering perspective The application of these concepts to a wide range of hydrologic engineering problems is discussed in detail The book is divided into sections preliminaries rainfall and evapotranspiration subsurface flow surface flow and environmental considerations Helpful equations solutions tables and diagrams are included throughout this practical resource Entropy Theory in Hydrologic Science and Engineering covers Introduction to entropy theory Maximum entropy production principle Performance measures Morphological analysis Evaluation and design of sampling and measurement networks Precipitation variability Rainfall frequency distributions Evaluation of precipitation forecasting schemes Assessment of potential water resources availability Evaporation Infiltration Soil moisture Groundwater flow Rainfall runoff modeling Streamflow simulation Hydrologic frequency analysis Streamflow forecasting River flow regime classification Sediment yield Eco index

*Entropy Theory and its Application in Environmental and Water Engineering* Vijay P. Singh, 2013-01-10 Entropy Theory and its Application in Environmental and Water Engineering responds to the need for a book that deals with basic concepts of entropy theory from a hydrologic and water engineering perspective and then for a book that deals with applications of these concepts to a range of water engineering problems The range of applications of entropy is constantly expanding and new areas finding a use for the theory are continually emerging The applications of concepts and techniques vary across different subject areas and this book aims to relate them directly to practical problems of environmental and water engineering The book presents and explains the Principle of Maximum Entropy POME and the Principle of Minimum Cross Entropy POMCE and their applications to different types of probability distributions Spatial and

inverse spatial entropy are important for urban planning and are presented with clarity Maximum entropy spectral analysis and minimum cross entropy spectral analysis are powerful techniques for addressing a variety of problems faced by environmental and water scientists and engineers and are described here with illustrative examples Giving a thorough introduction to the use of entropy to measure the unpredictability in environmental and water systems this book will add an essential statistical method to the toolkit of postgraduates researchers and academic hydrologists water resource managers environmental scientists and engineers It will also offer a valuable resource for professionals in the same areas governmental organizations private companies as well as students in earth sciences civil and agricultural engineering and agricultural and rangeland sciences This book Provides a thorough introduction to entropy for beginners and more experienced users Uses numerous examples to illustrate the applications of the theoretical principles Allows the reader to apply entropy theory to the solution of practical problems Assumes minimal existing mathematical knowledge Discusses the theory and its various aspects in both univariate and bivariate cases Covers newly expanding areas including neural networks from an entropy perspective and future developments

**Entropy Applications in Environmental and Water Engineering** Huijuan Cui, Bellie Sivakumar, Vijay P. Singh, 2019-03-07 Entropy theory has wide applications to a range of problems in the fields of environmental and water engineering including river hydraulic geometry fluvial hydraulics water monitoring network design river flow forecasting floods and droughts river network analysis infiltration soil moisture sediment transport surface water and groundwater quality modeling ecosystems modeling water distribution networks environmental and water resources management and parameter estimation Such applications have used several different entropy formulations such as Shannon Tsallis Rnyi Burg Kolmogorov Kapur configurational and relative entropies which can be derived in time space or frequency domains More recently entropy based concepts have been coupled with other theories including copula and wavelets to study various issues associated with environmental and water resources systems Recent studies indicate the enormous scope and potential of entropy theory in advancing research in the fields of environmental and water engineering including establishing and explaining physical connections between theory and reality The objective of this Special Issue is to provide a platform for compiling important recent and current research on the applications of entropy theory in environmental and water engineering The contributions to this Special Issue have addressed many aspects associated with entropy theory applications and have shown the enormous scope and potential of entropy theory in advancing research in the fields of environmental and water engineering

**Entropy-Based Parameter Estimation in Hydrology** V.P. Singh, 2013-04-17 Since the pioneering work of Shannon in the late 1940s 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 retrieval 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

Copulas and their Applications in Water Resources Engineering Lan Zhang, V. P. Singh, 2019-01-10 Complex environmental and hydrological processes are characterized by more than one correlated random variable These events are multivariate and their treatment requires multivariate frequency analysis Traditional analysis methods are however too restrictive and do not apply in many cases Recent years have therefore witnessed numerous applications of copulas to multivariate hydrologic frequency analyses This book describes the basic concepts of copulas and outlines current trends and developments in copula methodology and applications It includes an accessible discussion of the methods alongside simple step by step sample calculations Detailed case studies with real world data are included and are organized based on applications such as flood frequency analysis and water quality analysis Illustrating how to apply the copula method to multivariate frequency analysis engineering design and risk and uncertainty analysis this book is ideal for researchers professionals and graduate students in hydrology and water resources engineering

