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# 3D CFD Model of Hydrodynamics in Lowland Dam Reservoir in Poland

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**Abstract :** Introduction: The objective of the present work was to develop and validate a 3D CFD numerical model for simulating flow through 17 kilometers long dam reservoir of a complex bathymetry. In contrast to flowing waters, dam reservoirs were not emphasized in the early years of water quality modeling, as this issue has never been the major focus of urban development. Starting in the 1970s, however, it was recognized that natural and man-made lakes are equal, if not more important than estuaries and rivers from a recreational standpoint. The Sulejow Reservoir (Central Poland) was selected as the study area as representative of many lowland dam reservoirs and due availability of a large database of the ecological, hydrological and morphological parameters of the lake. Method: 3D, 2-phase and 1-phase CFD models were analysed to determine hydrodynamics in the Sulejow Reservoir. Development of 3D, 2-phase CFD model of flow requires a construction of mesh with millions of elements and overcome serious convergence problems. As 1-phase CFD model of flow in relation to 2-phase CFD model excludes from the simulations the dynamics of waves only, which should not change significantly water flow pattern for the case of lowland, dam reservoirs. In 1-phase CFD model, the phases (water-air) are separated by a plate which allows calculations of one phase (water) flow only. As the wind affects velocity of flow, to take into account the effect of the wind on hydrodynamics in 1-phase CFD model, the plate must move with speed and direction equal to the speed and direction of the upper water layer. To determine the velocity at which the plate will move on the water surface and interacts with the underlying layers of water and apply this value in 1-phase CFD model, the 2D, 2-phase model was elaborated. Result: Model was verified on the basis of the extensive flow measurements (StreamPro ADCP, USA). Excellent agreement (an average error less than 10%) between computed and measured velocity profiles was found. As a result of work, the following main conclusions can be presented: •The results indicate that the flow field in the Sulejow Reservoir is transient in nature, with swirl flows in the lower part of the lake. Recirculating zones, with the size of even half kilometer, may increase water retention time in this region •The results of simulations confirm the pronounced effect of the wind on the development of the water circulation zones in the reservoir which might affect the accumulation of nutrients in the epilimnion layer and result e.g. in the algae bloom. Conclusion: The resulting model is accurate and the methodology develop in the frame of this work can be applied to all types of storage reservoir configurations, characteristics, and hydrodynamics conditions. Large recirculating zones in the lake which increase water retention time and might affect the accumulation of nutrients were detected. Accurate CFD model of hydrodynamics in large water body could help in the development of forecast of water quality, especially in terms of eutrophication and water management of the big water bodies.

**Keywords :** CFD, mathematical modelling, dam reservoirs, hydrodynamics
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