

# Mapping of hazardous hydrological events in the Russian part of Selenga river basin

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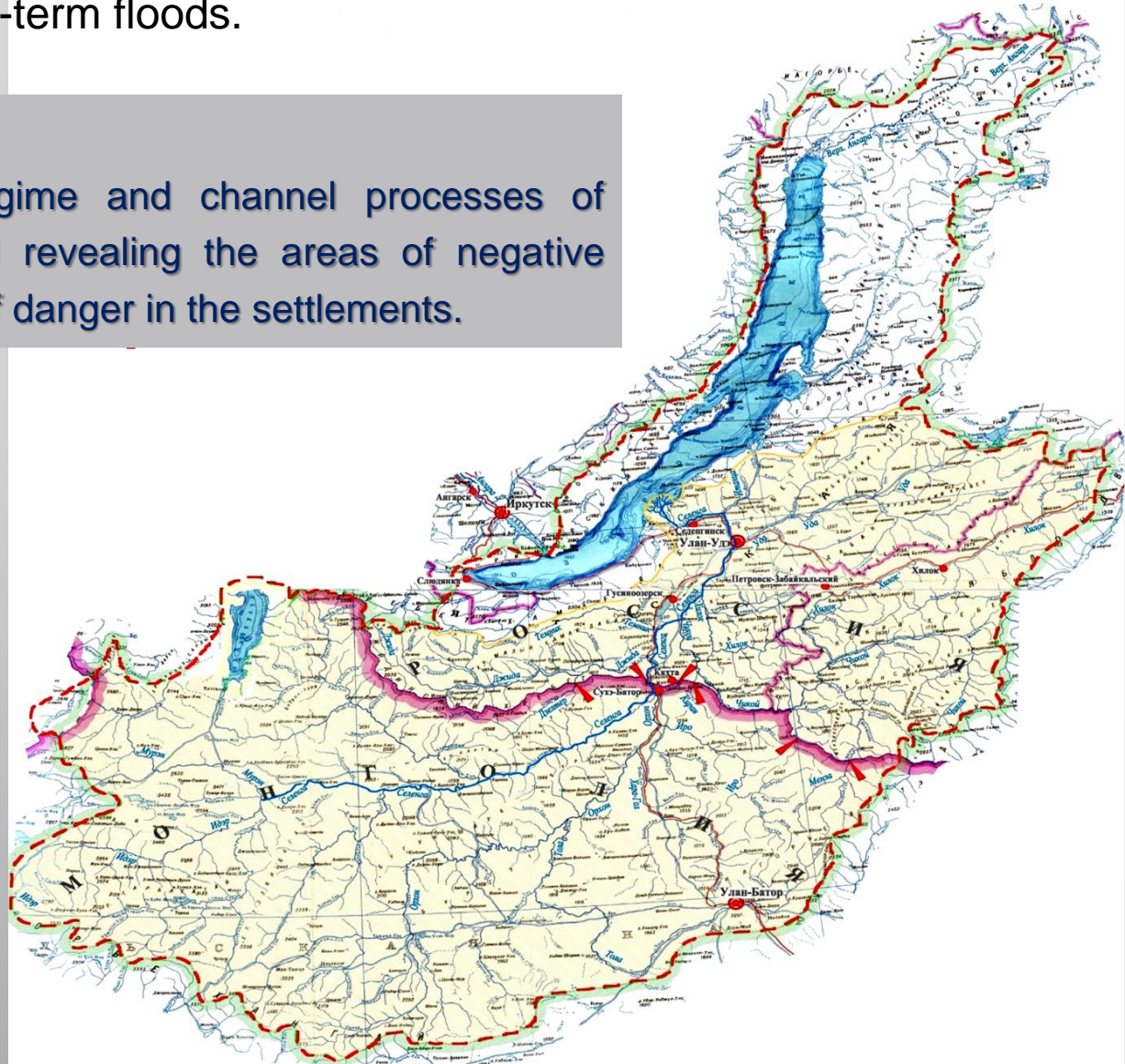
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The transboundary basin of the Selenga River, which covers an area of 447 thousand km<sup>2</sup>, is the main part of the catchment area of Lake Baikal, recognized by UNESCO as a World Natural Heritage Site in 1996. The territory is characterized by the contrast of natural processes, where periodically recurring droughts and associated forest fires alternate with destructive short-term floods.

**Purpose:**

After research of the water regime and channel processes of transboundary river Selenga and revealing the areas of negative impacts of water and the degree of danger in the settlements.







Negative impact of the waters caused by floods (summer flood, ice jams), mudflows, and the formation of flood ice.