*Stochastic and Statistical Methods in Hydrology and Environmental Engineering* Keith W. Hipel, 2012-12-06 Objectives The current global environmental crisis has reinforced the need for developing flexible mathematical models to obtain a better understanding of environmental problems so that effective remedial action can be taken Because natural phenomena occurring in hydrology and environmental engineering usually behave in random and probabilistic fashions stochastic and statistical models have major roles to play in the protection and restoration of our natural environment Consequently the main objective of this edited volume is to present some of the most up to date and promising approaches to stochastic and statistical modelling especially with respect to groundwater and surface water applications Contents As shown in the Table of Contents the book is subdivided into the following main parts GENERAL ISSUES PART I PART II GROUNDWATER PART III SURFACE WATER PART IV STOCHASTIC OPTIMIZATION PART V MOMENT ANALYSIS PART VI OTHER TOPICS Part I raises some thought provoking issues about probabilistic modelling of hydro logical and environmental systems The first two papers in Part I are

in fact keynote papers delivered at an international environmetrics conference held at the University of Waterloo in June 1993 in honour of Professor T E Unny In his keynote paper Dr S J Burges of the University of Washington places into perspective the historical and future roles of stochastic modelling in hydrology and environmental engineering Additionally Dr Burges stresses the need for developing a sound scientific basis for the field of hydrology Professor P E

**Mechano-Electric Correlations in the Human Physiological System** A. Bakiya, K. Kamalanand, R. L. J. De Britto, 2021-04-28 The aim of Mechano Electric Correlations in the Human Physiological System is to present the mechanical and electrical properties of human soft tissues and the mathematical models related to the evaluation of these properties in time as well as their biomedical applications This book also provides an overview of the bioelectric signals of soft tissues from various parts of the human body In addition this book presents the basic dielectric and viscoelastic characteristics of soft tissues an introduction to the measurement and characteristics of bioelectric signals and their relationship with the mechanical activity electromyography and the correlation of electromyograms with the muscle activity in normal and certain clinical conditions The authors also present a case study on the effect of lymphatic filariasis on the mechanical and electrical activity of the muscle Features Explains the basics of electrical and mechanical properties of soft tissues in time and frequency domain along with the mathematical models of soft tissue mechanics Explores the correlation of electrical properties with the mechanical properties of biological soft tissues using computational techniques Provides a detailed introduction to electrophysiological signals along with the types applications properties problems and associated mathematical models Explains the electromechanics of muscles using electromyography recordings from various muscles of the human physiological system Presents a case study on the effect of lymphatic filariasis on the mechanical and electrical activity of the muscle Mechano Electric Correlations in the Human Physiological System is intended for biomedical engineers researchers and medical scientists as well graduate and undergraduate students working on the mechanical properties of soft tissues

Advances in Streamflow Forecasting Priyanka Sharma, Deepesh Machiwal, 2021-06-20 Advances in Streamflow Forecasting From Traditional to Modern Approaches covers the three major data driven approaches of streamflow forecasting including traditional approach of statistical and stochastic time series modelling with their recent developments stand alone data driven approach such as artificial intelligence techniques and modern hybridized approach where data driven models are combined with preprocessing methods to improve the forecast accuracy of streamflows and to reduce the forecast uncertainties This book starts by providing the background information overview and advances made in streamflow forecasting The overview portrays the progress made in the field of streamflow forecasting over the decades Thereafter chapters describe theoretical methodology of the different data driven tools and techniques used for streamflow forecasting along with case studies from different parts of the world Each chapter provides a flowchart explaining step by step methodology followed in applying the data driven approach in streamflow forecasting This book addresses challenges in

forecasting streamflows by abridging the gaps between theory and practice through amalgamation of theoretical descriptions of the data driven techniques and systematic demonstration of procedures used in applying the techniques Language of this book is kept simple to make the readers understand easily about different techniques and make them capable enough to straightforward replicate the approach in other areas of their interest This book will be vital for hydrologists when optimizing the water resources system and to mitigate the impact of destructive natural disasters such as floods and droughts by implementing long term planning structural and nonstructural measures and short term emergency warning Moreover this book will guide the readers in choosing an appropriate technique for streamflow forecasting depending upon the given set of conditions Contributions from renowned researchers experts of the subject from all over the world to provide the most authoritative outlook on streamflow forecasting Provides an excellent overview and advances made in streamflow forecasting over the past more than five decades and covers both traditional and modern data driven approaches in streamflow forecasting Includes case studies along with detailed flowcharts demonstrating a systematic application of different data driven models in streamflow forecasting which helps understand the step by step procedures

