

Review

Multivariate Statistical Analysis for Water Quality Assessment: A Review of Research Published between 2001 and 2020

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Abstract: Research on water quality is a fundamental step in supporting the maintenance of environmental and human health. The elements involved in water quality analysis are multidimensional, because numerous characteristics can be measured simultaneously. This multidimensional character encourages researchers to statistically examine the data generated through multivariate statistical analysis (MSA). The objective of this review was to explore the research on water quality through MSA between the years 2001 and 2020, present in the Web of Science (WoS) database. Annual results, WoS subject categories, conventional journals, most cited publications, keywords, water sample types analyzed, country or territory where the study was conducted and most used multivariate statistical analyses were topics covered. The results demonstrate a considerable increase in research using MSA in water quality studies in the last twenty years, especially in developing countries. River, groundwater and lake were the most studied water sample types. In descending order, principal component analysis (PCA), hierarchical cluster analysis (HCA), factor analysis (FA) and discriminant analysis (DA) were the most used techniques. This review presents relevant information for researchers in choosing the most appropriate methods to analyze water quality data.

Keywords: multivariate analysis; water quality; monitoring; principal component analysis



Citation: Muniz, D.H.F.; Oliveira-Filho, E.C. Multivariate Statistical Analysis for Water Quality Assessment: A Review of Research Published between 2001 and 2020. *Hydrology* **2023**, *10*, 196. <https://doi.org/10.3390/hydrology10100196>

Academic Editor: Ranjan Senakulige

Received: 27 July 2023

Revised: 12 September 2023

Accepted: 26 September 2023

Published: 5 October 2023



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1. Introduction

The topic of water has received high visibility and attention on the global sustainability agenda. This is due to increasing pressure from factors such as economic development models, climate change, population growth and public health [1,2]. Sustainable development objective number 6 (SDG6) of the United Nations 2030 Agenda for Sustainable Development is entirely dedicated to water and, in addition to addressing major challenges of universal access to sanitation and water in desirable quantity and quality, presents issues related to water resources management [3].

The analysis, assessment and monitoring of water quality are important tools for water resource management, providing a comprehensive understanding of the state of water [4,5]. Although water quality data at the global level remain sparse, mainly due to the lack of monitoring in less developed countries, there has been a tendency for the generation of these data to increase, via studies that analyze water quality [1,6].

Water quality can be understood as a measure of the suitability of water in relation to natural quality, pollution effects or specific use based on physical, chemical and biological attributes [7]. This measure provides objective evidence that is needed in decision making in water resource management, in the use of water quality monitoring programs [8], in alerting people to ongoing and emerging problems (including chemical and microbial contamination, eutrophication, emerging contaminants, issues related to climate change, among others), in determining compliance with legal standards, in protecting the beneficial uses of water, in the assessment of environmental status, in temporal trends in water quality [9] and in the assessment of the effects on aquatic ecosystems [10].

Multivariate Analysis Of Quality Multivariate Analysis Of Quality

Timothy D. Scheibe, David C. Mays



Multivariate Analysis Of Quality Multivariate Analysis Of Quality:

Multivariate Analysis of Quality Harald Martens, M. Martens, 2001-02-08 Data analysis is a vital part of science today and in assessing quality multivariate analysis is often necessary in order to avoid loss of essential information Martens provides a powerful and versatile methodology that enables researchers to design their investigations and analyse data effectively and safely without the need for formal statistical training Offers an introductory explanation of multivariate analysis by graphical soft modelling Minimises mathematics providing all technical details in the appendix Presents itself in an accessible style with cartoons self assessment questions and a wide range of practical examples Demonstrates the methodology for various types of quality assessment ranging from human quality perception via industrial quality monitoring to environmental quality and its molecular basis All data sets available FREE online on Chemometrics World <http://www.wiley.co.uk/wileychi/chemometrics>

Design and Analysis of Quality of Life Studies in Clinical Trials Diane L. Fairclough, 2002-03-28 More and more frequently clinical trials include the evaluation of Health Related Quality of Life HRQoL yet many investigators remain unaware of the unique measurement and analysis issues associated with the assessment of HRQoL At the end of a study clinicians and statisticians often face challenging and sometimes insurmountable analytic prob

