

Drainage Engineering Lecture Notes

This book comprises selected papers from the International Conference on Civil Engineering Trends and Challenges for Sustainability (CTCS) 2019. The book presents latest research in several areas of civil engineering such as construction and structural engineering, geotechnical engineering, environmental engineering and sustainability, and geographical information systems. With a special emphasis on sustainable development, the book covers case studies and addresses key challenges in sustainability. The scope of the contents makes the book useful for students, researchers, and professionals interested in sustainable practices in civil engineering. This book comprises select papers presented at the International Conference on Trends and Recent Advances in Civil Engineering (TRACE 2018). The book covers interdisciplinary research and applications in integrated water resource management, river ecology, irrigation system, water pollution and treatment, hydraulic structure and hydro-informatics. The topics on water resource management include technological intervention and solution for climate change impacts on water resources, water security, clean water to all, sustainable water reuse, flood risk assessment, interlinking of rivers and hydro policy. The contents of this book will be useful to researchers and professionals working in the field of water resource management and related policy making.

This book comprises select proceedings of the International Conference on Sustainable Civil Engineering Practices (ICSCEP 2019). It covers several important aspects of sustainable civil engineering practices dealing with effective waste and material management, natural resources, industrial products, energy, food, transportation and shelter, while conserving and protecting the environmental quality and the natural resource base essential for future development. The book also discusses engineering solutions to sustainable development and green design issues. Special emphasis is given on qualitative guidelines for generation, treatment, handling, transport, disposal and recycling of wastes. The book is intended as a practice-oriented reference guide for researchers and practitioners, and will be useful for all working in sustainable civil engineering related fields.

This volume comprises select peer reviewed papers presented at the international conference - Advanced Research and Innovations in Civil Engineering (ARICE 2019). It brings together a wide variety of innovative topics and current developments in various branches of civil engineering. Some of the major topics covered include structural engineering, water resources engineering, transportation engineering, geotechnical engineering, environmental engineering, and remote sensing. The book also looks at emerging topics such as green building technologies, zero-energy buildings, smart materials, and intelligent transportation systems. Given its contents, the book will prove useful to students, researchers, and professionals working in the field of civil engineering.

This book presents the theory and computation of open channel flows, using detailed analytical, numerical and experimental results. The fundamental equations of open channel flows are derived by means of a rigorous vertical integration of the RANS equations for turbulent flow. In turn, the hydrostatic pressure hypothesis, which forms the core of many shallow water hydraulic models, is scrutinized by analyzing its underlying assumptions. The book's main focus is on one-dimensional models, including detailed treatments of unsteady and steady flows. The use of modern shock capturing finite difference and finite volume methods is described in detail, and the quality of solutions is carefully assessed on the basis of analytical and experimental

results. The book's unique features include: • Rigorous derivation of the hydrostatic-based shallow water hydraulic models • Detailed treatment of steady open channel flows, including the computation of transcritical flow profiles • General analysis of gate maneuvers as the solution of a Riemann problem • Presents modern shock capturing finite volume methods for the computation of unsteady free surface flows • Introduces readers to movable bed and sediment transport in shallow water models • Includes numerical solutions of shallow water hydraulic models for non-hydrostatic steady and unsteady free surface flows This book is suitable for both undergraduate and graduate level students, given that the theory and numerical methods are progressively introduced starting with the basics. As supporting material, a collection of source codes written in Visual Basic and inserted as macros in Microsoft Excel® is available. The theory is implemented step-by-step in the codes, and the resulting programs are used throughout the book to produce the respective solutions.

Streamlined to facilitate student understanding, this second edition, containing the latest techniques and methodologies and some new problems, continues to provide a comprehensive treatment of hydrology of watersheds, soil erosion problems, design and installation of soil conservation practices and structures, hydrologic and sediment yield models, watershed management and water harvesting. It also deals with the special requirements of management of agricultural and forested watersheds. This book is designed for undergraduate students of agricultural engineering for courses in hydrology, and soil and water conservation engineering. It will also be of considerable value to students of agriculture, soil science, forestry, and civil engineering. **KEY FEATURES** Emphasises fundamentals using numerous illustrations to help students visualise different phenomena Offers lucid presentation of field practices Presents the analysis and design of basic hydraulic structures Devotes an entire chapter to watershed management Provides numerous solved design problems and exercise problems to develop a clear understanding of the theory Gives theoretical questions, and objective type questions with answers to test the students' understanding.