**Handbook of Applied Hydrology, Second Edition** Vijay P. Singh, 2016-03-07 Fully Updated Hydrology Principles Methods and Applications Thoroughly revised for the first time in 50 years this industry standard resource features chapter contributions from a who's who of international hydrology experts Compiled by a colleague of the late Dr Chow Chow's Handbook of Applied Hydrology Second Edition covers scientific and engineering fundamentals and presents all new methods processes and technologies Complete details are provided for the full range of ecosystems and models Advanced chapters look to the future of hydrology including climate change impacts extraterrestrial water social hydrology and water security Chow's Handbook of Applied Hydrology Second Edition covers The Fundamentals of Hydrology Data Collection and Processing Hydrology Methods Hydrologic Processes and Modeling Sediment and Pollutant Transport Hydrometeorologic and Hydrologic Extremes Systems Hydrology Hydrology of Large River and Lake Basins Applications and Design The Future of Hydrology

**Risk Analysis Based on Data and Crisis Response Beyond Knowledge** Chongfu Huang, Zoe Nivolianitou, 2019-10-11 This book collects the papers presented at the 7th International Conference on Risk Analysis and Crisis Response RACR 2019 held in Athens Greece on October 15-19 2019 The overall theme of the seventh international conference on risk analysis and crisis response is Risk Analysis Based on Data and Crisis Response Beyond Knowledge highlighting science and technology to improve risk analysis capabilities and to optimize crisis response strategy This book contains primarily research articles of risk issues Underlying topics include natural hazards and major chemical accidents prevention disaster risk reduction and society resilience information and communication technologies safety and cybersecurity modern trends in crisis management energy and resources security critical infrastructure nanotechnology safety and others All topics include aspects of multidisciplinary and complexity of safety in education and research The book should be valuable to professors engineers

officials businessmen and graduate students in risk analysis and risk management      *Introduction to Tsallis Entropy Theory in Water Engineering* Vijay P. Singh, 2016-01-05 Focuses On an Emerging Field in Water Engineering A broad treatment of the Tsallis entropy theory presented from a water resources engineering point of view Introduction to Tsallis Entropy Theory in Water Engineering fills a growing need for material on this theory and its relevant applications in the area of water engineering This self contained      **Engineering Hydrology: An Introduction to Processes, Analysis, and Modeling** Sharad K. Jain, Vijay P. Singh, 2019-03-08 Publisher's Note Products purchased from Third Party sellers are not guaranteed by the publisher for quality authenticity or access to any online entitlements included with the product Understand the fundamentals methods and processes of modern hydrology This comprehensive engineering textbook offers a thorough overview of all aspects of hydrology and shows how to apply hydrologic principles for effective management of water resources It presents detailed explanations of scientific principles along with real world applications and technologies Engineering Hydrology An Introduction to Processes Analysis and Modeling follows a logical progression that builds on foundational concepts with modern hydrologic methods Every hydrologic process is clearly explained along with current techniques for modeling and analyzing data You will get practice problems throughout that help reinforce important concepts Coverage includes The hydrologic cycle Water balance Components of the hydrologic cycle Evapotranspiration Infiltration and soil moisture Surface water Groundwater Water quality Hydrologic measurements Streamflow measurement Remote sensing and geographic information systems Hydrologic analysis and modeling Unit hydrograph models River flow modeling Design storm and design flood estimation Environmental flows Impact of climate change on water management

Thermodynamic Approaches in Engineering Systems Stanislaw Sieniutycz, 2016-05-20 Thermodynamic Approaches in Engineering Systems responds to the need for a synthesizing volume that throws light upon the extensive field of thermodynamics from a chemical engineering perspective that applies basic ideas and key results from the field to chemical engineering problems This book outlines and interprets the most valuable achievements in applied non equilibrium thermodynamics obtained within the recent fifty years It synthesizes nontrivial achievements of thermodynamics in important branches of chemical and biochemical engineering Readers will gain an update on what has been achieved what new research problems could be stated and what kind of further studies should be developed within specialized research Presents clearly structured chapters beginning with an introduction elaboration of the process and results summarized in a conclusion Written by a first class expert in the field of advanced methods in thermodynamics Provides a synthesis of recent thermodynamic developments in practical systems Presents very elaborate literature discussions from the past fifty years

Sustainability of Water Resources Basant Yadav, Mohit Prakash Mohanty, Ashish Pandey, Vijay P. Singh, R. D. Singh, 2022-10-29 This book covers a wide spectrum of water resources management including water supply and demand operation and maintenance of water distribution systems water quality assessment impacts of climate change on hydrological



extremes and water governance Rapid urbanization industrialization and population growth are the major factors contributing to a significant rise in water demands across all the sectors in India Although the Indian Summer Monsoon Rainfall contributes primarily to the available surface and groundwater resources recurrent non uniform erratic rainfall events have resulted in widespread water scarcity On many occasions extreme meteorological conditions trigger the severity of water related disasters such as floods and droughts The untreated wastewater from domestic and industrial sources discharged through un engineered means adds to the issue as it ends up polluting the surface and groundwater resources

