

Article

Flood Risk Assessment and Mapping in the Hadejia River Basin, Nigeria, Using Hydro-Geomorphologic Approach and Multi-Criterion Decision-Making Method

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Abstract: Flood risk management is crucial for climate change resilience. The Hadejia River basin is known for severe and frequent floods, which have destroyed houses and farmlands and claimed many lives. This study developed a GIS-based flood risk and vulnerability mapping assessment using the Analytical Hierarchical Process (AHP) to outline scenarios that reduce risk and vulnerability associated with floods in the Hadejia River basin. The risk mapping of the basin integrated seven hydro-geomorphological indicators influencing extreme events (elevation, mean annual rainfall, slope, distance from rivers, soil type, and drainage density) and six socio-economic vulnerability indicators (population density, female population density, literacy rate, land use, employment rate, and road network) using a multi-criterion analysis. The average annual rainfall data of 36 years (1982–2018) were used for flood plain mapping in this study. Combining the flood hazard and socio-economic vulnerability indices of the basin revealed high-to-very high flood risk in the downstream and central upstream portions of the basin, which cover about 43.4% of the basin area. The local areas of Auyo, Guri, Hadejia, Ringim, Kafin Hausa, and Jahun were identified as zones at a very high flood risk. The study also revealed that flood hazard and vulnerability indicators have different influences on flood risk. The validated results resonate with the records of previous flood distribution studies of the basin. This research study is significantly important for developing strategic measures and policy revision through which the government and relief agencies may reduce the negative impact of floods in the Hadejia River basin.

Keywords: flood risk; flood hazard; socio-economic vulnerability; multi-criterion analysis; Analytical Hierarchical Process (AHP)

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1. Introduction

Floods are amongst the most catastrophic, frequent, and widespread natural disasters worldwide, causing severe economic and environmental damage with devastating effects on livelihoods [1–11]. About 47% of disasters related to weather are the result of floods [12]. About 34% of worldwide natural disasters from 1960 to 2014 were floods that caused financial losses for over 2.5 billion USD per annum and the death of 1254 persons per year [11,12]. Floods affected 2.8 billion people and killed 540,000 people between 1980 and 2009 across the world [13–15]. According to the IPCC [16], in the future, the African Continent will experience a drastic increase in extreme hydrological events, including floods. Studies showed that West Africa recently experienced precipitation above average

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Decision Making for Hydrosystems T. E. Unny, Edward A. McBean, 1982 **River Flow Modelling and Forecasting** D.A. Kraijenhoff, J.R. Moll, 2012-12-06 Advances in computer technology in the technology of communication and in mathematical modelling of processes in the hydrological cycle have recently improved our potential to protect ourselves against damage through floods and droughts and to control quantities and qualities in our water systems This development was demonstrated in a 1983 post experience course at Wageningen University where an international group of experts reviewed successful modelling techniques and described the design and operation of a number of forecasting and control systems in drainage basins and river reaches of various sizes and under various geographical and climat ological conditions A special effort was made to bridge the gap between theory and practice case studies showed that each forecasting system was designed to meet a set of specific requirements and they illustrated that the forecasting system can only be expected to operate reliably if on the one hand it is based on sound theoretical concepts and methods and if on the other hand it is robust so that also under adverse conditions it will continue to collect and process the necessary input data and produce correct and timely signals We were pleased to meet with encouragement for preserving the course material and making it available to a wider public This was effected by the team of authorf who elaborated updated and harmonized the materia in two stages first into an issue of our university department and finally into the manuscript of this book **Engineering Reliability and Risk in Water Resources** L. Duckstein, Erich J. Plate, 2012-12-06 Hydraulic hydrologic and water resources engineers have been concerned for a long time about failure phenomena One of the major concerns is the definition of a failure event E of its probability of occurrence P_tE and of the complementary notion of reliability However as the stochastic aspects of hydraulics and water resources engineering were developed words such as failure reliability and risk took on different meanings for different specialists For example risk is defined in a Bayesian framework as the expected loss resulting from a precisely defined failure event while according to the practice of stochastic hydraulics it is the probability of occurrence of a failure event The need to standardize the various concepts and operational definitions generated numerous exciting discussions between the co editors of this book during 1983 84 when L Duckstein under sponsorship of the Alexander von Humboldt Foundation FRG was working with E Plate at the Institute of Hydrology and Water Resources of the University of Karlsruhe After consulting with the Scientific Affairs Division of NATO an organizing committee was formed This comittee J Bernier France M Benedini Italy S Sorooshian U S A and co directors L Duckstein U S A and E J Plate F R G brought into being this NATO Advanced Study Institute ASI Precisely stated the purpose of this ASI was to present a tutorial overview of existing work in the broad area of reliability while also pointing out topics for further development Water Resources Systems Planning and Management Sharad K. Jain, V.P. Singh, 2003-09-12 This book is divided into four parts The first part Preliminaries begins by introducing the basic theme of the book It provides an overview of the current status of water

