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ASSESSMENT LOCATION AND PARAMETERS OF ICE JAM ON THE BASIS OF RIVER WATER LEVEL REGIMES STUDY

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ABSTRACT

Definition of the ice jam formation time, its length along the river channel and value of the ice mass is an important point for the ice jam phenomena forecasting as well as for the decision of engineering hydrology tasks.

So, let's consider this problem on the example of well-known ice jam on the Lena river near Lensk [town] formed in May, 2001.

Ice breaking on the Lena and, particularly, near Lensk town is frequently accompanied by the ice jam formation. The jam extends on tens of kilometers, causing the water level elevation.

It results in the flood-lands flooding and numerous destructions in and near the river course.

The accurate forecast of river breaking-up and certain information on ice passing conditions during ice floating permits us to undertake some adequate measures to prevent the consequences of the ice jam in due time.

The problems of the Lena ice conditions, ice jams, and water level rise were deeply studied by K. Polyakova, Rudnev, V. Kilyaminov etc.

But, as the Lensk'2001 ice jam showed, the problem is rather far from the final solution.

In this work we make an attempt to show, how to define the point of the ice jam formation and how to locate the "head" of the jam.

This will allow us to destroy the jam's lock in no time.

Further, using the same water level measurements and the river bed hydromorfological adjectives of the considered frontage, we can find out the ice thickness for a length of the jam.

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The problem may be solved more effectively, if the water level observations on standard and transient gauging stations will be sampled more frequently.

Of course, the unified elevation fixing of the water gauges in absolute or conventional altitudinal system is necessary.

Basing on water level gaugings, let's construct a graph of water level posteriority $Z = (x, \tau)$.

The axes of the graph are directed as shown below (different from V. S. Antonov's work): the longitudinal axe x is a distance up the river and the vertical one is a time axis.

In the field of these coordinates the points with water levels should be marked according to gauge stations arrangement.

Then, the dipstick marks with equal meaning are connected with a line and, hence, we have several lines of equal water-level z.

Due to the behavior of these lines we can do a corresponding conclusion.

For example, if the ice-jam exists, the isolines near its "head" will start coming together.

As soon as the erosion of the ice jam begins, and especially if the bursting occurs, the isolines start to disperse and later they go in the same direction.

The graph $Z = (x)$, reflecting the water level surface in the river, will be a good support for the graph shown above.

These graphs, examined and formatted for the Lena near Lensk, allowed us to state the following: in 2001 the catastrophic ice jam, consisting of two jams, was formed in the following conditions: at first it occurred downstream Nua village (probably near Glukhoi island) on 14/15 May.

Then, as this jam expanded up-stream, the second ice jam was formed near the Batamayski island.

According to the graph analysis, we can suppose that either natural factors or blasting operations caused the shearing of ice in the jam and its thickness increase, which, in its turn, affected an extreme water level rise near Lensk and down the river.

The rise of water-level in this time is conditioned by the ice-jam head compression.

As it is followed from the above, if in the initial period the jam was affected with breaking load, evidently, the job will be done better than an out-of-date impact on the ice jam mass.

Using equal water-surface contours for 18/05/2001 we can determine the down gradient, and the flow width finds over cross direction profiles.

By the water discharge Q on the Solyanka village hydrologic section we'll find out the ice thickness in the ice jam, applying, for example, the hydraulic design methods.

According to the above, we'll use the following empiric formula:

$$Q = \left[\frac{I^{1/2}}{(1.6B^{2/3} n)} \right] F^{5/3}, \tag{1}$$

where I is a down gradient, B is stream width, n is an effective roughness factor, F is the river free area.

On certain values of Q, B, I, n using the formula (1) let's find the river free area below the ice jam and, then, the cross-section area of the ice-jam for the above-mentioned sections.

$$F_r = F_c - F, \tag{2}$$

where F_c is a cross-section area of river with the ice-jam F_j.

The ice thickness in the jam on the considered plot is found by dividing the cross-section area F_j on the river width *B.*

The result of the carried-out calculations on the stated plan was that the ice thickness in the head of the ice-jam to 18/05/2001 (2380-2400 km from the Lena's outfall) came to 12.0 meters.

