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*THE INFLUENCE OF ANTHROPOGENIC ACTIVITIES UPON THE ISHYM RIVER CHANNEL PROCESSES**

SUMMARY. The article presents an analysis of cartographic materials and field work. The study has been conducted for 150 years. Significant changes of the morphometric characteristics of the river channel have been recorded: the width of the channel has changed by 10–40 m, a number of ancons have gemmated, and dead arms of the river have changed its morphometry and habitus. During the field work multiple areas of the river channel overgrowing, upsilting and active gullying were identified. The field reconnaissance survey and analysis of indirect indicators revealed the two main reasons for the development of these processes. The first reason is natural—it is the formation of landslips on the river banks, which are sandy, weakly reinforced by vegetation, and thus easily erodible. The second reason is anthropogenic—it is human activity carried out in the river channel (construction of dams, river crossings), resulting in recession of the river low stages because of the regulated runoff, and on the water-shed area facilitating the flow of pollutants.

KEY WORDS. River bed deformations, meander, anthropogenic activity, upsilting, overgrowing

The disruption of the natural river regime as a result of anthropogenic impact eventually causes river channel deformations of different character. Most ways of anthropogenic activities both in the hydrographic water basin and in the river channel have different scales of impact and cause disruption in the "basin-stream-river channel" system [1–3]. Under the growing anthropogenic pressure the study of river channel processes become vitally important because such disruption complicates the practical use of water resources in general and can make their use impossible (for example, if the level of the water stream used for public water supply drops drastically, the populated area can be left without water).

The objective of the survey is to identify the character and features of the river channel transformation processes caused by anthropogenic pressure by the example of the Ishym River study.

B.F. Snishchenko, [4] was the first to offer a well-developed classification of engineering structures impact on river channels; it is based on two main classes—active and passive. The former transform the river channel, the latter influence it by their

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very presence. According to the distribution of their impact on river channels anthropogenic activities are divided into regional and local; according to the pattern of river channel deformation they can be erosion, accumulation, and neutral; according to the impact period they are constant, long-term, and temporary [5]. The direct impact on the river channel leads to artificial transformation of cross section, redistribution of water consumption and width velocity, creation of man-made landscape [6]. Alongside this, the impact of engineering structures, works and technical means will depend on the specific conditions of river formation, the river size, as well as the co-relation of anthropogenic activities when some of them take place simultaneously. As a result the "double impact" conditions are achieved.

The anthropogenic transformation of the Ishym River started long ago. The author who lived in the 18th century witnessed "...during spring floods the river discloses its wild character destroying its banks. Within its history the town experienced it many times. In 1774 the river erosion destroyed two nearby streets of houses..." [7]. Thus, because of the rapid flow and lateral erosion resulting in landslip, Ishym merchants decided to align the riverbed. "To prevent the town destruction in the time of flood it was decided to stop bank strengthening and to change the river channel in the late 1820s. Afterwards the citizens helped to dig a canal connecting Sinkino Lake and a new riverbed. As a result, the river took a new course and the previous one became a pond named Ishymchik..." [7].

Materials and methods. The objective was achieved through analyzing the map data and field works of 2008. The materials to study the Ishym River course deformations were the *Tobolsk Province, the Town of Ishym Geometric Special Plan* 1859 map, provided by Ishym Sate Archive, the 1968 map scaled 1:100,000; Landsat 5TM shots (the internet source).

The study of the 1859 map and the 2009 satellite imagery allows tracking the changes of the riverbed during 150 years. Digital imaging of the map and the satellite imagery were performed with the ArcGis software.

Results. Comparing the received results proved the decrease in the riverbed morphometric characteristics for the past 150 years. The riverbed width changed by 10–20 m, in some places by 40 m. The changes in the river habitus became visible—drying up and dead arm formation. The former ancon located within Ishym area stopped its development because of the anthropogenic interference when the riverbed was aligned in the 19th century. The demonstration of riverbed deformations and estimation of its morphometric changes can be done implicitly because the 1859 filming and imaging quality was low and because the map control over modern objects was difficult.