resources utilization the likely scenario of future demands and advantages and disadvantages of systems techniques An understanding of how the hydrological data are measured and processed is important before undertaking any analysis The discussion is extended to emerging techniques such as Remote Sensing GIS Artificial Neural Networks and Expert Systems The statistical tools for data analysis including commonly used probability distributions parameter estimation regression and correlation frequency analysis and time series analysis are discussed in a separate chapter Part 2 Decision Making is a bouquet of techniques organized in 4 chapters After discussing optimization and simulation the techniques of economic analysis are covered Recently environmental and social aspects and rehabilitation and resettlement of project affected people have come to occupy a central stage in water resources management and any good book is incomplete unless these topics are adequately covered The concept of rational decision making along with risk reliability and uncertainty aspects form subject matter of a chapter With these analytical tools the practitioner is well equipped to take a rational decision for water resources utilization Part 3 deals with Water Resources Planning and Development This part discusses the concepts of planning the planning process integrated planning public involvement and reservoir sizing The last part focuses on Systems Operation and Management After a resource is developed it is essential to manage it in the best possible way Many dams around the world are losing some storage capacity every year due to sedimentation and therefore the assessment and management of reservoir sedimentation is described in details No analysis of water resources systems is complete without consideration of water quality A river basin is the natural unit in which water occurs The final chapter discusses various issues related to holistic management of a river basin

Waterpower '83, International Conference on Hydropower, September 18-21, 1983, Hyatt Regency/Knoxville, Tennessee: Conventional hydro and pumped storage modernization of existing conventional hydro operations ,1983

Hydrosystem Restoration Handbook: Streamflow Recharge and Lake Rehabilitation Saeid Eslamian,Faezeh Eslamian,2024-11-27 Handbook of Hydrosystem Restoration Streamflow Recharge SFR and Lake Rehabilitation LR comprises global case studies that encompass the most up to date management approaches in streams It provides comprehensive methods for sustainable water supply through debris removal along with conservation practices to assist researchers and graduate students specializing in this field Covers traditional and novel techniques for efficient water resources management to overcome the water scarcity problem Includes the latest methods for Sustainable and Integrated Water Resources Management Contains case studies from Africa Australia China Eurasia India MENA Countries Canada and North America that offer deep analysis of techniques of flow restoration and groundwater artificial recharge

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book provides a thorough exploration of groundwater recharge starting from foundational concepts and traditional techniques moving through practical case studies and culminating in advanced methodologies and future innovations Real world relevance By presenting diverse case studies and regional implementations this book effectively connects theoretical knowledge to practical applications demonstrating how water challenges are addressed in various contexts around the globe Forward looking perspective With a focus on cutting edge research emerging technologies and sustainable water management practices this book offers readers valuable insights into the evolving field and its potential future impacts

Hydrosystems Engineering and Management Larry W. Mays, Yeou-Koung Tung, 1992 This text is intended for a senior graduate level course in hydrosystems Students who take this course must have previously taken a course in hydrology and hydraulics The term Hydraulics can also be used to describe different types of water projects The scope of this text covers both of these definitions The major focus of the text is to bring together the use of mathematical modelling with the use of hydrosystems for the analysis design operation and management of water projects To accomplish this goal the authors present the basic principles of optimization probability and risk analysis and then apply these principles to the areas of water supply management and water excess management Proceedings of the 6th International Workshop on Hydro Scheduling in Competitive Electricity Markets Arild Helseth, 2018-10-31 This book includes a collection of research articles presented at the 6th International Workshop on Hydro Scheduling in Competitive Electricity Markets The workshop was a unique and intimate forum for researchers and practitioners to present state of the art research and development concerning novel methodological findings best practices and real life applications of hydro scheduling It also provided a platform for discussing the developments that are taking place in the industry sharing different experiences and discussing future trends related to this area This proceedings book is a collection of the most relevant high quality articles from the workshop Discussing the state of the art in the field of hydro scheduling it is a valuable resource for a wide audience of researchers and practitioners in the field now and in the interesting and challenging times ahead **On the Development of a Real-time Flood**