Effect of Cancer On Quality of Life David Osoba, 2021-11-01 This book is comprised of extensive reviews and instructional chapters that discuss the quality of life in several aspects of cancer The first six chapters deal with conceptual issues relating to measuring quality of life in adult and pediatric populations with cancer The next five chapters provide practical information on how to select quality of life measures the statistical analysis of trials economic evaluations to be considered and some possible abuses of quality of life measures Five chapters review the results of studies using selected quality of life measures and provide recent information on their performance These are followed by three chapters dealing with specific issues relating to nausea and vomiting associated with cancer therapy Three chapters are devoted to the problems of assessing and controlling pain in patients who have cancer There are also two chapters that deal with the quality of life in palliative care

Effect of Cancer on Quality of Life is intended for all who have an interest in measuring the quality of life in patients with cancer This includes investigators who are just entering the field and can benefit from instructions on how to conduct quality of life research as well as those who are experienced in conducting this kind of research

Association Between Sleep Quality and Aging Joel Ramirez, Kewei Chen, 2024-03-11 With life expectancy on the rise the proportion of people aged 60 or older is projected to account for more than one fifth of the global population by 2050 Sleep quality is one of the most common health concerns that increases with age Changes in sleep patterns associated with old age include disturbed sleep onset an increase in sleep fragmentation more frequent daytime dysfunction and less slow wave sleep than younger adults Sleep is a complex physiological process critical to our health and survival the many functions of sleep range from cerebral metabolic waste clearance and energy conservation to supporting cognitive performance and psychological well being Insufficient sleep has

been linked to an increased risk of developing several chronic conditions including type 2 diabetes cardiovascular disease immunodeficiency chronic pain depression and neurodegenerative diseases such as dementia due to Alzheimer s disease What remains unclear is how variations in sleep quality are related to cognitive performance and how this relationship changes with age with several decades of research on the subject having produced mixed results Despite this much recent evidence indicates a strong relationship between disturbed sleep and accelerated cognitive decline in older adults For example several studies have found that a loss in sleep quality precedes the emergence of cognitive deficits and that sleep disturbances may therefore constitute an early marker of cognitive decline Sleep disturbances also become more extensive with the progression of neurodegenerative diseases which raises questions about the possibility of a bidirectional relationship

Comprehensive Quality by Design for Pharmaceutical Product Development and Manufacture Gintaras V. Reklaitis, Christine Seymour, Salvador García-Munoz, 2017-09-01 Covers a widespread view of Quality by Design QbD encompassing the many stages involved in the development of a new drug product The book provides a broad view of Quality by Design QbD and shows how QbD concepts and analysis facilitate the development and manufacture of high quality products QbD is seen as a framework for building process understanding for implementing robust and effective manufacturing processes and provides the underpinnings for a science based regulation of the pharmaceutical industry Edited by the three renowned researchers in the field *Comprehensive Quality by Design for Pharmaceutical Product Development and Manufacture* guides pharmaceutical engineers and scientists involved in product and process development as well as teachers on how to utilize QbD practices and applications effectively while complying with government regulations The material is divided into three main sections the first six chapters address the role of key technologies including process modeling process analytical technology automated process control and statistical methodology in supporting QbD and establishing the associated design space The second section consisting of seven chapters present a range of thoroughly developed case studies in which the tools and methodologies discussed in the first section are used to support specific drug substance and drug product QbD related developments The last section discussed the needs for integrated tools and reviews the status of information technology tools available for systematic data and knowledge management to support QbD and related activities Highlights Demonstrates Quality by Design QbD concepts through concrete detailed industrial case studies involving of the use of best practices and assessment of regulatory implications Chapters are devoted to applications of QbD methodology in three main processing sectors drug substance process development oral drug product manufacture parenteral product processing and solid liquid processing Reviews the spectrum of process model types and their relevance the range of state of the art real time monitoring tools and chemometrics and alternative automatic process control strategies and methods for both batch and continuous processes The role of the design space is demonstrated through specific examples and the importance of understanding the risk management aspects of design space definition is highlighted

Comprehensive Quality by Design for Pharmaceutical Product Development and Manufacture is an ideal book for practitioners researchers and graduate students involved in the development research or studying of a new drug and its associated manufacturing process *Frontiers in Statistical Quality Control 7* Hans-Joachim Lenz, Peter-Theodor Wilrich, 2012-12-06 This volume treats the four main categories of Statistical Quality Control General SQC Methodology On line Control including Sampling Inspection and Statistical Process Control Off line Control with Data Analysis and Experimental Design and fields related to Reliability Experts with international reputation present their newest contributions

