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Comparison between curvilinear and rectilinear grid based hydraulic models for river flow simulation

Giasemi G. Morianou[a,*], Nektarios N. Kourgialas[a], George P. Karatzas[a]

[a]*School of Environmental Engineering - Technical University of Crete, Polytechneioupolis, Chania 73100, Greece.*

Abstract

In the present work, the two-dimensional hydraulic models MIKE 21 and MIKE 21C were used in order to simulate the water depth at the downstream section of the Koiliaris River Basin in Crete-Greece. Specifically, an important goal of the present study was the comparison of the widely used MIKE 21 with the MIKE 21C model. The MIKE 21C model has been developed specifically to simulate 2D flows and morphological changes in rivers. It is based on an orthogonal curvilinear grid and comprises two parts: (a) the hydrodynamic part that is based on the Saint-Venant equations and (b) the morphological change part for the simulation of sediment transport. In contrast to model MIKE 21C, the general version of MIKE 21 is based on a rectilinear grid. The difference between the curvilinear and the rectilinear grid is that the curvilinear grid lines follow the bank lines of the river, providing a better resolution of the flow near the boundaries. The water depth results of the two models were compared with field observations and a series of statistical indicators. It was concluded that the curvilinear grid based model results were in better agreement with the field measurements.

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Keywords: MIKE 21C model; MIKE 21 model; curvilinear grid; rectilinear grid

* Corresponding author. Tel.: +30 28210 37793

E-mail address: giasemi.mor@gmail.com

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1. Introduction

Several hydraulic models have been used for the simulation of river flow. The most commonly in use are the one-dimensional models, which are simpler to use but fail to provide detailed information regarding the flow field. This limitation can be overcome by applying the two-dimensional models. Widely used software packages for 2D modelling are the MIKE 21 model [2, 9] and the FLOW 2D model [8]. Two-dimensional modelling has the advantage of flow propagation simulation with great accuracy. Nevertheless, 2D models require substantial computational time and a fine river grid. The purpose of this study was to simulate river flow by using a curvilinear grid based model (MIKE 21C) in comparison to a rectilinear grid model (MIKE 21).

2. Study area

The Koiliaris River Basin is located 15 km east of the city of Chania in Crete. The basin extends from the White Mountains to the coastline and has a total catchment area of 130 km^2. The total length of the Koiliaris River network is 36 km. The river has two temporary tributaries and two permanent discharged from the karstic system of the White Mountains through Stylos springs (Fig. 1). From the intersection point, where all the streams meet, to the outflow point the length of the river is 3.3 km. The topography of the study area is smooth with a mild slope of 12% [5] and the geology of the basin is mainly karst with quaternary–neogenic deposits and flysch formations. In the Koiliaris River basin, there are three telemetric hydrometric stations. For the present study, flow data from the hydrometric station of Agios Georgios are used to determine hydrological parameters.

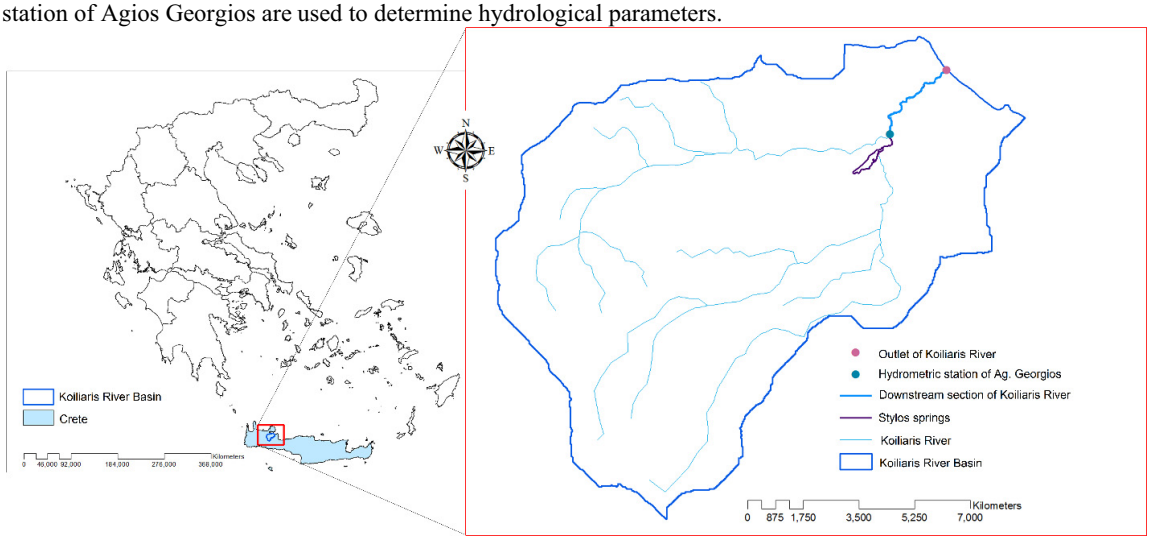

Fig. 1. Location of Koiliaris River Basin

3. Methodology

3.1. MIKE 21 & MIKE 21C hydrodynamic equations

MIKE 21 and MIKE 21C are two-dimensional mathematical models for the simulation of water flow and sediment transport. The hydrodynamic part of the models solves the vertically integrated Saint-Venant equations (continuity and conservation of momentum) in two directions. Eq. 2, 3 & 4 describe the MIKE 21 HD model [2] and Eq. 4, 5 & 6 describe the MICE 21C HD model [4].

MIKE 21 hydrodynamic equations