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DEPTH AVERAGED MODELING OF TURBULENT RIVER FLOW

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Problems connected with wastewater discharge into rivers as well as flood control problems are issues of current importance. Extensive scientific knowledge about the structure of a river stream is the essential basis for minimizing damage and making predictions about the behavior of the river.

The purpose of this work is to construct a mathematical model and a computational method for simulating the river stream and to apply them to investigating the problems connected with transport of pollutants and local flooding on the plain rivers that are ice-covered in winter.

The river ow turbulence has a great in uence on bed formation and on transport of pollutants by a stream. The model proposed [1] is based on depth-integrated RANS equations. This approach is preferable because it combines acceptable computational cost and precision of obtaining results. Averaged turbulent stresses appearing in the model were defined from Boussinesqs hypothesis. Turbulent characteristics of the ow were computed from the depth averaged high-Reynolds modification of the k-epsilon turbulence model proposed by Launder and Spalding [2] that had been successfully applied to large-scale ow modeling. The model also includes wind stresses on water surface, bottom share stressesd depending on roughness, and terms to account for the Coriolis force that are significant for the ow in a river.

A finite volume method on the staggered structured grid was used to discretize the equations. Convective uxes were discretized with both MLU and MUSCLE schemes. Solution of the discrete system was obtained with a SIMPLE iterative algorithm based on coupled correction of the depth and velocity fields on each time step. The principal innovation of the algorithm proposed is accounting for the variability of the water depth in the source term in the momentum equations.

Steady turbulent ow in a small shallow river that had been accurately investigated both experimentally and computationally was modeled to validate the model and method proposed.

The main object of the research is the 50 km section of the Tom River near the city of Tomsk (Siberia, Russia). Two problems that could be solved using the method proposed are the analysis of transport of pollutants from wastewater discharge into the river and the prediction of the areas that could be affected by local flooding from spring snow melt and ice ow. The results of the calculations for two test cases for the problems described show agreement with general concepts and represent ow patterns observed in field studies of the river.

REFERENCES

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