Headed for Lensk, it reduced with some variation to 10 meters.

Here, we can't agree with the authors of [3], which analysis showed the ice-jam accumulation at night on 16/17 May near Nua village.

The equal water-surface contours $Z = (x, \tau)\, Z = (x)$, examinated carefully, produce another conclusion, as said above.

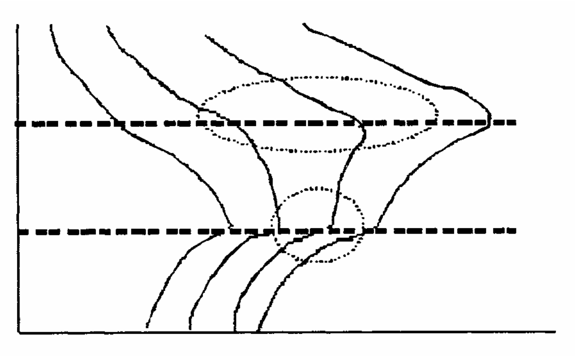

Fig 1. Diagram of water level change isolines in the ice-jam formation;
where τ_1 is a jam formation point, τ_2 – is a jam destruction point,
1 is the isolines convergence area , 2 is an area of the isolines dispersion

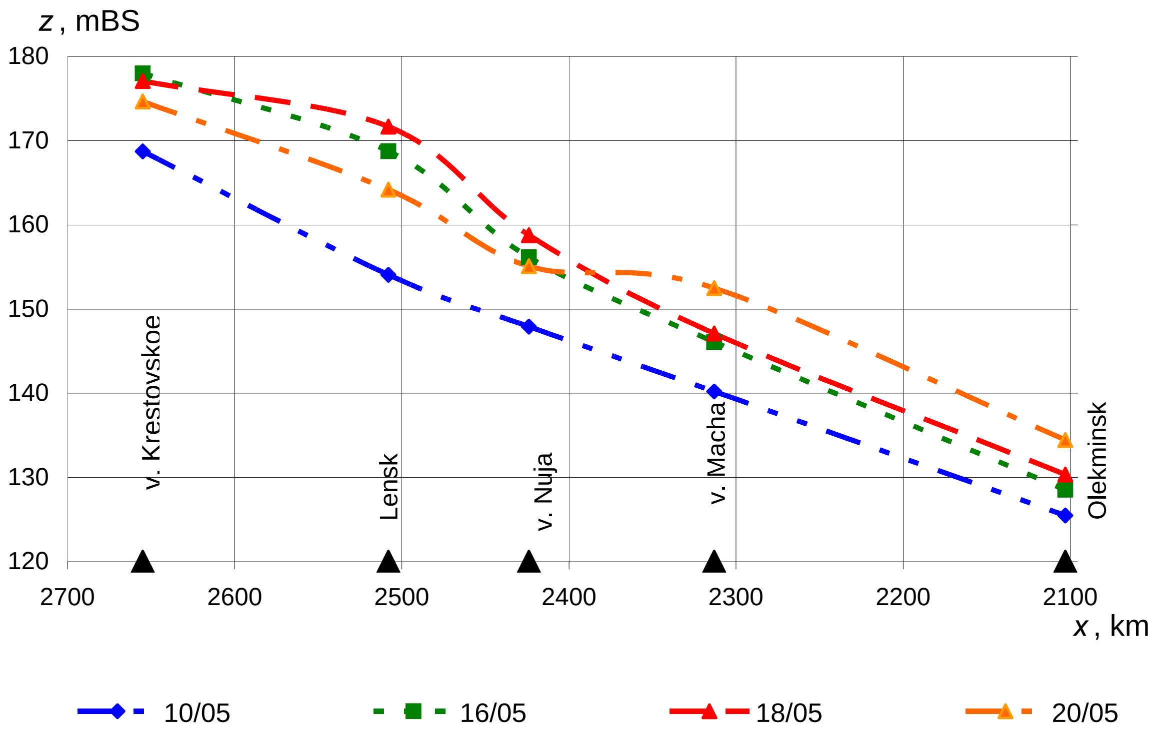

Fig.2. Water surface curves on considered plot during the ice-jam formation in different days (10/05, 16/05, 18/05, 20/05)

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