# FLOODS IN THE BASIN OF THE SELENGA RIVER



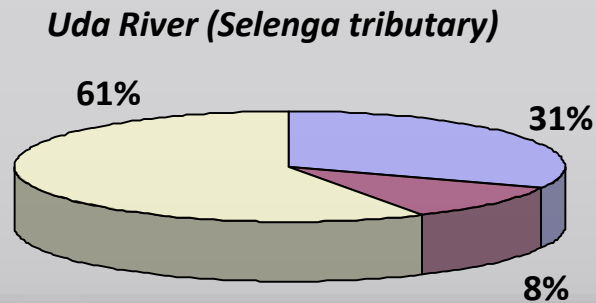
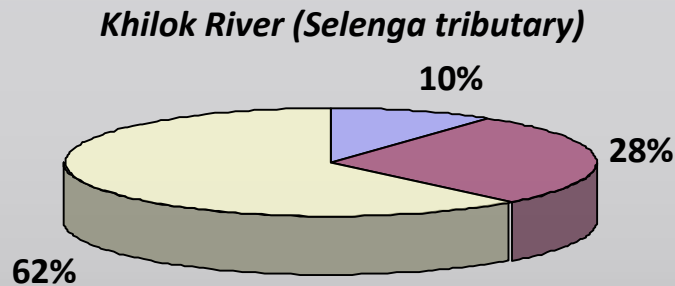
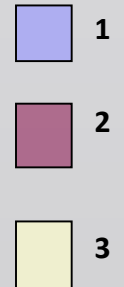
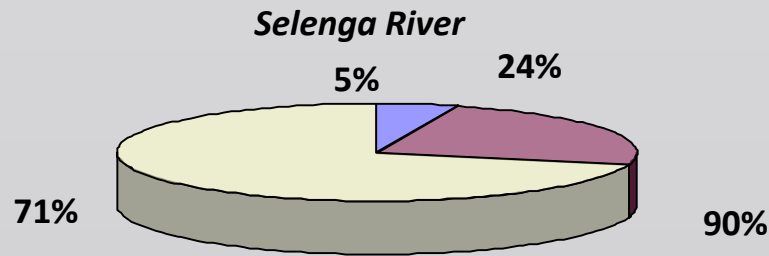
- The series of biggest floods for 100 years: 02.07.1908; 11.08.1932; 11.06.1936; 05.08.1940; 05.08.1971; 29.07.1973 and the number of significant floods – 1931, 1938, 1942 and 1990-s.
- The damage caused to economy (in prices for the period of flooding): in 1971 – 1,4 billion of rubles, 1973 – 0,7 billion of rubles, 1993 – 40 billion of rubles.



# GENESIS OF THE FLOODS

Types of the floods on the Selenga River and its main tributaries:

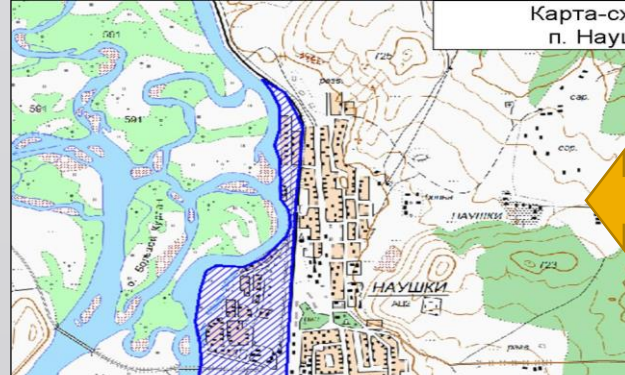
1 – ice-jam flood; 2 – snowmelt flood; 3 – summer flood



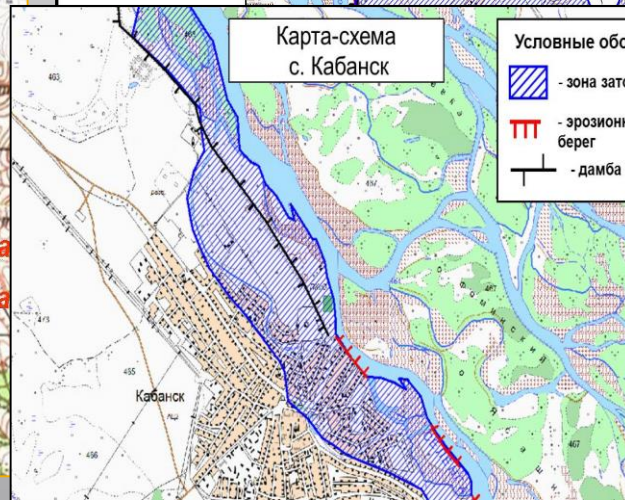
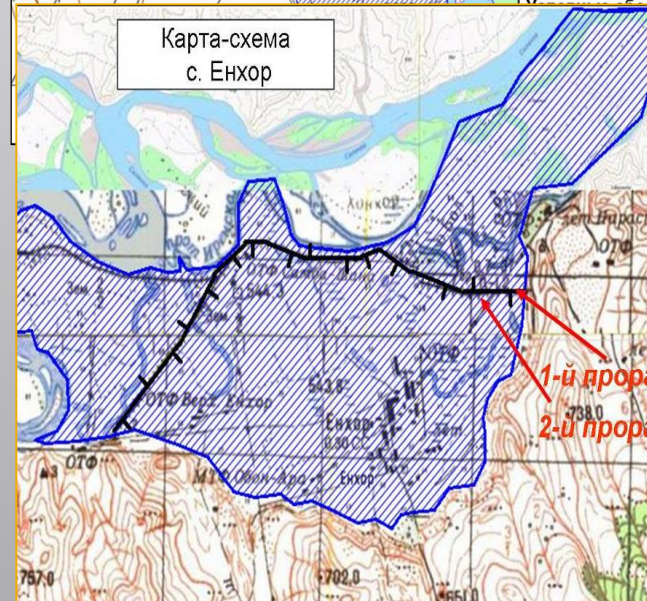
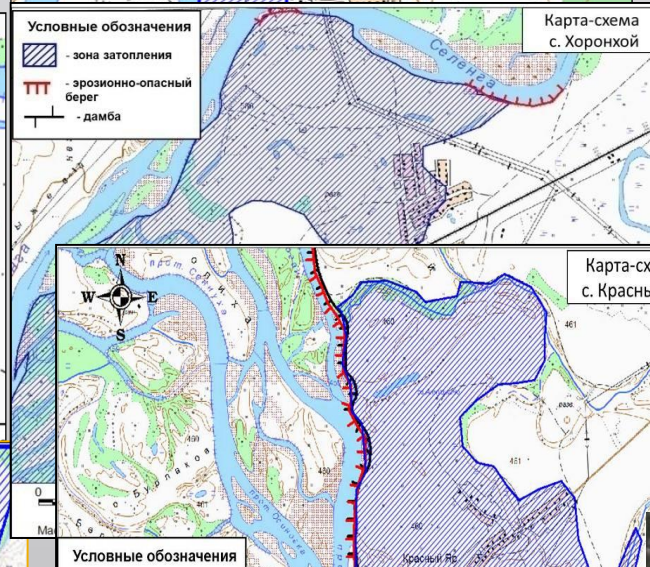
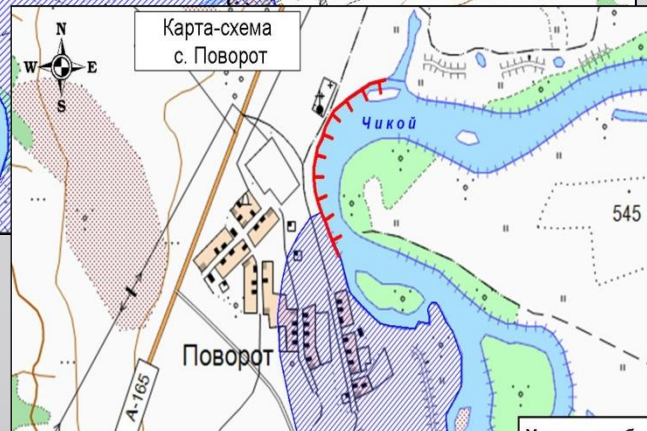
1973