Groundwater Contamination and Remediation Timothy D. Scheibe, David C. Mays, 2018-12-07 This book is a printed edition of the Special Issue Groundwater Contamination and Remediation that was published in Water

Tools of Total Quality Lyonnet, 2012-12-06 For a long time quality has been one of industry's main preoccupations It remains so today There is some foundation for the statement that there is a quality crisis in Europe the methods traditionally used in our industries being unable to meet today's demands Consequently it is essential to look for new directions in which to progress taking account of the methods for achieving quality that have been developed in recent years These methods impact on all parts of the industrial enterprise marketing manufacturing research and development after sales services All staff administrative or technical are involved The present book describes the tools that can help anyone who is concerned with the concept of total quality it will also be a valuable educational aid for students reading for degrees or other qualifications in engineering P Lyonnet I General questions and concepts 1 INTRODUCTION HOW CAN WE ACHIEVE TOTAL QUALITY This book is concerned with the various techniques and methods of analysis that can be used to ensure total quality in a project In this first chapter we show the costs that result from not achieving quality so as to make clear how important a quality assurance service is to any enterprise We stress also the involvement of marketing particularly in laying down specifications for reliability

Revolutionary Automobile Production Systems for Optimal Quality, Efficiency, and Cost Amasaka, Kakuro, 2024-05-13 In today's fast paced and competitive manufacturing landscape industries worldwide face the pressing challenge of optimizing production processes to meet ever growing demands for efficiency quality and sustainability Traditional manufacturing systems often need help to meet these demands leading to inefficiencies quality issues and increased costs To address these challenges there is a critical need for a comprehensive understanding of advanced production management principles such as the Toyota Production System TPS and its evolution into the Advanced TPS Revolutionary Automobile Production Systems for Optimal Quality Efficiency and Cost serves as a definitive guide for scholars seeking to understand and implement the principles of TPS and Advanced TPS in modern manufacturing management By offering a deep dive into these systems philosophy theory and practical applications the book equips readers with the knowledge and tools needed to revolutionize their manufacturing processes Whether you're a scholar looking to expand your knowledge or a practitioner seeking to enhance your organization's manufacturing capabilities this book offers a

compelling solution to modern manufacturing challenges

Cumulative Sum Charts and Charting for Quality

Improvement Douglas M. Hawkins, David H. Olwell, 1998-01-23 Covering CUSUMs from an application oriented viewpoint while also providing the essential theoretical underpinning this is an accessible guide for anyone with a basic statistical training The text is aimed at quality practitioners teachers and students of quality methodologies and people interested in analysis of time ordered data Further support is available from a Web site containing CUSUM software and data sets

Essential Statistical Concepts for the Quality Professional D. H. Stamatis, 2012-05-02 The essence of any root cause analysis in our modern quality thinking is to go beyond the actual problem This means not only do we have to fix the problem at hand but we also have to identify why the failure occurred and what was the opportunity to apply the appropriate knowledge to avoid the problem in the future Essential Statistical Concepts for the Quality Professional offers a new non technical statistical approach to quality for effective improvement and productivity by focusing on very specific and fundamental methodologies and tools for the future Written by an expert with more than 30 years of experience in management quality training and consulting the book examines the fundamentals of statistical understanding and by doing so demonstrates the importance of using statistics in the decision making process The author points out pitfalls to keep in mind when undertaking an experiment for improvement and explains how to use statistics in improvement endeavors He discusses data interpretation common tests and confidence intervals and how to plan experiments for improvement The book expands the notion of experimentation by dealing with mathematical models such as regression to optimize the improvement and understand the relationship between several factors It emphasizes the need for sampling and introduces specific techniques to make sure accuracy and precision of the data is appropriate and applicable for the study at hand The author's approach is somewhat new and unique however he details tools and methodologies that can be used to evaluate the system for prevention These tools and methodologies focus on structured repeatable processes that can be instrumental in finding real fixable causes of the human errors and equipment failures that lead to quality issues

