

Preface

The twentieth century witnessed massive urbanization at a rapid pace in developing countries, and this pace is continuing in the twenty-first century. Currently, nearly half of the world's population lives in urban areas. The rapid urbanization is a direct result of economic growth and people's urge toward higher comfort and access to education, health, and travel facilities. Urbanization, more often, causes strain on natural and man-made resources that are meant for the well-being of people. One direct and most perceptible consequence of urbanization is the change in land use and land cover, which, in turn, impacts the hydrological resources and the hydrological cycle. This impact is witnessed through changes in surface and groundwater levels, surface runoff patterns, diurnal variations in temperature, humidity, cloud cover, smog, pollution, radiation, and wind. Therefore, scientific studies on urban hydrology are vital for appropriate design of urban landscapes and civil infrastructure works.

A center of excellence for "Integrated Landuse Planning and Water Resources Management" sponsored by Ministry of Urban Development, Government of India, was established at the Indian Institute of Technology Guwahati in the year 2010 to undertake studies on urban hydrology of the northeast region of India. As part of the mandate, the center conducted an international conference ENSURE 2012 and invited authors to submit articles related to urban hydrology. A number of authors presented highly thoughtful research papers on the topic, and seeing their value, it was decided to publish these conference articles in a book form. Consequently, we revisited the conference themes and articles and selected some of them for inclusion in this volume.

The subject matter of the book is, therefore, divided into six parts. One major impact of urbanization is the rapid increase in floods and storm waters. Part I, comprising of four chapters, deals with the impact of urbanization and mitigation measures to reduce the negative impacts of urbanization. The impact on hydrological processes, such as infiltration and surface runoff of a hilly terrain, due to changing slopes brought out by urban development, is analyzed using laboratory experiments in one of the chapters. These experiments highlighted the impacts

of the presence and absence of vegetation on surface runoff. The role of imperviousness on surface runoff and infiltration due to urbanization is analyzed in chapter “[Impact of Total and Effective Imperviousness on Runoff Prediction](#)” by comparing the outputs of hydrological models of a region using total and effective impervious areas. Chapter “[Issues of Urban Drainage—Present Status and the Way Forward](#)” discusses on issues related to urban drainage and the way to move forward. The advantages of optimal allocation of ecological management practices in a hilly urban watershed to alleviate the impacts of urban floods were discussed in the final chapter in this part.

Remote sensing and GIS are widely used in various applications of natural resources, and hydrology is one of the most benefitted sciences from the use of remote sensing. GIS, remote sensing, and digital elevation models are very much important in urban hydrological modeling, and these tools are efficient in assessing the quantity of water resources for sustainable management. Therefore, Part II deals with remote sensing and GIS applications especially in urban hydrology. It is comprised of three chapters. One of the most adopted forms to quantify the losses due to infiltration is the use of curve number technique. The first chapter of this part describes the use of GIS and satellite images in the Soil Conservation Services (SCS) [now called Natural Resources Conservation Service (NRCS)] curve number method to estimate surface runoff, infiltration, and groundwater recharge. The next chapter discusses the effect of rainfall, and land use and land cover change on surface runoff as well as on surface soil erosion, mainly due to the change in vegetation area, of an urban region using remote sensing and GIS. The final chapter in this part describes the use of digital elevation models to characterize flood plains of a river passing through urban locations.

Any hydrological study will be incomplete without dealing with groundwater and subsurface water of the region. Special emphasis is given to subsurface hydrology in this book. Therefore, groundwater and subsurface water hydrology of urban areas is the theme of Part III that consists of five chapters. Some ideas in this part emphasize the need and importance of groundwater management and rainwater harvesting in arid and semiarid areas. The authors of some chapters have critically reviewed the anthropogenic causes of saltwater intrusion in urban coastal regions due to overexploitation of groundwater. Applications of groundwater models, like MODFLOW, to predict and forecast water levels and describe the aquifer stresses are also important studies in this part. There are chapters on the need of groundwater management due to rapid urbanization and linked optimization for groundwater contamination monitoring networks. Also discussed in this part is the conjunctive use of rainwater harvesting methods as tools for artificial recharge of groundwater to aid urban water supply systems. The velocities and patterns of flow of subsurface water through porous media depend on the type of soil, degree of water saturation, and the soil–water characteristics. A useful study on soil–water characteristics for urban hill soils of northeast India is presented in one of the chapters in this part.