# **Flood zones modelling and mapping**



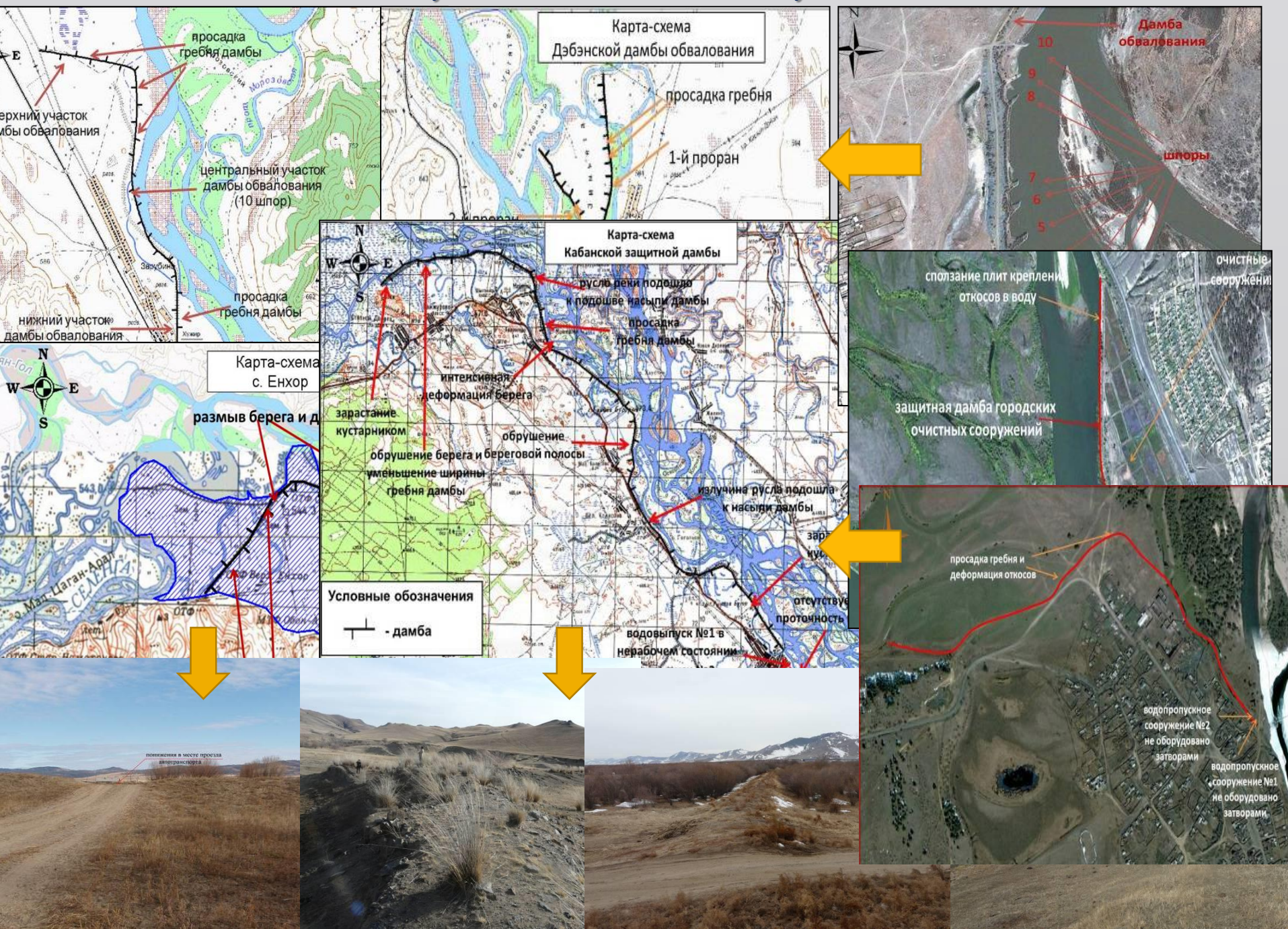


The results of reconnaissance survey showed that:  
54 settlements **on the Selenga River** are periodically flooded,  
19 of them are located in the most dangerous areas