Sustainable

Energy-Water-Environment Nexus in Deserts Essam Heggy, Veronica Bermudez, Marc Vermeersch, 2022-04-25 This book addresses challenges and opportunities in the Energy Water Environment EWE nexus with a particular focus on research and technology development requirements in harsh desert climates Its chapters include selected contributions presented during the 1st international conference on sustainable Energy Water Environment nexus in desert climates ICSEWEN 19 held at the Qatar Environment and Energy Research Institute QEERI in Doha Qatar in December 2019 This volume is comprised of three main chapters each describing important case studies and progress on water energy and environmental questions A fourth chapter on policies and community outreach on these three areas is also included This compilation aims to bridge the gap between research and industry to address the socioeconomic impacts of the nexus imbalance as perceived by scientists industrial partners and policymakers The content of this book is of particular importance to graduate students researchers

and decision makers interested in understanding water energy and environmental challenges in arid areas Researchers in environmental and civil engineering chemistry hydrology and environmental science can also find unique in situ observations of the current nexus imbalance in deserts climate to validate their investigations It is also an invaluable guide for industry professionals working in water energy environment and food sectors to understand the rapidly evolving landscape of the EWE nexus in arid areas The analyses observations and lessons learned summarized herein are applicable to other arid areas outside North Africa and the Arabian Peninsula as well such as central Australia the southwest of the United States and deserts in central Asia

Science SQC, New Quality Control Principle Kakuro Amasaka,2012-12-06 As is represented by the world s top level Japanese automotive manufacturers Japanese manufacturers have been climbing to winning positions in global businesses The driving force of their success includes responsiveness to diversifying market needs and elevating quality requirements clarification of development concepts that facilitate new technology application of technology to product planning and design advanced production control systems that elaborately utilize state of the art manufacturing technologies and flexible efficient production Many Japanese manufacturers succeeded in fulfilling these factors mainly because they utilize Japanese style Lean Production Systems or the so called Toyota Production System TPS and Japanese style scientific quality management approaches such as Statistical Quality Control SQC and Total Quality Management TQM in order to improve their corporate management technology As severe competition among manufacturers intensify both in Japan and overseas action against quality problems that remarkably diminish customer satisfaction and customer first quality management is becoming important Scientific quality control methods that aim to optimize production processes for building in quality were undermined by the past expansion of quantity oriented manufacturing through automation with massive and heavy equipment

An Introduction to Water Quality Science Sourav Das,2023-09-25 This book discusses the significance of water quality parameters in aquatic ecosystems offering a concise and practical measurement methodology for early career researchers and post graduate students in the fields of environmental science oceanography and aquatic science The keys topics covered include aquatic sampling basics of physicochemical properties and carbonate chemistry of aquatic science the importance of nutrients in natural water bodies biological productivity in aquatic ecosystems aquatic pollution and statistical analyses of different types of water science data Several parameters such as microplastics dimethylsulfoniopropionate and polychlorinated biphenyls have also been incorporated in the book for comprehensive coverage of the topic The book is meant as a practical guide for beginners and young researchers using a clear writing style and practical examples highlighting the significance of water science parameters and their measurement protocols in aquatic environments

Improving quality of life in patients with differentiated thyroid cancer Oded Cohen,Gianlorenzo Dionigi,Avi Hefetz Khafif,2023-03-28

Statistics in Industry Ravindra Khattree,Calyampudi Radhakrishna Rao,2003-07-18 This volume presents an exposition of topics in industrial statistics It serves as a reference for researchers in

industrial statistics industrial engineering and a source of information for practicing statisticians industrial engineers A variety of topics in the areas of industrial process monitoring industrial experimentation industrial modelling and data analysis are covered and are authored by leading researchers or practitioners in the particular specialized topic Targeting the audiences of researchers in academia as well as practitioners and consultants in industry the book provides comprehensive accounts of the relevant topics In addition whenever applicable ample data analytic illustrations are provided with the help of real world data

