# CHAPTER 1
# INTRODUCTION

The accurate determination of the geometry of a channel whose boundary is composed of particles that are all on the verge of motion, is very important in the design of irrigation canals, channelization schemes, as well as for flow regulation. Such a channel, which is referred to as a 'threshold channel', is used as the basis for the most efficient unlined channel design. This is because a threshold channel has the minimum area needed to convey a given discharge, without any erosion of the boundary taking place. It thus requires a minimum of excavation, and little or no dredging; desirable features in the construction and maintenance of channels.

However, the threshold channel is limited in its applicability where natural rivers and streams are concerned. Gravel and sand-silt rivers support suspended sediment transport as well as bedload transport. Some gravel rivers are composed of sediment of such coarseness that suspension of this sediment is minimal. However, they are still observed to transport a considerable amount of bedload sediment along a central bed region, while maintaining stable banks. On the other hand, a threshold channel does not allow for sediment transport since all particles on its boundary are in a state of static equilibrium. Threshold channels are therefore unable to represent the 'stable bank, mobile bed' condition observed in gravel and sand-silt rivers.

A more realistic representation of these rivers would be a channel composed of a flat central bed region, connected to two curving bank regions. Several investigators have developed models that are consistent with this geometry. However, these models do not sufficiently account for the phenomenon called 'momentum-diffusion', which has a significant effect on the formation of natural channels.

The objective of this work was to determine the predominant processes involved in straight rivers, set up the governing equations that would adequately represent these processes, and develop a numerical model that would predict the optimal dimensions and corresponding boundary shear stress distribution for such a channel.

Chapter 2 discusses in detail, some of the more recent models used to represent natural rivers. It highlights their main features, as well as their limitations; one of which is the inadequate representation or non-incorporation of mometum-diffusion in the development of these models. This chapter explains why it is necessary to use momentum-diffusion in conjunction with a 'flat bed, curving bank' geometry, in order to properly represent the optimal 'stable bank, mobile bed' case.

Chapter 3 deals with the concepts that serve as the foundation for the present numerical model. Based on these concepts, governing equations are derived and boundary conditions are specified.

Chapter 4 outlines the numerical scheme used to determine the geometry and stress distribution of an optimal stable channel. In this chapter, the various numerical techniques used at various stages of the scheme are highlighted and explained.

Chapter 5 analyzes the data generated from simulations using the numerical model. These data are compared with experimental, as well as field data, available from previous investigators. It presents equations and plots that have been developed based on the numerical model results, and can be used for design purposes in lieu of the numerical model. Design examples that demonstrate the use of these equations and plots are given. The limitations of the numerical model are also discussed in this chapter.

Chapter 6 discusses the case of a channel that conveys sediment in suspension, as well as bedload. Governing equations that may be used to develop a numerical solution for such a case are proposed.

Chapter 7 summarizes how well the present numerical model represents the phenomena observed in natural rivers, and suggests certain areas which need to be further investigated and improved.