**Entropy Measures, Maximum Entropy Principle and Emerging Applications** Karmeshu, 2012-10-01 The last two decades have witnessed an enormous growth with regard to applications of information theoretic framework in areas of physical biological engineering and even social sciences In particular growth has been spectacular in the field of information technology soft computing nonlinear systems and molecular biology Claude Shannon in 1948 laid the foundation of the field of information theory in the context of communication theory It is in deed remarkable that his framework is as relevant today as was when he first proposed it Shannon died on Feb 24 2001 Arun Netravali observes As if assuming that inexpensive high speed processing would come to pass Shannon figured out the upper limits on communication rates First in telephone channels then in optical communications and now in wireless Shannon has had the utmost value in defining the engineering limits we face Shannon introduced the concept of entropy The notable feature of the entropy framework is that it enables quantification of uncertainty present in a system In many realistic situations one is confronted only with partial or incomplete information in the form of moment or bounds on these values etc and it is then required to construct a probabilistic model from this partial information In such situations the principle of maximum entropy provides a rational basis for constructing a probabilistic model It is thus necessary and important to keep track of advances in the applications of maximum entropy principle to ever expanding areas of knowledge

Fundamentals of Statistical Hydrology Mauro Naghettini, 2016-10-26 This textbook covers the main applications of statistical methods in hydrology It is written for upper undergraduate and graduate students but can be used as a helpful guide for hydrologists geographers meteorologists and engineers The book is very useful for teaching as it covers the main topics of the subject and contains many worked out examples and proposed exercises Starting from simple notions of the essential graphical examination of hydrological data the book gives a complete account of the role that probability considerations must play during modelling diagnosis of model fit prediction and evaluating the uncertainty in model predictions including the essence of Bayesian application in hydrology and statistical methods under nonstationarity The book also offers a comprehensive and useful discussion on subjective topics such as the selection of probability distributions suitable for hydrological variables On a practical level it explains MS Excel charting and computing capabilities demonstrates the use of Winbugs free software to solve Monte Carlo Markov Chain MCMC simulations and gives examples of free R code to solve nonstationary models with nonlinear link functions with climate

covariates      *Entropy and Energy Dissipation in Water Resources* V.P. Singh, M. Fiorentino, 2012-12-06 Since the landmark contributions of C E Shannon in 1948 and those of E T Jaynes about a decade later applications of the concept of entropy and the principle of maximum entropy have proliferated in science and engineering Recent years have witnessed a broad range of new and exciting developments in hydrology and water resources using the entropy concept These have encompassed innovative methods for hydrologic network design transfer of information flow forecasting reliability assessment for water distribution systems parameter estimation derivation of probability distributions drainage network analysis sediment yield modeling and pollutant loading bridge scour analysis construction of velocity profiles comparative evaluation of hydrologic models and so on Some of these methods hold great promise for advancement of engineering practice permitting rational alternatives to conventional approaches On the other hand the concepts of energy and energy dissipation are being increasingly applied to a wide spectrum of problems in environmental and water resources Both entropy and energy dissipation have their origin in thermodynamics and are related concepts Yet many of the developments using entropy seem to be based entirely on statistical interpretation and have seemingly little physical content For example most of the entropy related developments and applications in water resources have been based on the information theoretic interpretation of entropy We believe if the power of the entropy concept is to be fully realized then its physical basis has to be established

**Handbook of Applied Hydrologic and Water Resources Engineering** Raveendra Kumar Rai, Chandra Shekhar Prasad Ojha, Vijay P. Singh, 2025-02-26 The Handbook of Applied Hydrologic and Water Resources Engineering examines the planning and design of water supply systems flood control works drought mitigation measures navigation facilities and hydraulic structures as well as feasibility and environmental impact studies for various water related projects It is based on the experience gained through consultancy in dealing with various water resources issues and problems teaching and research It serves as a useful resource for graduate students and faculty members in civil engineering agricultural engineering and water resources engineering as well as practicing engineers working in civil environmental and agricultural fields      Hydrological Systems Modeling - Volume I Lev S. Kuchment, Vijay P. Singh, 2009-06-18 Hydrological Systems Modeling is a component of Encyclopedia of Water Sciences Engineering and Technology Resources in the global Encyclopedia of Life Support Systems EOLSS which is an integrated compendium of twenty one Encyclopedias This 2 volume set contains several chapters each of size 5000 30000 words with perspectives applications and extensive illustrations It carries state of the art knowledge in the fields of Hydrological Systems Modeling and is aimed by virtue of the several applications at the following five major target audiences University and College Students Educators Professional Practitioners Research Personnel and Policy Analysts Managers and Decision Makers and NGOs

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