Receptor Modeling for Air Quality Management P.K. Hopke,1991-06-03 This book presents the background and application of receptor models for the source identification and quantitative mass apportionment of airborne pollutants Over the past decade receptor models have become an accepted part of the process for developing effective and efficient air quality management plans Information is provided on the ambient and source sampling and chemical analysis needed to provide the input data for receptor models Commonly used models are described with examples so that the air quality specialist can see how these models are applied Recent advances in several areas of the field are presented as well as the perspective of both U S Federal and State level air quality managers on how these models fit into the development of a management plan The aim of the book is to provide a practical guide to persons who may be given the task of implementing receptor modeling as a part of some air quality management problem The intention of all the chapter authors is to furnish both the basic information needed to begin doing receptor modeling as well as some insight into some of the problems related to the use of these models These tools like any others used in solving complex technological problems are not a panacea but do represent powerful aids in data analysis that can lead to insights as to how an airshed functions and thus to effective and efficient air quality management strategies

Introduction to Quality by Design (QbD) N. K. Jain,Neha Bajwa,2024-04-09 This book offers a comprehensive exploration of the Quality by Design QbD methodology guiding readers from theory to practical application with accessible examples It equips readers with both foundational and advanced knowledge emphasizing the critical parameters necessary for designing pharmaceutical products that meet the highest quality standards The book goes beyond theory to demonstrate how to effectively implement QbD principles in various aspects of pharmaceutical research and development including analytical methods formulation and packaging processes Through a step by step approach it prepares researchers in pharmaceutical sciences as well as professionals in the pharmaceutical and healthcare industries including suppliers to successfully integrate QbD into their work

Quality Control in the Beverage Industry Alexandru Grumezescu,Alina Maria Holban,2019-08-15 Quality Control in the Beverage Industry volume 17 in the Science of Beverages series presents a detailed account of the most common aspects and challenges relating to quality control It covers the latest global trends in how to improve beverages using assessment tools authenticity approaches and novel quality control technologies The book presents a great hands on approach for anyone who needs to understand the big picture regarding analytical methods Topics covered include safety the economic impacts of

contamination and detection techniques Provides tools to assess and measure sulfites in beverages using different instrumental techniques Presents the application of nanotechnology for the improvement of beverages including taste structure and overall quality Includes analytical procedures for measuring and controlling quality *Quality Control for Rental Assistance Subsidies Determinations* JoAnn Kuchak,2011 This is a print on demand edition of a hard to find publication HUD s Quality Control for Rental Assistance Subsidy Determinations studies provide national estimates of the extent severity costs and sources of rent errors in tenant subsidies for the Public Housing Agency administered Public Housing Section 8 Housing Choice Voucher and Moderate Rehabilitation programs and the owner administered Section 8 and Section 202 and Section 811 programs with Project Rental Assistance Contracts or Project Assistance Contracts These programs account for nearly all of HUD s current housing assistance outlays as well as the large majority of units assisted by HUD This study was designed to measure the extent of administrator income and rent determination error by housing providers Illus

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Table of Contents Multivariate Analysis Of Quality Multivariate Analysis Of Quality

1. Understanding the eBook Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - The Rise of Digital Reading Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Advantages of eBooks Over Traditional Books
2. Identifying Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - User-Friendly Interface
4. Exploring eBook Recommendations from Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Personalized Recommendations
 - Multivariate Analysis Of Quality Multivariate Analysis Of Quality User Reviews and Ratings
 - Multivariate Analysis Of Quality Multivariate Analysis Of Quality and Bestseller Lists
5. Accessing Multivariate Analysis Of Quality Multivariate Analysis Of Quality Free and Paid eBooks
 - Multivariate Analysis Of Quality Multivariate Analysis Of Quality Public Domain eBooks
 - Multivariate Analysis Of Quality Multivariate Analysis Of Quality eBook Subscription Services

- Multivariate Analysis Of Quality Multivariate Analysis Of Quality Budget-Friendly Options
- 6. Navigating Multivariate Analysis Of Quality Multivariate Analysis Of Quality eBook Formats
 - ePub, PDF, MOBI, and More
 - Multivariate Analysis Of Quality Multivariate Analysis Of Quality Compatibility with Devices
 - Multivariate Analysis Of Quality Multivariate Analysis Of Quality Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Highlighting and Note-Taking Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Interactive Elements Multivariate Analysis Of Quality Multivariate Analysis Of Quality
- 8. Staying Engaged with Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Multivariate Analysis Of Quality Multivariate Analysis Of Quality
- 9. Balancing eBooks and Physical Books Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Multivariate Analysis Of Quality Multivariate Analysis Of Quality
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Setting Reading Goals Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Fact-Checking eBook Content of Multivariate Analysis Of Quality Multivariate Analysis Of Quality
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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