ENVIRONMENTAL HYDRAULICS SERIES

Physical Processes and Measurement Devices

Edited by Jean-Michel Tanguy

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Environmental Hydraulics
volume 1

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Introduction

This series on hydraulics is divided into five volumes. Volume 1 discusses the context for this environmental hydraulics treatise: the evolution of the different scientific and technical disciplines involved along with the space and time dimensions of the processes described. It evokes the importance of the global flood risk and outlines a first quantification approach of the impact of climate change on hydrology. It then describes in detail the physical processes relating to hydrology, hydraulics and river morphodynamics.

This continues with a part dedicated to describing the physical processes and the hydrosystems involved. The following part lists systems of measurements that may provide data for digital models:

– firstly focusing on estuarian processes, the tide, waves, storm surge and storm forecasting and on shore;

– then describing forecasting systems for weather parameters linked to the hydrological cycle, those necessary for the acquisition of topographical and bathymetric data, and for the characterization of soils and water in the soil. We then address the river field with systems of measurement of water levels and floods relative to the quality of water, to the measurement of ice thickness and coverage, to measurements of river sedimentology and in urban hydrology. We continue with the measurement of sea parameters: currents, swells and the sea level and by sedimentological measures in an inshore environment. The last chapter discusses new technologies arising from the spatial dimension.

Volume 2 focuses on mathematical modeling in hydrology and fluvial hydraulics, with a following part dedicated to the mathematical modeling of marine hydraulics, to transportation models and conceptual models.

Introduction written by Jean-Michel TANGUY.

Volume 3 discusses digital modeling.

Volume 4 shows examples of software applications in water engineering case studies.

Finally, Volume 5 describes a few operational software packages in the field of water engineering.

PART 1

Floods and Climate Change

Chapter 1

Presentation of the Environmental Hydraulics Treatise

1.1. Context

The management of water has become daily news, whether due to excess, with large devastating floods in the world, or due to scarcity with dry summers or the progression of semi-arid and arid areas that we know today. This pushes public authorities to enforce measures of protection and resource management. Climate evolution would appear to exacerbate extreme phenomena. According to the World Meteorological Organization (WMO) source (see also Chapter 2):

– approximately 1.5 billion people in the world were victims of floods from 1991 to 2000. Recently, an increase in the number of disasters associated with this phenomenon has been observed, mainly due to the development of land in floodplains and its densification. Natural disasters create a lot of suffering, particularly in developing countries with low income economies which are sensitive to the repetition of these events. It is true that the fact of living in a flood plain provides undeniable advantages in terms of richness of soils in order to obtain high agricultural yields;

– drought is probably the type of natural disaster with the most devastating effects. From 1991 to 2000, this phenomenon was responsible for more than 280,000 deaths in the world and caused billions of dollars of material damage. By 2025, it is expected that the population living in countries facing water shortage

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Chapter written by Jean-Michel TANGUY and Denis DARTUS.

problems will increase from 1 to 2.4 billion people, representing 13% to 20% of the world population.

The *World Summit on Sustainable Development* held in Johannesburg in August and September 2002 underlined the need to "fight against drought and floods through better use of information, climate and weather forecasting, fast warning systems, better management of land and natural resources, agricultural practices and ecosystems conservation in order to reverse the current trends in soils and water degradation…"

In addition, because of global warming, an increased frequency of some extreme weather phenomena like heat waves and very heavy rainfalls is expected, but nothing is yet certain (see Chapter 3). We do not have enough hindsight in terms of climate change as yet to isolate evolutions caused by changes in natural conditions from those due to human activities. However, everything seems to contribute to an increase in greenhouse gas emissions. The global awareness of these problems has led to the ratification of major international protocols on climate change like Kyoto in 1997 or Bali in 2007 which laid the groundwork and then outlined the main principles of sustainable development. All this led to international or European initiatives which have since been outlined in regulations in each country. Moreover, it is in this context that in France the Environment Round Table (*Grenelle de l'Environnement*) was launched, which has given more emphasis to water conservation. This favorable context reminds us that water is a valuable resource and is of limited quantity, which should encourage developers to adopt an integrated approach by considering the impacts of each project in a much wider context and consider its actions both in the short and long term.

1.2. Origin of environmental hydraulics

In this critical context, it seemed necessary to establish a state of knowledge regarding hydraulics in a broad sense, so as to inform policy makers by providing overwhelming evidence not only on the behavior of water and its richness, but also on its fragility. This treatment of environmental hydraulics deals with the physical processes of water from a raindrop all the way to the sea. Its publication stems from a number of motivations:

– the lack of works covering this subject in its *global nature*. The literature is rich in works covering meteorology, hydrology, hydraulics or hydrogeology on the one hand and mathematical modeling and numerical methods on the other hand. These works are often very theoretical and do not grant enough space for illustrations and practical examples. We want to present these fields in an integrated manner, starting from the description of physical processes through mathematical