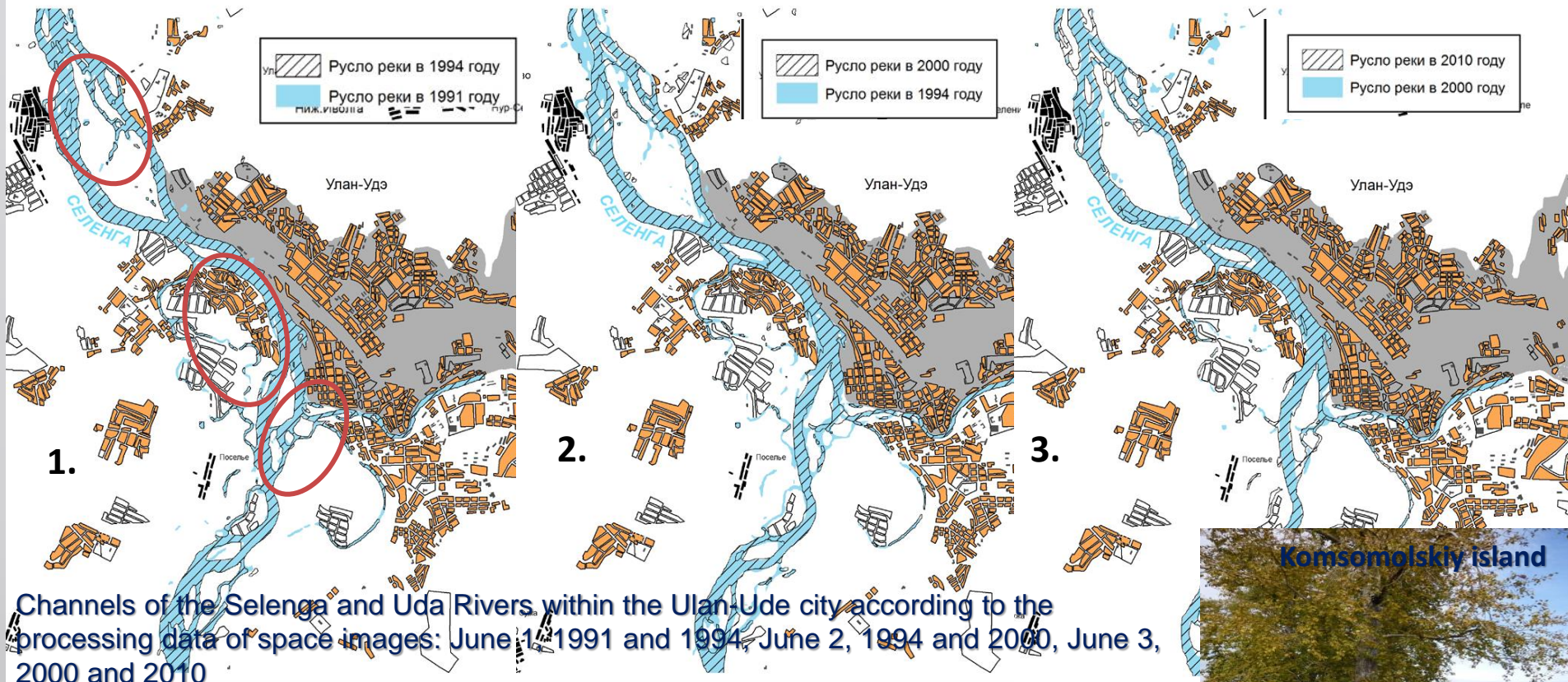


# Reconnaissance survey of current condition of 22 hydro-technical constructions





# CHANNEL PROCESSES OF THE SELENGA RIVER on the example of Ulan-Ude city



**Problems:** 1. Alluvium accumulation up to 2 m occurred in the right branch of Selenga river, and the deepening of the channel to 2-2,5 m and the erosion of the coast – in the left channel.

2. Deformation changes and re-deposition of alluvium occurred around island Malyi Ulan. Every year there are changes of planned outlines of the island.

3. Meander bar from the erosion produce develop opposite to the island on the left bank of the Selenga river, and the depth at the shore reach maximum values for the whole channel.

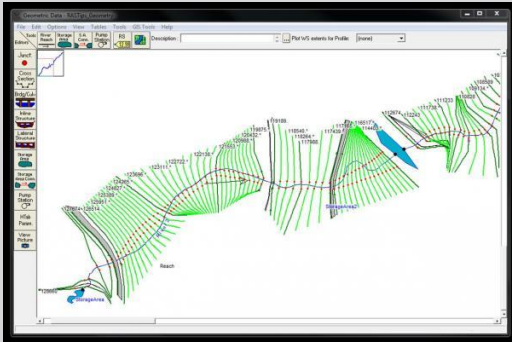
4. Downstream to the Selenga flow near the left bank of Malyi Ulan island there is a formation of the bay-bar from the erosion products, this bay bar tends to move under the bridge.





# MODELING OF THE FLOOD ZONES. SOFTWARE

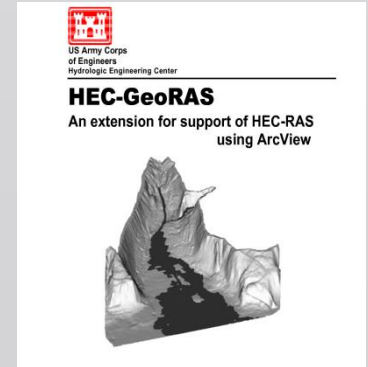
Modeling of flood zones within the settlements was produced with the usage of software packages HEC-RAS, HEC-GeoRAS and ArcGIS.