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This proceedings volume contains 38 papers presented at the 4th Working Conference on "Reliability and Optimization of Structural Systems", held at the Technical University of Munich, Germany, September 11- 13, 1991. The Working Conference was organised by the IFIP (International Federation for Information Processing) Working Group 7.5 of Technical Committee 7 and was the fourth in a series,

following similar conferences held at the University of Aalborg, Denmark, May 1987, at the Imperial College, London, UK, September 1988 and at the University of California, Berkeley, California, USA, March 1990. The Working Conference was attended by 54 participants from 16 countries. The objectives of Working Group 7.5 are: • to promote modern structural systems optimization and reliability theory, • to advance international cooperation in the field of structural system optimization and reliability theory, • to stimulate research, development and application of structural system optimization and reliability theory, • to further the dissemination and exchange of information on reliability and optimization of structural systems • to encourage education in structural system optimization and reliability theory. At present the members of the Working Group are: A. H.-S. Ang, U.S.A. M. Grimmelt, FRG G. A. Ugwti, Italy N. C. Lind, Canada M. J. Baker, UK H. O. Maden, Denmark P. Bjerager, Norway R. E. Melcher, Australia C. A. Cornell, U.S.A. F. Moene, U.S.A.

This volume contains selected papers presented during the International Conference on Environmental Geotechnology, Recycled Waste Material and Sustainable Engineering (EGRWSE-2018). The multidisciplinary articles in this volume discuss environment-friendly technologies and the application of 'smart' solutions and initiatives to improve infrastructure and services, with a strong emphasis on sustainability and conservation of resources. This volume will be of interest to engineers, professionals, and researchers working on improving urban infrastructure and strengthen civic amenities in a sustainable manner.

Hydroinformatics systems are systems that combine computational hydraulic modelling with information systems (including knowledge-based systems). They are gaining rapid acceptance in the areas of environmental planning, design and management. The present book focuses exclusively on sewage systems, starting with their planning and then going on to discuss their design, operation and rehabilitation. The very experienced authors discuss business and information needs in the management of urban drainage, tools for collecting and archiving such data, and their use in modelling catchment hydrology, sewer systems hydraulics, wastewater quality, wastewater treatment plant operation, and receiving waters. The control and operation of sewer

systems in real time is described, followed by a discussion of their maintenance and rehabilitation. Intelligent decision support systems for managing the urban drainage business process are presented. Audience: Researchers into sewer design, municipal engineers, planners and managers interested in an innovative approach to all aspects of the planning, design and operation of sewer systems.

A survey of the problems encountered in flood control and drainage engineering. Among the topics studied are: estimation of design flood; flood routing through reservoirs and channels; design of spillways; and flood mitigation through planning of reservoir capacities and operation of reservoirs.

These proceedings showcase the best papers selected from more than 500 submissions, introducing readers to the top research topics and the latest developmental trends in the theory and application of Man-Machine-Environment System Engineering (MMESE). This research topic was first established in China by Professor Shengzhao Long in 1981, with direct support from one of the greatest modern Chinese scientists, Xuesen Qian. In a letter to Shengzhao Long from October 22nd, 1993, Xuesen Qian wrote: "You have created a very important modern science and technology in China!" MMESE primarily focuses on the relationship between Man, Machine and Environment, studying the optimum combination of related Man-Machine-Environment systems. In this paradigm, "Man" refers to working people as the subject at the workplace (e.g. operators, decision-makers); "Machine" is the general name for any object controlled by Man (including tools, machinery, computers, systems and technologies), and "Environment" describes the specific working conditions under which Man and Machine interact (e.g. temperature, noise, vibration, hazardous gases etc.). In turn, the three goals of optimization are to ensure safety, efficiency and economy in this context. These proceedings present interdisciplinary studies on the concepts and methods of physiology, psychology, system engineering, computer science, environmental science, management, education, and other related disciplines. They offer a valuable resource for all researchers and professionals whose work involves interdisciplinary areas touching on MMESE subjects. This work describes the role of sediment transport in the operation and maintenance of demand-based downstream

