Transcritical shallow-water flow past topography:
finite-amplitude theory

Gennady El
Department of Mathematical Sciences, Loughborough University,
Loughborough, LE11 3TU, UK
Tel: +44 1509 222869, email: g.el@lboro.ac.uk

Abstract:
In this talk I will present recent results obtained jointly with Roger Grimshaw (Loughboroug
and Noel Smyth (Edinburgh) on the generation of undular bores in one-
dimensional fully nonlinear shallow-water flows past localised topographies [1]. The
description is made in the framework of the forced Su-Gardner (a.k.a. 1D Green-
Naghdi) system of equations, with a primary focus on the transcritical regime when
the Froude number of the oncoming flow is close to unity. A combination of the
local transcritical hydraulic solution over the localized topography, which produces
upstream and downstream hydraulic jumps, and unsteady undular bore solutions
describing the resolution of these hydraulic jumps, is used to describe various flow
regimes depending on the combination of the topography height and the Froude num-
ber. We take advantage of the recently developed modulation theory of Su-Gardner
undular bores [2] to derive the main parameters of transcritical fully nonlinear shallow-
water flow, such as the leading solitary wave amplitudes for the upstream and down-
stream undular bores, the speeds of the undular bores edges and the drag force. Our
results confirm that most of the features of the previously developed description in the
framework of the uni-directional forced KdV model [3] hold up qualitatively for finite
amplitude waves, while the quantitative description can be obtained in the framework
of the bi-directional forced Su-Gardner system.

References: