

Numerical modelling of channel processes and analysis of possible channel improvement measures on the Lena River near city Yakutsk

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City Yakutsk (administrative, culture and industrial center of the North East of Russia) situated on the left bank of large Russian river Lena last decades has faced with many problems, concerning intensive channel processes. Most dramatic among them are sediment accumulation near main water intake structure, supplying city Yakutsk by the drinking water, and deterioration in conditions of the navigation roots to the main city ports.

Hydrodynamic modelling has been chosen as the main tool for analyses of the modern tendencies in channel processes and for the evaluation of possible channel improvement measures efficiency. STREAM_2D program complex (authors V. Belikov et al.), which is based on the numerical solution of two-dimensional Saint-Venant equations on a hybrid curvilinear quadrangular and rectangular mesh and take into account sediment transport, was used for the simulations. Detailed field data about water regime of the Lena river, bathymetry of the channels and topography of the floodplains was collected for model developing. Model area has covered 75 km of the Lena river valley including branched channels and wide floodplain from Tabaga to Kangalassy gauge cites. Data of these stations were used for model boundary conditions assigning. Data of gauge station city Yakutsk as well as measured during field campaign water levels and flow velocities was taken into account for model calibration and validation. Results of modelling has demonstrated close correspondence with observed water levels and discharges distribution between channel branches for different hydrological situations.

Different combinations of hydrographs of 1, 10, 50% exceedance probability was used as input for modelling of channel deformations. Simulation results has shown that in future 10 years aligning of water discharges distribution between main Lena river branches near Yakutsk is possible, that is a positive tendency from the point of view of water supply of the city. More than 15 variants of channel improvement measures, including different dam constructions, river bed dredging, closing of some river branches were considered and included into modelling scenarios. Analyses of results of modelling has allowed to reveal, that more expensive big dams which are partitioning off a part the main channel are not so effective, because their construction lead to significant increasing of flow velocities and corresponding increasing in sediment transport. Local channel regulations measures (small dam at Ponomarev island near Yakutsk and bed dredging) can give some effect in a few years due to formation of the new line of the depths maximum near water intake structure and Yakutsk port. For improving of the navigation conditions near Ghatay port closing of the small channel branch Ghataiskaya can be effective.