controlled irrigation canals. Sediment deposition in these irrigation canals severely affects the operation of the automatic flow control system. The book also discusses sediment transport modelling in irrigation canals. A simplified 1-D mathematical model SETRIC (SEdiment TRansport in Irrigation Canals) has been improved with the inclusion of downstream control component for the downstream controlled irrigation canals. Based on field measurements and sediment transport modelling, a number of approaches have been proposed for sediment management in such irrigation canals by improvement in their design and operation. This book will be of interest to Irrigation Engineers and Managers, Hydraulic Engineers, Water Resources Engineers and Managers, Civil Engineers, and Agricultural Engineers.

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[A Muskingum-Cunge Channel Flow Routing Method for Drainage
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[Materials for Subsurface Land Drainage Systems](#)

[Proceedings of the 4th IFIP WG 7.5 Conference Munich,
Germany, September 11-13, 1991](#)

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Fully renewed and extended, this edition is a valuable source of information for anyone involved in drainage engineering and management. It provides new theories, technologies, knowledge and experiences in combination with traditional land development practices in the humid temperature zone. Aspects covered include: management and maintenance; On the basis of instrument electrical and automatic control system, the 5th International Conference on Electrical Engineering and Automatic Control (CEEAC) was established at

the crossroads of information technology and control technology, and seeks to effectively apply information technology to a sweeping trend that views control as the core of intelligent manufacturing and life. This book takes a look forward into advanced manufacturing development, an area shaped by intelligent manufacturing. It highlights the application and promotion of process control represented by traditional industries, such as the steel industry and petrochemical industry; the technical equipment and system cooperative control represented by robot technology and multi-axis CNC; and the control and support of emerging process technologies represented by laser melting and stacking, as well as the emerging industry represented by sustainable and intelligent life. The book places particular emphasis on the micro-segments field, such as intelligent micro-grids, new energy vehicles, and the Internet of Things.

"In the research Model Predictive Control on Open Water Systems, the relatively new control methodology Model Predictive Control is configured for application of water quantity control on open water systems, especially on irrigation canals and large drainage systems. The methodology applies an internal model of the open water system, by which optimal control actions are calculated over a prediction horizon. As internal model, two simplified models are used, the Integrator Delay model and the Saint Venant model. Kalman filtering is applied to initialize the internal models. The optimization uses an objective function in which conflicting objectives can be weighed. In most of the cases, these conflicting objectives are keeping the water levels at different locations in the water system within a range around setpoint and executing this by using as little control effort or energy as possible. To tune the weight factors in the objective function, an estimate of the maximum allowed value of each variable in the objective function is used. The optimization takes the constraints of the control structures into account. Every control time step, the optimal control actions are calculated, while only the first set of control actions is actually executed. This results in a controlled water system that is constantly maintaining the objective in an optimal way, while taking predictions, such as expected irrigation demands or extreme storm events and the constraints of the water system into account."

Hydroinformatics addresses cross-disciplinary issues ranging from technological and sociological to more general

environmental concerns, including an ethical perspective. It covers the application of information technology in the widest sense to problems of the aquatic environment. This two-volume publication contains about 250 high quality papers contributed by authors from over 50 countries. The proceedings present many exciting new findings in the emerging subjects, as well as their applications, such as: data mining, data assimilation, artificial neural networks, fuzzy logic, genetic algorithms and genetic programming, chaos theory and support vector machines, geographic information systems and virtual imaging, decision support and management systems, Internet-based technologies. This book provides an excellent reference to researchers, graduate students, practitioners, and all those interested in the field of hydroinformatics.