The estimation of riverbed deformations over the past 40 years was assisted by the 1968 map scaled 1:100,000 and the satellite imagery of 1987, 2000, and 2009 processed by the ArcGis and MapInfo software.

Overlaying the satellite imagery taken at different times of two parts of the Ishym River i.e. Larikha village—Voronino village and Simanovo village—Laikovo village, showed the ancon changes over the past 40 years. The choice of the parts for analysis

is accounted for by the fact that the former correlates the site of the 2008 field works studying the riverbed; the latter covers the town area and the upstream and downstream of the river. This area shows the most visible changes in the riverbed — overgrowing, appearance of islets and fluvial arms.

In Larikha village area the riverbed width changed by 5–10 m, the ancon radius—by 20–30 m, the ancon curve—by 40 m, the meander belt width—by 25 m. In Voronino village area the riverbed width changed by 5–7 m, the ancon radius—by 12–20 m, the ancon curve—by 80 m, the meander belt width—by 50 m. The former meander of the river near Voronino village also changed—the riverbed width in the middle decreased by 20 m.

The deformations took place in the part of the river in the Simanovo village—Laikovo village area: the bank line shift is 10–30 m. In 1968 near Simanovo village area the ancon loop looked like a chain of small lakes linked by small canals between each other and the main stream. The 2009 image shows no sign of such canals, and the meander scar became a range of separate small lakes. The dynamics of the bank line shift is given in Figures 1 and 2.

The bank line tends to shift left for the both areas. But there are some parts in the area under study where the shift is to the left. It is hard to identify a clear tendency. For example, in Larikha village area some parts of the bank line shifted 30 m right in 1968–1987 and by 2009 the shift has become up to 95 m. In Voronino village area the bank line shifted max 20 m right. The previous meander near the village also shifted right but the distance is 40 m. It may be difficult to register the ancon shift dynamics because the S-ancon shifts around a fairly stable point, the limit is the loop breach leading to a dead arm formation.

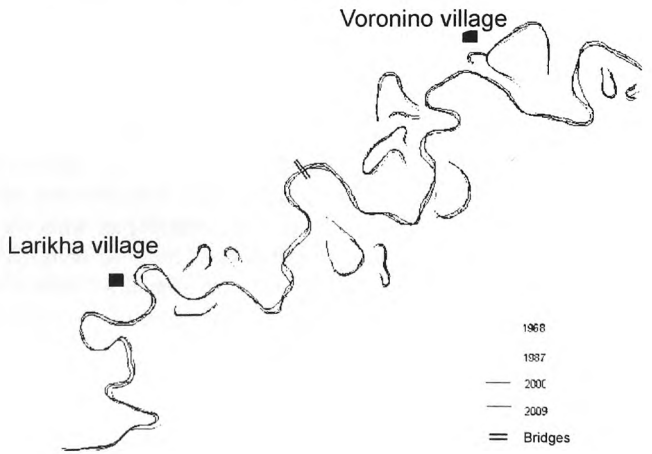


Figure 1: The bank line shift dynamics for the Larikha village—Voronino village area.

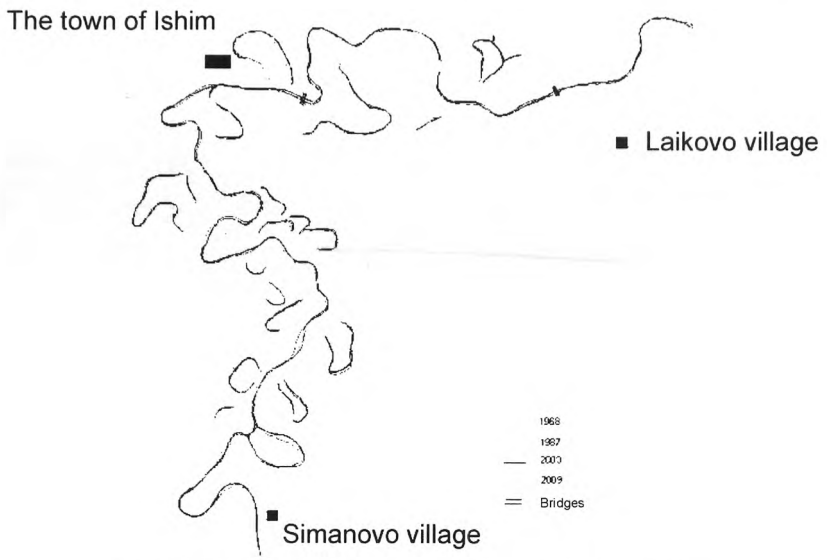


Figure 2: The bank line shift dynamics for the Simanovo village—Laikovo village area.

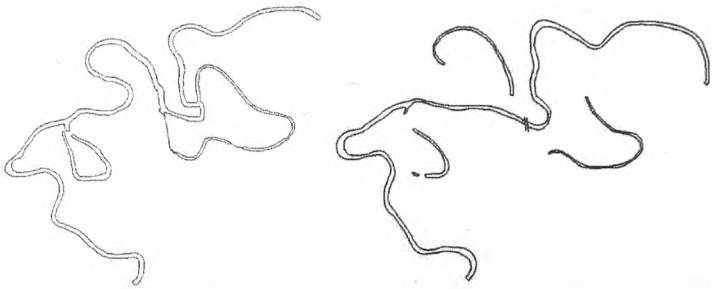
In some parts of Simanovo village area the bank line shifted 50 m left for the first 20 years of the period in question, and by 2009 the shift was 80 m. In the Ishym area the bank line shifted left as well and by 2009 the shift was 70 m. The Ishymchik dead arm suffered deformation either, and the bank line shifted 60 m. In Laikovo village area the bank line shift is not so intensive, it is max 30 m.

The dead arms of the Larikha village—Voronino village area have their morphometric characteristics changed. They tend to either downsize or dry up. In the Simanovo village—Laikovo village area the same transformations can be seen. Thus, the ancon loop near Simanovo village was linked to the main stream of the Ishym River in 1968. But by 2009 the ancon gemmated and the dead arm appeared (Figure 3).

The river channel and banks study was performed during 2008 field works which led to the identification of many parts damaged by overgrowing, upsilting and active gullying. The field reconnaissance survey and analysis of indirect indicators revealed the two main reasons for the development of these processes.

The first reason is related to the formation of landslips on the river banks, which are high, sandy, weakly reinforced by vegetation, especially along the edges, and thus easily erodible (the sign of lateral erosion). During flood waters period the processes intensify and cause extended bank sloughs. These spots form large ditches resulting in gullying. Big amounts of the ground fall into the river and change its bottom points, sometimes forming islets which can get overgrown with vegetation. The field works found active overgrowing in the opposite bank downstream (Figures 4–7). Shallow

water vegetation consists of sledges (the Carex River) and rush flowers (*Butomus umbellatus*). All the above mentioned processes result in the change of this part of the riverbed: the tortuosity increases, the width narrows, bifurcation arises.



a b

Figure 3: The Ishym Riverbed deformations within Ishym area (a—1859; b—2009).

The second reason for the river overgrowing and upsilting is a negative influence of anthropogenic activities performed in the riverbed, namely bridge construction. During the construction the river channel and bed (in the section and along the bank line) suffer damage caused by machinery, and pollution caused by construction material and waste disposal. All these lead to the changes in the granulometric and chemical composition of the bed deposits, and thus, to overgrowing. It can be proved by the fact that the Ishym River is overgrown by aquatic vegetation (rush flowers (*Butomus umbellatus*), water plantain (*Alisma plantago-aquatica*), different sledges (the Carex River)) a few meters downstream the bridge built in 2006 in the location of Korkinskaya street in Ishym.

