

Preface

*I come from haunts of coot and hern,
I make a sudden sally
And sparkle out among the fern,
To bicker down a valley.*

*By thirty hills I hurry down,
Or slip between the ridges,
By twenty thorpes, a little town,
And half a hundred bridges.*

*Till last by Philip's farm I flow
To join the brimming river,
For men may come and men may go,
But I go on forever.*

...

The Brook, Alfred Lord Tennyson (1809–1892)

Flow in a river that goes on forever is one of the most evident manifestations of gravity. The river and its characteristics must be studied, must be understood. The book, *Fluvial Hydrodynamics*, goes in this direction written by an *unknown hydraulician*.

The state of the art in fluvial hydrodynamics can be examined only through a careful exploration of the theoretical development and applied engineering technology. This book is primarily focused, since most up-to-date primary research findings in this field are presented, on the research aspects that involve a comprehensive understanding of the mechanics and physics of sediment transport by turbulent flow. It begins with the fundamentals of hydrodynamic principles applicable to open-channel flow followed by turbulence characteristics related to sediment motion. Then, the sediment dynamics are described from a classical perspective by applying the mean bed shear approach, and additionally, incorporating a statistical description of the role of turbulence. The book also describes the local scour problems at hydraulic structures and scale models. It is thus intended primarily as a course textbook at the graduate/research level and also as a guide for field engineers, keeping up with modern scientific developments. Therefore, as a simple prerequisite, the readers should have a basic background knowledge in

hydraulics/fluid mechanics and an understanding of fundamentals of calculus, probability, statistics and physics.

In the field of civil engineering, where engineers typically learn about rivers in courses called open channel hydraulics and sediment transport, sound knowledge of fluvial hydrodynamics is important because it determines the aggradations and degradations of the river systems, life span of hydraulic structures and river protection works, etc. Thus, it is not surprising that this subject is of interest to a wide circle of professions that include hydraulicians, hydrologists, geologists, sedimentologists, geographers, civil engineers, environmental engineers, and so on.

I understand from the discussions with and comments from colleagues and students over the years during delivering lectures on an international short course on *turbulent flows, sediment transport and scour* offered to different universities around the world and on the regular graduate courses on *hydraulics of sediment transport* and *turbulent fluid flows* at my Institute (Indian Institute of Technology, Kharagpur) that the phenomena concerning the dynamics of sediment particles under a turbulent flow invite many open questions. My primary attempt is therefore to address the fundamental aspects of fluvial hydrodynamics from the viewpoint of micro-mechanical interaction of sediment particles with turbulent flow.

I am of the opinion that it could be possible to build a sound understanding of fluvial hydrodynamics on the typical foundation of fluid mechanics, basic calculus, probability, statistics and physics. Introducing new aspects found in the research of turbulent flow, this book updates the theories of sediment transport. It is therefore my hope that this book would close the gap between the micro-mechanics of sediment transport and the stochastic characteristics of turbulent flow. It differs from the traditional treatments of open channel hydraulics and sediment transport in its greater emphasis on the basic physics of turbulent flow in terms of quantitative analytical information.

A course based on this book would be appropriate for graduate and research students in hydraulic engineering and earth sciences curricula and would expected to be taught by a teacher with an active interest in this field. Under these circumstances, instructors would assign students in exploring questions that arise and in discussing papers from the journals, and to involve them in laboratory experiments and/or field studies. Therefore, I have also included exercises that can be used to explore the problems of practical importance involving complex hydrodynamic phenomena in the context of sediment dynamics. I would be greatly rewarded if this book proves to be of any assistance in improving existing scarcity of textbooks on sediment transport by turbulent flow.

I express my deep sense of indebtedness to *Pawel Rowinski*, Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland, who proposed and inspired me to write this book in his capacity as the Editor-in-Chief of the Springer book series: *Geoplanet: Earth and Planetary Sciences*. He was an endless source of help and encouragement. I heartily thank *Oscar Castro-Orgaz*, University of Cordoba, Spain for reviewing the manuscript at various stages in its development. I also thank *Walter Hans Graf*, Laboratoire de Recherches Hydrauliques, École Polytechnique Fédérale, Lausanne, Switzerland for his suggestions at the final stage of

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This work would not have been possible without the constant encouragement and support of my parents, *Kana Dey* (mother) and *Bimalendu Dey* (father), while pursuing my school level, undergraduate, and graduate education; and of my advisors of doctoral research, *Sujit K. Bose*, (former Professor) S. N. Bose National Centre for Basic Sciences, Kolkata, India, and *Ghandikota L. N. Sastry*, (former Professor) Indian Institute of Technology, Kharagpur, India, who most inspired and educated me.

The love, support, and encouragement of my wife *Swastika*, son *Sibasish*, and daughter *Sagarika* have sustained me in this work, as in every part of my life. Every human being owes a great deal to their friends and I am no exception. I treasure my close association with all my friends for their support, cooperation, and sincere help in various ways.

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