Reliable subsurface drainage systems for groundwater table and salinity control are needed to maintain or enhance the productivity of irrigated lands and to contribute to the rural development of lowlands in the humid tropic. This publication presents guidelines to assess the need for envelopes and for the selection of appropriate materials (i.e. pipes and envelopes) for the proper and lasting performance of subsurface drainage systems. In addition, it also contains guidelines for adequate installation and maintenance of drainage materials as well as the required specifications and standards of such materials, which may be used in tender documents for implementation of subsurface drainage works. Practical guidelines for the implementation of laboratory and field investigations to evaluate the performance of drainage materials have also been included.--Publisher's description.

This monograph provides an overview of the principles required for a service orientation in the management of irrigation and drainage systems. The material covered is designed to emphasize an area largely neglected in the irrigation and drainage management literature. The dominating philosophy underlying this book is that irrigation and drainage systems must be managed as a service business responsive to the needs and changing requirements of its customers. It is postulated that this service approach to the management of irrigation and drainage systems constitutes a key element of the strategy that is needed to improve the current level of performance of many irrigation and drainage systems worldwide. Enhanced performance of irrigation is a prerequisite if we are to face the enormous challenge of producing greater quantities of food to

meet the demand of a growing population. This is particularly the case in an environment with increasing competition for water from industry and urban water users, set against mounting concerns about environmental sustainability.

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[Management of Irrigation and Drainage Systems](#)

This text book brings together 26 chapters, 546 figures, 166 tables, a glossary of 332 definitions. Being the result of ILRI's core business: bringing together the principles and applications of drainage, by giving international courses on drainage

by Professor Poul Harremoes Environmental engineering has been a discipline dominated by empirical approaches to engineering. Historically speaking, the development of urban drainage structures was very successful on the basis of pure empiricism. Just think of the impressive structures built by the Romans long before the discipline of hydraulics came into being. The fact is that the Romans did not know much about the theories of hydraulics, which were discovered as late as the mid-1800s. However, with the Renaissance came a new era.

Astronomy (Galileo) and basic physics (Newton) started the scientific revolution and in the mid-1800s Navier and Stokes developed the application of Newton's laws to hydrodynamics, and later, St. Venant the first basic physics description of the motion of water in open channels. The combination of basic physical understanding of the phenomena involved in the flow of water in pipes and the experience gained by "trial and error", the engineering approach to urban drainage improved the design and performance of the engineering drainage infrastructure. However, due to the mathematical complications of the basic equations, solutions were available only to quite simple cases of practical

significance until the introduction of new principles of calculation made possible by computers and their ability to crunch numbers. Now even intricate hydraulic phenomena can be simulated with a reasonable degree of confidence that the simulations are in agreement with performance in practice, if the models are adequately calibrated with sample performance data.

This textbook focuses specifically on the combined topics of irrigation and drainage engineering. It emphasizes both basic concepts and practical applications of the latest technologies available. The design of irrigation, pumping, and drainage systems using Excel and Visual Basic for Applications programs are explained for both graduate and undergraduate students and practicing engineers. The book emphasizes environmental protection, economics, and engineering design processes. It includes detailed chapters on irrigation economics, soils, reference evapotranspiration, crop evapotranspiration, pipe flow, pumps, open-channel flow, groundwater, center pivots, turf and landscape, drip, orchards, wheel lines, hand lines, surfaces, greenhouse hydroponics, soil water movement, drainage systems design, drainage and wetlands contaminant fate and transport. It contains summaries, homework problems, and color photos. The book draws from the fields of fluid mechanics, soil physics, hydrology, soil chemistry, economics, and plant sciences to present a broad interdisciplinary view of the fundamental concepts in irrigation and drainage systems design. Land Drainage - Principles, Methods and Applications presents the latest information, concepts and technology for ensuring sustainable agricultural production and environmental management by adopting land drainage measures. It focuses on a subject, central to the sustainability of irrigated agriculture. The authors' considerable field work experience and strong grip on the subject are pivotal in conceptualizing this book. This book provides an explicit description of the subject for students as well as the practicing engineers in this area. A logical sequence is followed in the presentation of chapters, beginning with the occurrence of drainage problems, their causes, remedies, design and execution of drainage systems and the benefits of drainage. The book can claim to be the only comprehensive title on the subject in India. SALIENT FEATURES