HEC-RAS  
package for modeling  
the flow of water in the rivers



ArcGIS  
the world's leading GIS application



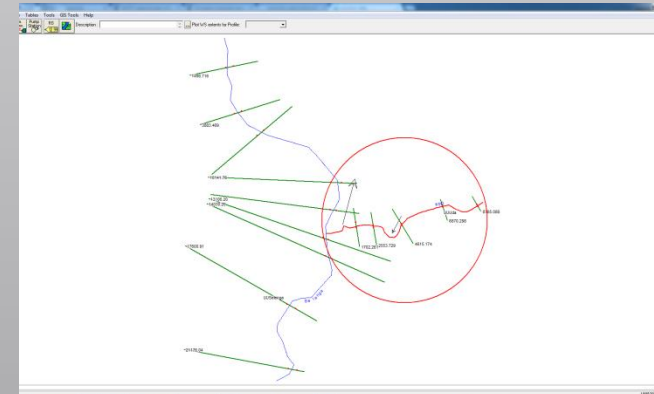
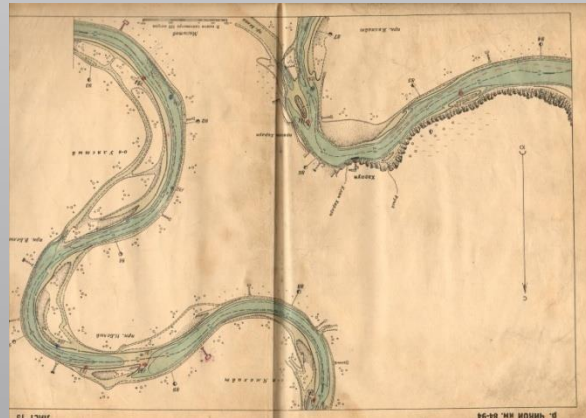
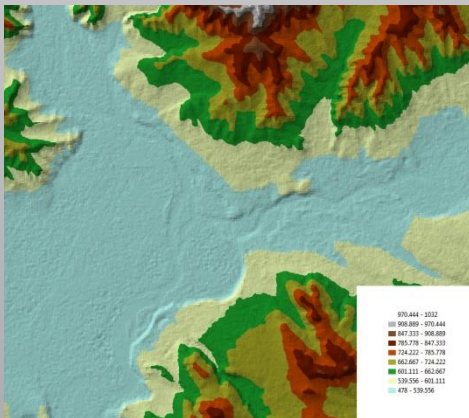
HEC-GeoRAS  
tools for communication  
HEC-RAS and ArcGIS

# MODELING OF THE FLOOD ZONES. ALGORITHM

Development of the digital elevation model from the topographic maps 1:25000 (for Ulan-Ude 1:2000) on the classical technology "scanning - vectoring - digital map"

Morphometric characteristics of the river channels in DEM are given according to data pilot maps of the Selenga and Chikoy Rivers and aho-sounding shooting

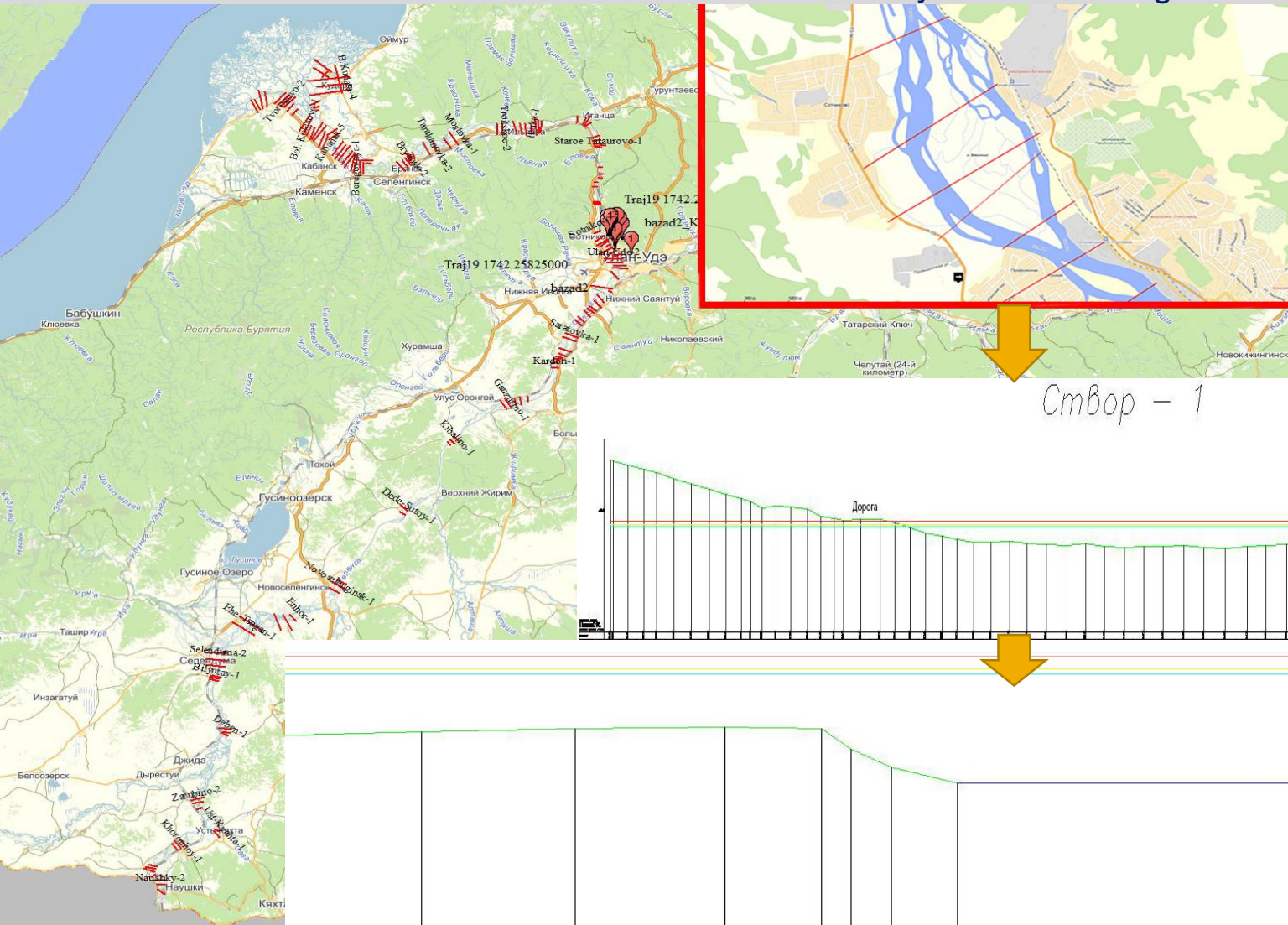
Setting the geometric and morphometric characteristics of the channel. Setting the existing hydro-technical constructions



