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Chapter 1

Introductory Chapter: An Introduction to Topics in Hydrometeorology

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1. Introduction

Hydrometeorology is the study of both the atmospheric and terrestrial phases of the hydrological cycle, with emphasis on the interrelationship between them (i.e. the transfers of water and energy between the land surface and the lower atmosphere). Accordingly, the science of hydrometeorology bridges across both hydrology and meteorology [1]. The subject of hydrometeorology encompasses a wide variety of topics [2, 3] that are of high interest in programs involving the atmospheric sciences, the transport of moisture in the atmosphere, surface-water and soil-water hydrology, earth-surface and atmospheric interactions, and techniques in engineering mathematics including the evolving applications in Computational Engineering Mathematics or "CEM". Recent advances in CEM are opening new opportunities for researchers to address diverse challenging multi-dimensional applications in hydrometeorology. Because of the massive database sizes involved, both in hydrometeorology data collection (greatly augmented by private observers equipped with highly accurate monitoring reporting equipment connected to the web central databases), the evolving field of "visualization" has developed where focus is upon generating depictions of these data to increase understanding [4], and to assemble the data for further assessment and analysis for subsequent detailing and publication.

In the current book, a selection of data interpretations and experiences are presented as an enticement to students and practitioners for motivating further intellectual growth in the growing field of study known as "hydrometeorology." Many universities borrow specific topics from the field of hydrometeorology in related courses such as Computational Engineering Mathematics or its earlier version, Engineering Mathematics (or other variants). Perhaps few other demonstrations of vector calculus are as noteworthy and understandable as the description of the vector calculus topics of vector curl and vector divergence, as by examining the evolution of a weather tornado or hurricane, or of the use of these vector concepts in describing weather systems as they move over the planet. The notion of wind flow velocity readily leads to the description of multidimensional vectors, and the readily observable effects of wind rotation as well as expansion and contraction of a moving stream tube of air often invite the student or practitioner or hobbyist, to seek further understanding of the mathematical underpinnings of these vector concepts.

Of particular value are the numerous weather hobbyists [5] as well as the more detailed and validated databases [6, 7] that are increasingly made available for general use. Several publications containing highly descriptive diagrams and remarkable photographs are now available both in hard copy and in the Internet, further exciting the observer and hydro meteorologist to explore the various ways to describe the planet's weather systems and related hydrologic and earth-surface interactions.

The well-known "Moore's Law" truly has application in this area of investigation in that computational advances in power and mathematical capabilities have created an innovation-rich environment where the understanding of the global transport systems can be better interrelated and their interdependence linkages better identified and described. In the following, a very brief introduction is made to each of the chapters in the book. The editors celebrate the assemblage of knowledge achieved by these chapter authors and coauthors.

Bannari et al. used SMOS, OLI, and TRIS data to study the soil moisture that characterizes over the Guelmim city and its neighborhood in the Southwestern of Morocco. This area has very limited rainfall, and when it rains, it is intense over a short period, leading to flash floods. The end results were compared with published data from NOAA climate prediction center. They have described in detail their algorithm which can help other researchers to extend its application for varying geographical domains. The approach used can be integrated with other applications and can help urban planners to design contingencies for any future flooding event.

Although the rainfall measured from gages are reliable, their sparse spatial distribution warrants developing techniques by which the measured gage rainfall values across a network can be extended and corrected to arrive at rainfall estimate at other locations. Correction to the measured values by incorporating altitude and topographical variation can provide reasonable precipitation estimates for planning and design purposes. Dinka addressed this problem by developing a conceptual regression model for the Matahara area, which is located in the middle of Awash valley, about 200 km south east of Addis Ababa, Ethiopia. The relationship between monthly rainfall totals and altitude over Matahara region was examined using the optimized ordinary least square method.

Taffarello et al. presented the hydrometeorological characteristics of few chosen watersheds from Brazil. The challenges in developing baseline performance data across various watersheds that have varying vegetal, anthropic, geological, topographical, land use patterns, biodiversity, and soil characteristics have been discussed. The linkages between ecosystem and soil moisture were reviewed. Salient data from chosen ecosystem-based adaptation (EbA) projects that are being implemented for restoring the watersheds have been presented. Their effort can translate to a valuable tool for decision-makers to review the efficacy of existing best watershed management practices aimed at improving the capacity of aquifers and in devising new practices that can be effectively implemented by integrating all the concerned parties.

Ghosh assessed the spatial and temporal drought intensity during 1991–2002 for the Gangetic region in eastern part of India. The standard precipitation index was used in the analysis

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together with seven parameters to evaluate drought. The analysis showed that the deficit precipitation in this region since the 1950s has been on upward trend, thus affecting the local socioeconomic fabric in the society. This study sheds more reliable information related to drought that can help area managers to streamline their drought preparedness strategies. Additionally, this approach can be applied to other regions in the world, which rely largely on rainfall for their agricultural needs.

Any effort aimed at conserving soil requires a reliable approach to predict soil erosion, the accuracy of which depends on the input precipitation value. Since at many rainfall monitoring stations, the recorded data are not continuous which need to be first addressed (Zanoni et al.). Three methods (weighted likelihood, multiple regression, and weighted likelihood based on multiple regression) for filling the gaps in measured rainfall values in Brazil watersheds were analyzed. Filling in the rainfall gaps translated to a continuous data for 2001–2004 period from which the rainfall erosivity was calculated at chosen stations in Parana river basin. The erosion values from the three methods were compared, and weighted likelihood method was recommended for further analysis.

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