- 1. Follows an application-centric approach based on mathematical and statistical concepts*
- 2. Provides a global scenario of drainage by studying different drainage models*
- 3. Discusses drainage in the Indian context*
- 4. Text is supported by statistical inputs and well illustrated examples*
- 5. Includes self-assessment questions with answers and a number of solved and unsolved problems*
- 6. Includes case studies of Drainage and Salt Management*

Sediment transport in irrigation canals influences to a great extent the sustainability of an irrigation system. Unwanted erosion or deposition will not only increase maintenance costs, but may also lead to unfair, unreliable and unequitable distribution of irrigation water to the end users. Proper knowledge of the characteristics, including behaviour and transport of sediment will help to design irrigation systems, plan efficient and reliable water delivery schedules, to have a controlled deposition of sediments, to estimate and arrange maintenance activities, etc. The main aim of these lecture notes is to present a detailed analysis and physical and mathematical descriptions of sediment transport in irrigation canals and to describe the mathematical model SETRIC that predicts the sediment transport, deposition and entrainment rate as function of time and place for various flow conditions and sediment inputs. The model is typically suited for the simulation of sediment transport under the particular conditions of

non-wide irrigation canals where the flow and sediment transport are strongly determined by the operation of the flow control structures. The lecture notes will contribute to an improved understanding of the behaviour of sediments in irrigation canals. They will also help to decide on the appropriate design of the system, the water delivery plans, to evaluate design alternatives and to achieve an adequate and reliable water supply to the farmers.

A Muskingum-Cunge channel flow routing scheme is modified for application to large drainage networks with compound cross sections and for continuous long-term simulation. The modifications consist of a decoupling and separate routing of main and overbank channel flow, an introduction of a variable time step to increase model efficiency during periods of steady flow, and an interval determination of the numerical increment. The resulting hydrologic model is verified by comparing its flow routing results with those of hydraulic benchmark models solving the full unsteady flow equations. Test conditions consist of hypothetical flood hydrographs, long prismatic channels with simple and compound sections, and a third order drainage network. For the tested conditions, the model produces hydrograph peaks, times to peak and shapes that compare well with those of the hydraulic benchmarks. Hydrograph distortions due to overbank flood plain storage and multiple peaks from complex drainage networks are also well reproduced. The execution time of the model is generally one order of magnitude faster than that of the hydraulic benchmark models. Muskingum-Cunge, Channel Flow Routing, drainage networks, Compound Cross-Sections, variable time step.

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[**Proceedings of the 3rd International Conference on Sustainability in Civil Engineering**](#)

This book comprises the select proceedings of the International Conference on Recent Advances in Civil Engineering (ICRACE) 2020, held at the Cochin University of Science and Technology, Cochin, Kerala, India. The book focuses on latest research in different areas of civil engineering and lays special emphasis on sustainable construction practices. It is divided into seven major themes: (i) Modern materials and sustainable construction, (ii) Environmental engineering and management, (iii) Geotechnical engineering, (iv) Health, safety and environment, (v) Irrigation, water resources and management, (vi) Structural Engineering, and (vii) Transportation engineering and traffic

planning. Given the range of the topics covered, this book can be useful for students, scholars and professionals interested in the different sub-disciplines of civil engineering.