Considering the various expenditures on field and laboratory exercises to study hydrological phenomena, computational modeling mechanisms allow for

gaining an understanding of these phenomena at low cost. Therefore, Part IV is on applications of computational and numerical models to urban hydrological problems. It contains five chapters. The hydraulic models for urban drainage systems often need to consider erosion and sedimentation. Some research studies, in this part, highlight the need for two-dimensional computational models for urban drainage. These computational models determine the critical sections of urban drains that are quite important in drainage design. Urban floods can be modeled using computational software, such as HEC-HMS and HEC-RAS. Simulation results from these computational models can assess the risk associated with these floods. Some chapters in this part deal with risk assessment due to urban floods. An interesting chapter in this part is the use of well water-level fluctuations to develop seismographs for highly sensitive seismic regions. In yet another chapter in this part, the authors present the use of momentum transfer methods, in their computational models, to evaluate flow in compound open channels. There are chapters that discuss optimal reservoir operation policies, including environmental flows, for hydropower projects of northeast India.

Soft computing techniques in urban hydrology are dealt with in Part V that contains five chapters. There are many soft computing tools used in hydrological analysis—artificial neural network, fuzzy logic, fuzzy sets, wavelets, etc. The first chapter in this part deals with the application of fuzzy sets in the design of a water distribution network. The uncertainties, if any, in the inputs for urban networks are shown to be overcome by the use of fuzzy sets. The use of wavelet transforms in hydrology is discussed in the next chapter. Artificial intelligence methods, such as artificial neural networks and fuzzy logic, are used in urban hydrology with large success. Soft computing tools can also be used independently or in combination like wavelet–neural networks and adaptive neurofuzzy. The use of such soft computing tools can also be extended to predict pipeline leakages in urban centers or river stages adjacent to urban locations or prediction of surface runoff, etc. Soft computing models depend extensively on time series data, and an article describes that the preprocessing of these data can enhance the performance of such models.

The concluding part, i.e., Part VI, is on socio-economic aspects and the role of society in overall urbanization impacts. It comprises six discourses. The importance of socio-economic studies to understand population, land requirement, economic status, etc., of the people residing in urban hilly areas to assess the carrying capacity of hills is discussed in the first write-up of this part. The effect of urbanization is critically remarked in a chapter that describes the performance of students in the course curriculum. The rapid population growth in the university affects the overall well-being of the campus community, and several environmental parameters are compromised, as a result. Another chapter discusses the role and importance of community in river basin management. Some chapters discuss the role of local bodies in municipal solid waste management, role of government in sustainable urban development, etc. Another important aspect of urbanization is the migration of large population from rural and semiurban areas to urban areas. Such events cause a huge strain on natural and man-made resources, and there are chapters in

this part that discuss such issues. The final study in this part discusses the benefits of using urban and natural water bodies as means of transport and communication.

Overall, the book comprising six parts covers a wide range of topics on urban hydrology, urban watershed management, and the socio-economic aspects of urbanization in a single volume. As this book consolidates most of the water and environmental issues related to urbanization, the reader will be benefitted in gathering useful information at one go. Moreover, the parts are selected on thematic aspects, and the reader can directly go to the respective parts for his or her topic of interest.

The authors admit that there are limitations of this book and it is not complete. However, best efforts have been made to consolidate all the related themes in a single book. The authors express their gratitude to the organizing committee of ENSURE 2012 in providing the contents of this book and acknowledge the efforts of students of Department of Civil Engineering, IIT Guwahati, in assisting in the development of the book.

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