Chapter 1

Introductory Chapter: Applications in Water Systems

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Additional information is available at the end of the chapter

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1. Introduction

Water is, without doubt, an essential and basic resource for the existence of life on the planet, as it is the primary component of the ecosystem and is used for many purposes, three of which are of main importance, that is, irrigation, industry, and domestic application. Therefore, water security challenges may affect the environmental, economic, and social stability of the world. The seriousness of these conditions highlights the need to examine the impact of climate change acting at the planetary level on water security and people movement. This topic is addressed in Chapter 1, which investigates the effect of rainfall and temperature, which are climate change variables, on water security and people movement in three Sub-Saharan African countries. The study reveals increasing rural-urban migrations in the next decade in the selected countries due to high rainfall variabilities and increasing temperatures, using VAR and granger causality tests. There will be a large number of rural communities leaving from their villages to urban areas due to water availability conditions and poor agricultural production levels, with all that follows.

With the evolution of urbanization, industrialization, and intensive agricultural practices, one of the most damaged natural elements is water, and then the aquatic environment. Therefore, the need to pay more attention to the quality of all types of water bodies including river reaches, lakes, reservoirs, estuaries, and coastal waters, to analyze the effects and locate the causes of their pollution and to manage it, has led to the development of water quality models. Since pollutants, which flow into the water bodies are transferred by both advection and diffusion and react chemically and biologically, the priority is to configure the hydrodynamic processes that occur in the target area. Thus, hydrodynamic models able to simulate circulation and currents are jointly needed. Two different applications of hydrodynamic modeling in similar water bodies, i.e. lakes, are presented in this book. Chapter 2 concerns the study of the effect of wind waves, when the probability of occurrence of the wind direction is given by a circular or elliptic distribution, on the shape of shallow water bodies, initially rectangular or triangular. The segmentation of these water bodies into circular or elliptic lakes is predicted

in each case using the BG model. Chapter 3 aims to improve understanding of the hydrodynamic characteristics in different tropical lakes located in Malaysia, for which current knowledge remains inadequate due to the absence of long-term monitoring data. Chapter 4 focuses on the fundamental concepts and principles of surface water analysis, and the application of a model that combines hydrodynamics and water quality. The fundamentals of surface water hydrodynamics and quality including water properties, hydrodynamic processes, governing equations, the fate of contaminants, and their transport are reviewed. Two case studies, the hydrodynamic and quality modeling of a lake and a river, are presented in this section to show how the respective models are applied for different kinds of water bodies. The aim is to help improve the understanding of the different hydrodynamic processes involved in nature, in order to facilitate decision making in real surface water systems management.

Another important aspect of environmental hydraulics is the solid transport. Suspended sediment transport in large rivers is constituted mainly by cohesive sediments, which form aggregates or flocs. The removal of cohesive sediments in aquaculture tanks that are close to these water bodies is a difficult problem. Due to its size, density, and shape, the hydrodynamic behavior of flocs is very different from that of noncohesive sediments as they depend on the interaction with the water column. Chapter 5 shows a model to estimate the floc settling velocity using the fractal theory and by including an adequate definition of the drag coefficient for permeable flocs. The goodness of the results is validated using experiments with flocs from aquaculture recirculation tanks that cultivate trout. The most suitable methods for analyzing the size and the settling velocity of flocs are shown to be the optical methods, because they do not destroy flocs and allow for microscopic analysis.

The management of water quality concerns the control of pollution caused by human activity, so that the water is not degraded to the point that it is no longer suitable for planned uses. If this happens when the use is drinking, it becomes essential to establish an alarm situation that blocks the supply of water. Chapter 6 describes an interesting methodology for abnormality detection in water network. More specifically, a noise pattern analysis is used (i) to demonstrate how water quality events can be classified and then (ii) to reduce the level of false alarms in the monitoring system. The analysis carried out in this section, assisted by practical examples, can also assist control systems in regard to the automatic classification process of observed events, in order to reduce the level of false alarms in water monitoring systems.

Finally, I would like to express my personal appreciation to all the authors who have contributed to giving life to this book. I am sure that all the contributions can give interesting insights to the scientific world inherent in the field of Hydraulics and Environmental Engineering.

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