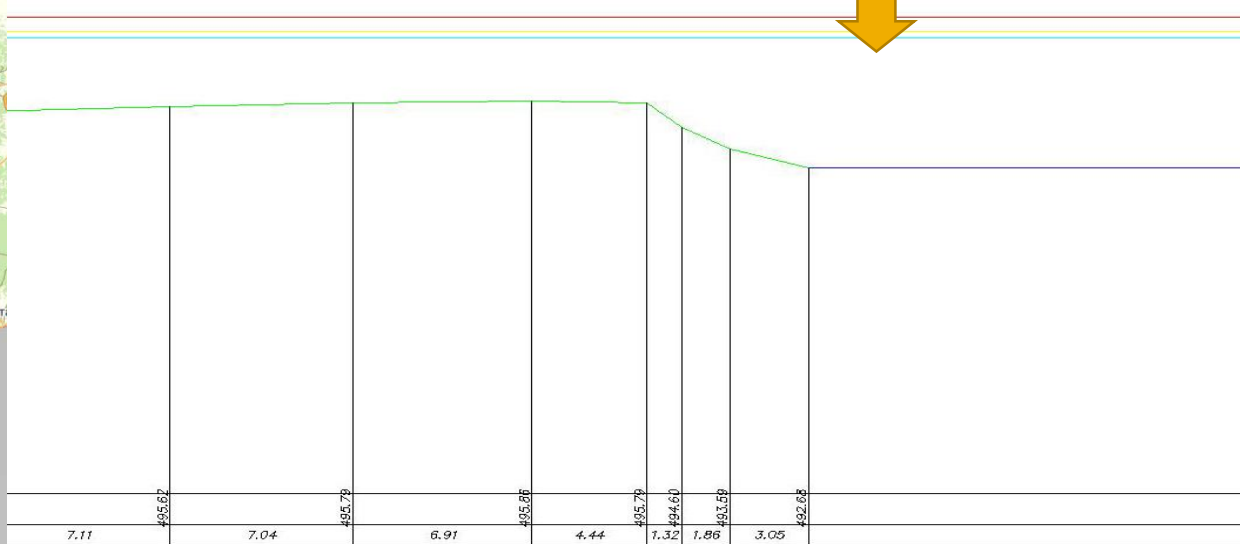
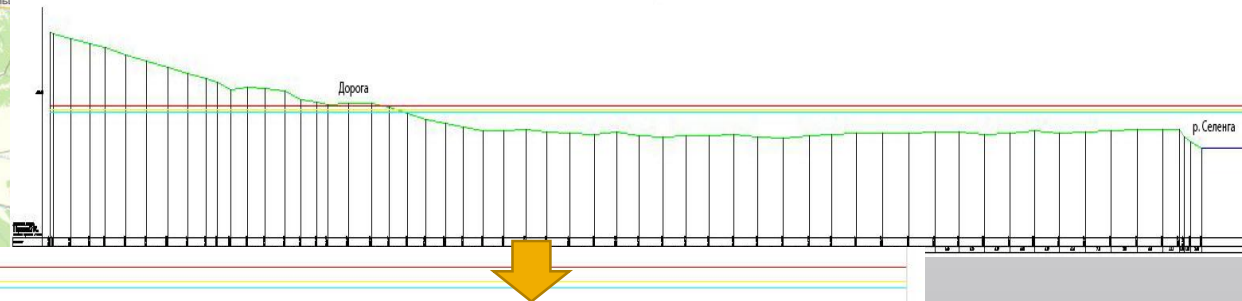