Modern Land Drainage 2nd edition is a fully revised and updated edition of the 2004 edition. Modern Land Drainage describes traditional drainage formulas (Hooghoudt, Kirkham, Donnan, Ernst, Glover-Dumm) for rainfed agriculture in the humid temperature zone. Significant parts are devoted to drainage for salinity control of irrigated land in (semi-) arid zones, and to drainage of rice land in the humid tropics. Institutional, management and maintenance aspects are extensively covered, as well as the mitigation of adverse impacts of drainage interventions on the environment. The latest computer applications for drainage design in the context of integrated water management are described (DRAINMOD, HEC, SWAP, etc.). Field surveys are executed by governments, with the aid of consultants, but rarely are the end stakeholders (i.e., farmers and general public) involved from inception to planning to execution of a drainage system. Yet, during the Operation, Management and Maintenance (OMM) phase of a water management system, they are expected to takeover, run, bear and be responsible for the costs of OMM. The book describes successful methodologies and processes to be followed for engagement of stakeholders at all levels, from government to farm, from minister to farmer, and, from beginning to end. The book covers all aspects needed for sustainable drainage. The latest survey methodologies with satellites and drones are suggested to assess cause and effect. Waterlogging and salinity are the effect of something caused most likely upstream of the drainage problem location. Hence treating the cause may be more cost-effective. Triple Bottom Line (social, environmental and financial considerations) and the water-food-energy nexus are an integral part of the drainage design process. Controlled drainage, i.e. the balance of removal and conservation of drainage water and minimising solute transport as low as reasonably achievable (ALARA principle) is extensively described. This work is intended for use both as a university level textbook and as a professional handbook; it is of particular value to professionals engaged in drainage development in the context of integrated water resources and river basin management, civil and agricultural engineers, government officials, university students and libraries.

This book comprises select proceedings of the First International Conference on Geomatics in Civil Engineering (ICGCE 2018). This book presents latest research on applications of geomatics engineering in different domains of civil engineering, like structural engineering, geotechnical engineering, hydraulic and water resources engineering, environmental engineering and transportation engineering. It also covers

miscellaneous applications of geomatics in a wide range of technical and societal problems making use of geospatial information, engineering principles, and relational data structures involving measurement sciences. The book proves to be very useful for the scientific and engineering community working in the field of geomatics and geospatial technology.

This study describes the development of water management in Bangladesh, including flood control and drainage schemes. The present landuse situation and hydrological conditions are presented and the coastal lowland development of Southeast Asia is reviewed. A performance analysis of different flood control and drainage systems are discussed, with reference to the coastal belt of Bangladesh. This book aims to set out an approach for sustainable development and water management for coastal Bangladesh, developing the concepts of effective techniques, tools and institutional infrastructure which should support implementation of flood control and drainage schemes.

This proceeding represents state-of-the-art trends and developments in the emerging field of engineering asset management as presented at the Eight World Congress on Engineering Asset Management (WCEAM).

The Proceedings of the WCEAM 2013 is an excellent reference for practitioners, researchers and students in the multidisciplinary field of asset management, covering topics such as: 1. Asset condition monitoring and intelligent maintenance, 2. Asset data warehousing, data mining and fusion, 3. Asset performance and level-of-service models, 4. Design and life-cycle integrity of physical assets, 5. Deterioration and preservation models for assets, 6. Education and training in asset management, 7. Engineering standards in asset management, 8. Fault diagnosis and prognostics, 9. Financial analysis methods for physical assets, 10. Human dimensions in integrated asset management, 11. Information quality management, 12. Information systems and knowledge management, 13. Intelligent sensors and devices, 14. Maintenance strategies in asset management, 15. Optimisation decisions in asset management, 16. Risk management in asset management, 17. Strategic asset management, 18. Sustainability in asset management. King WONG served as Congress Chair for WCEAM 2013 and ICUMAS 2013 is the President of the Hong Kong Institute of Utility Specialists (HKIUS) and Convener of International Institute of Utility Specialists (IIUS). Peter TSE is the Director of the Smart Engineering Asset Management laboratory (SEAM) at the City University of Hong Kong and served as the Chair of WCEAM 2013 Organising Committee. Joseph MATHEW served as the Co-Chair of WCEAM 2013 is also WCEAM 's General Chair. He is the Chief Executive Officer of Asset Institute, Australia.

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