Modeling the Dynamics of Shallow Water for Control Problems of Floodplain Areas

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The basis for the numerical modeling of the self-consistent dynamics of surface waters and sediment transport is the original Lagrangian-Eulerian CSPH-TVD method for solving the Saint-Venant and Exner equations, taking into account the physical factors essential for the understanding of the shallow water and surface soil layer motions, including complex terrain structure and its evolution due to sediment transport. Parallelization was carried out using the OpenMP-CUDA technology for supercomputers with several GPUs interacting via the PCI-E/NVLINK interface. The areas of application for such models are very broad and cover the environmental and hydrological tasks (seasonal flooding, rainfalls, transport of pollutants in water bodies), the ecological safety problems (effects of the dam destruction, tsunami impact on the coast, formation of nonlinear waves due to earthquakes), the technical expertise in the design of various types of hydraulic works (for example, various dams, floodgates, canals, dikes, etc.). The shallow water models with high-precision digital terrain allow the construction of flood cadastral maps. The problems associated with modeling the hydrological regime of the Volga-Akhtuba floodplain (VAF), which is a unique landscape due to the spring flood, are discussed in detail. Perhaps the only way to preserve the VAF ecosystem is the implementation of hydraulic projects aimed at increasing the level of watering of the territory in conditions of small and medium floods, which are caused by the regulation of the Volga River due to the system of hydroelectric

power stations. Numerical simulations of the dynamics of surface waters are the basis for the model of the integrated hydrological, environmental and socio-economic structure of the floodplain area, which is the subject of strategic control. The goal of such control is to implement a territorial structure that maximizes the value of the aggregated criterion for a stable state of the system.