# HYDROMORPHOLOGICAL STUDY

## Location of cross sections in the valleys of the Selenga River



Смвop - 1

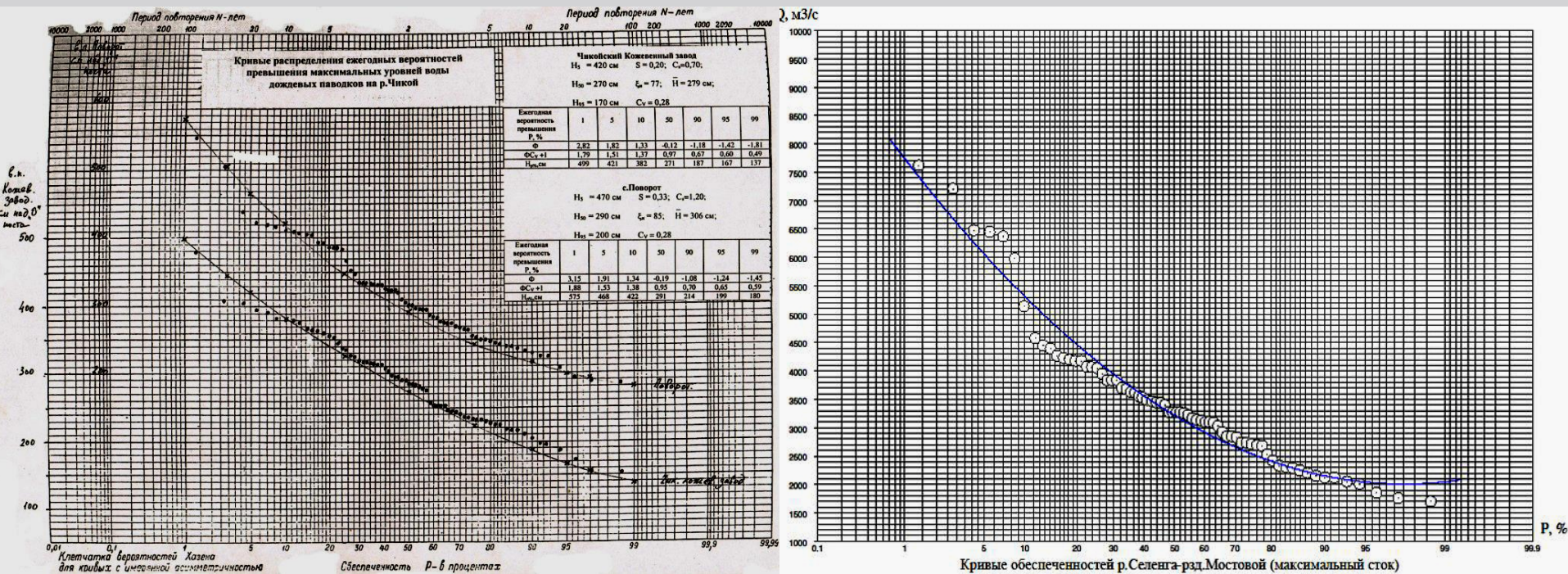


Монголия



## Estimated levels of water in the settlements

Rare water levels (1, 3, 5 % frequency) were obtained using the curves of occurrence of water levels and flows in the gauges on the Selenga river with the use of graphs  $Q = f(H)$ . For analyzed settlements without gauging stations we used the method of interpolation with account of the longitudinal section and the river fall based on large-scale maps.



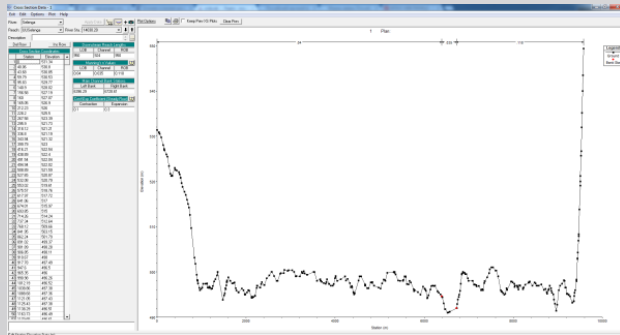


# Modeling of flood zones

Setting the boundary conditions of model – estimated water discharge, Manning roughness coefficients for the channel and the floodplain, depending on the type of underlying surface

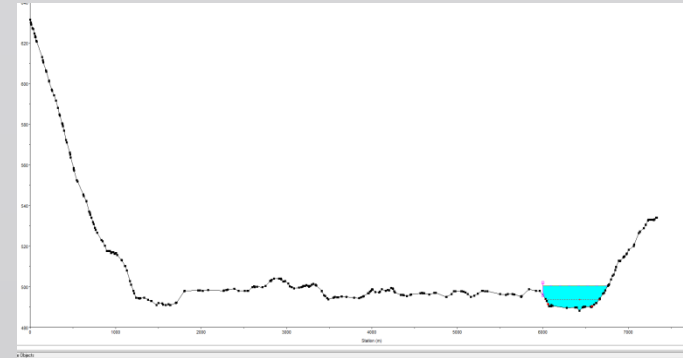
Solution to simplified one-dimensional shallow water equation in HEC-RAS (Saint-Venant equation) using the implicit finite-difference scheme. Solution is valid for continuous steady flow.

The result of modeling – the level of water surface in control cross-sections during the flood