Forecasting Model for the Panama Canal Watershed Carlos Alberto Vargas, 1990 **Experience in Operation of Hydrosystems** T. E. Unny, Edward A. McBean, 1982 Proceedings of the Eighth Power Systems Computation Conference, Helsinki, 19-24 August 1984, 1984 Proceedings of the Section on Statistics and the Environment American Statistical Association. Section on Statistics and the Environment, 2000 *Flood Forecasting* Thomas E. Adams, Chandana Gangodagamage, Thomas C. Pagano, 2024-09-18 Flood Forecasting A Global Perspective Second Edition covers hydrologic forecasting systems on both a national and regional scale This updated edition includes a breakdown by county contribution and solutions to common issues with a wide range of approaches to address the difficulties inherent in the development implementation and operational success of national scale flood forecasting systems Special attention is given to recent advances in machine learning techniques for flood forecasting Overall the information will lead to improvements of existing

systems and provide a valuable reference on the intricacies of forecast systems in different parts of the world Covers global and regional systems thus allowing readers to understand the different forecasting systems and how they developed Offers practical applications for groups trying to improve existing flood forecasting systems Includes innovative solutions for those interested in developing new systems Contains analytical and updated information on forecasting and monitoring systems

Water for Resource Development David L. Schreiber,1984 *Hydropower, Energy and the Environment*
International Energy Agency,1993 *Expansion Planning for Electrical Generating Systems* International Atomic Energy Agency,1984 *Bibliographie* ,1984 *Technical Reports Series* ,1959 **Concise Encyclopedia of Environmental Systems** P.C. Young,1993-08-09 The Concise Encyclopedia of Environmental Systems provides a concise overview of the current state of the art in the study of environmental systems Contains specially commissioned articles and updated and revised articles from the acclaimed Systems atmospheric processes and air quality ecosystems environmental chemistry geology soil processes and geophysics hydrology fluid dynamics and water quality marine processes meteorology and climatology In addition many of the articles cover the methodological procedures used in environmental systems analysis with contributions on automatic control and management computers in modelling and management environmental planning environmetric methods including time series analysis mathematical modelling including data based physically based and simulation modelling remote sensing and image processing uncertainty in environmental systems and sensitivity analysis The encyclopedia is extensively cross referenced on two levels to articles of direct relevance as well as to other articles which will provide the reader with more general background information

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Table of Contents Decision Making For Hydrosystems Forecas

1. Understanding the eBook Decision Making For Hydrosystems Forecas
 - The Rise of Digital Reading Decision Making For Hydrosystems Forecas
 - Advantages of eBooks Over Traditional Books
2. Identifying Decision Making For Hydrosystems Forecas
 - 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 Decision Making For Hydrosystems Forecas
 - User-Friendly Interface
4. Exploring eBook Recommendations from Decision Making For Hydrosystems Forecas
 - Personalized Recommendations
 - Decision Making For Hydrosystems Forecas User Reviews and Ratings
 - Decision Making For Hydrosystems Forecas and Bestseller Lists
5. Accessing Decision Making For Hydrosystems Forecas Free and Paid eBooks
 - Decision Making For Hydrosystems Forecas Public Domain eBooks
 - Decision Making For Hydrosystems Forecas eBook Subscription Services

- Decision Making For Hydrosystems Forecas Budget-Friendly Options
- 6. Navigating Decision Making For Hydrosystems Forecas eBook Formats
 - ePub, PDF, MOBI, and More
 - Decision Making For Hydrosystems Forecas Compatibility with Devices
 - Decision Making For Hydrosystems Forecas Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Decision Making For Hydrosystems Forecas
 - Highlighting and Note-Taking Decision Making For Hydrosystems Forecas
 - Interactive Elements Decision Making For Hydrosystems Forecas
- 8. Staying Engaged with Decision Making For Hydrosystems Forecas
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Decision Making For Hydrosystems Forecas
- 9. Balancing eBooks and Physical Books Decision Making For Hydrosystems Forecas
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Decision Making For Hydrosystems Forecas
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Decision Making For Hydrosystems Forecas
 - Setting Reading Goals Decision Making For Hydrosystems Forecas
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Decision Making For Hydrosystems Forecas
 - Fact-Checking eBook Content of Decision Making For Hydrosystems Forecas
 - 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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