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Simulation of the meander cut-off by 2D hydrodynamic model for erodible bed

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The retrospective simulation of the Pyoza river (Arkhangelsk region, Russia) meander cut-off in 2003-2008 has been undertaken. As a result of the river bend straightening two large villages were cut off from the road network of the region.

The initial data for modeling were obtained by analyses of archive satellite images for the period from 1997 together with the runoff data, as well as by the field survey of September 2019. The simulation was performed by the latest version of the STREAM_2D CUDA software, using a new method for the numerical solution of two-dimensional Saint-Venant equations [1]. It was adapted for the complicated bottom topography typical for a wide floodplain with a meandering channel flooded in high water stage.

The mass-exchange equations for three layers of sediment over the unerodible bed were solved together with the hydrodynamic equations. When calculating channel deformations, the gravitational effect due to bottom slope and the influence of secondary currents on the sediment shift were taken into account [2].

The Pyoza river is the lowest large tributary of the Mezen' river flowing into the White sea. It is distinguished by a typical alluvial channel, meandering along wide floodplain composed by sands and sandy loams. The maximum runoff usually corresponds to spring snow-melting and can reach 1500-2000 m^3/s.

To schematize the computational domain of the Pyoza river section of 13 km long, a hybrid grid of irregular structure was constructed, consisting of 37 329 cells of a quadrangular shape for the channel and a triangular one for the floodplain.

The simulation started at the year 1997 when where was no any rill across the meander neck. The time step of calculation was taken to be one day.

Modeling made it possible to simulate realistically the essential steps and mechanisms of the meander cut-off: the development of a pioneer straightening rill, its widening and deepening, as well as blocking of the old channel by a point bar in its upper reaches, as well as its further silting and aggradation.

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