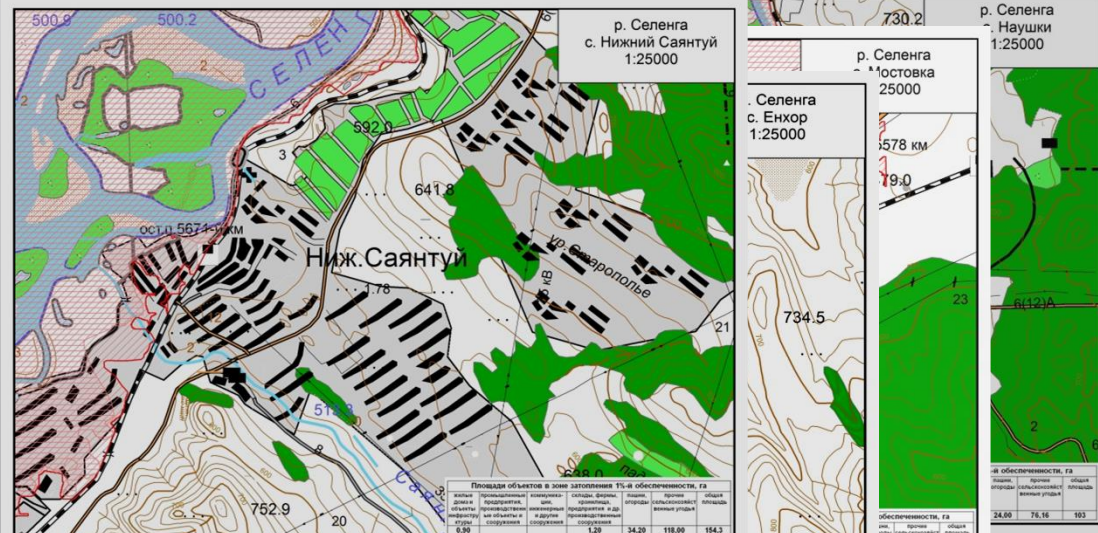
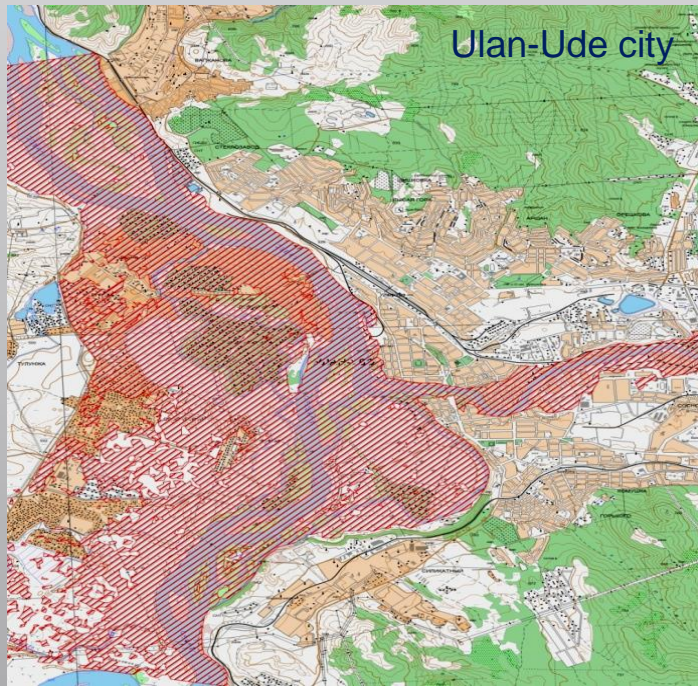


$$Y_2 + Z_2 + \frac{a_2 V_2^2}{2g} = Y_1 + Z_1 + \frac{a_1 V_1^2}{2g} + h_e$$

$$h_e = L \bar{S}_f + C \left| \frac{a V_2^2}{2g} - \frac{a V_1^2}{2g} \right|$$



## MODELING OF FLOOD ZONES. CARTOGRAPHIC DRAWING



Proceed data are exported to the ArcGIS environment, where flood zones are automatically draw on basis of a digital elevation model.



## Analysis of the negative impact

Infrastructure	Units	Flood of 1 % frequency	Ice-jam flood
The area of the settlements	ha	<b>24665,2</b>	<b>913,71</b>
The total flooding area in the settlements	ha	<b>4878,54</b>	<b>233,24</b>
The proportion of the flooded area in the settlements to the total area of the settlements	%	<b>19,77</b>	<b>25,5</b>
Population	persons	<b>39167</b>	<b>1295</b>
Area of residential development, incl.: residential houses	ha	<b>30,13</b>	<b>2,31</b>
gardens, home gardens, backyards	ha	<b>862,45</b>	<b>105,8</b>
summer cottage	pcs	<b>5400</b>	<b>400</b>
Engineering and transport infrastructure, incl.:			
Electric power lines 10 kW (air lines)	km	<b>17,2</b>	<b>0</b>
communication lines	km	<b>5</b>	<b>0</b>
federal road network	km	<b>12,2</b>	<b>0,1</b>
local road network	km	<b>37,47</b>	<b>3,5</b>
railway	km	<b>0</b>	<b>0,1</b>
Production and warehouse infrastructure, incl. : industrial premises, warehouses, workshops	ha	<b>57,54</b>	<b>44,59</b>
industrial enterprises	ha	<b>0,7</b>	<b>5,68</b>
agricultural lands	ha	<b>1858,47</b>	<b>69,9</b>

Infrastructure	Units	Prognosis of the area of bank erosion zone		
		5 years	10 years	25 years
The total area of bank erosion zone	ha	<b>28,3845</b>	<b>57,7106</b>	<b>142,3297</b>
Area of residential development, incl.:				
Residential houses	pcs	<b>0</b>	<b>5</b>	<b>60</b>
Maintenance buildings	ha	<b>0</b>	<b>0,1</b>	<b>1,7042</b>
Gardens, parks	ha	<b>0,4111</b>	<b>1,4068</b>	<b>10,105</b>
Fences	ML	<b>656</b>	<b>3236</b>	<b>11629,32</b>
Electric power lines	km	<b>0</b>	<b>0</b>	<b>0</b>
Road network (local roads)	km	<b>1,01</b>	<b>23,738</b>	<b>109,913</b>
Industrial area	ha	<b>0,2</b>	<b>0,3</b>	<b>20</b>



**Thank you for  
your attention!**

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