Basically it should be mentioned that the right bank is overgrown by aquatic vegetation in 0.5 m up to 8–12 m wide zones.

The most overgrown is the part of the river from Simonovo village (Ishym District) upstream Ishym and along the town area. This can be justified by the impact of the town recreation zones (organized and non-organized beaches), and country areas (dachas) located close to the riverbed (Figures 6, 7). These facilities must dispose of great amounts of organic and biogenic substances to add to the overgrowing effect.

The most vivid examples are the two places in the town. Number one is the "local beach" (*Beregovaya Street*), number two is the so called *Korovy Beach* with the left (high) bank occupied by residential housing and country areas and the right (low) bank occupied by private cattle-pens and milking-sheds. This territory is also used for watering and pasturing of cattle, and for unauthorized recreational activities despite pollution and unattractive landscape. In the driest season (late July–early August) this part of the riverbed is completely overgrown and the river depth is about 1.2 m. Due to the water volume, the riverbed has a low flushing capacity and thus low anthropogenic impact resistance.

Figure 4: The sign of lateral erosion, the Ishym River—upstream Larikha village.

Figure 5: The Ishym Riverbed in the Voronino village—Larikha village area.

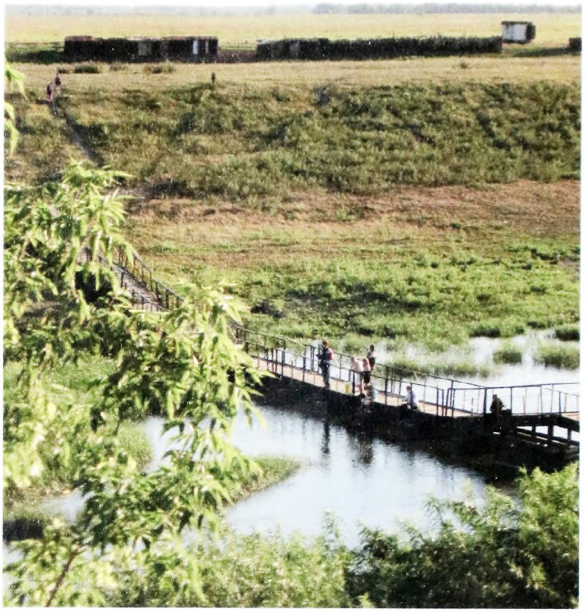


Figure 6: The Ishym River area near the floating bridge within the Ishym area (Korovy Beach).

Figure 7: The river overgrowing in the Ishym "dacha" areas.

Discussion. Big-scaled hydraulic engineering breaks a natural water regime and stops a transit drain of channel-making and suspended sediments. The regulated drain is the main reason for the riverbed transformation along hundreds of kilometers of big rivers. Ancons and banks suffer significant changes. Water surface slopes decrease, yielding erosion increases. [5], [8-9].

The Ishym River being important for economic and social development of the south of Tyumen Region has several hydraulic structures. They are water supply reservoirs in Kazakhstan (Sergeevskoye and Petropavlovskoye); and up to 2007 in Tyumen Region before the river reaches the town of Ishym it had 11 flood-control dams, 1 flow-breaking dam, 3 stanches and 3 ponds, located in the Ishym River branches.

The earlier estimates [10] show that Kazakhstan water-supply reservoirs cause great changes in the Ishym River water content, its environment as well as in the river flood-bed and valley. The dry climate and the high air temperatures influence the river upstream and downstream. Water loss is caused by evaporation from the reservoir surfaces and surrounding areas.

The hydraulic regimes changes downstream. The generally low water level leads to rare water discharge into the flood-bed in the part of the river between Ilynskoye settlement and the town of Ishym. Pastures and meadows become impoverished. Bed-plates, gulleys and brooks get flooded increasingly rarely. The low flood-bed water return leads to the disruption of the natural river regime. After the waster-supply reservoirs were created, the flood time got longer. Sometimes floods happen twice, the second time is caused by the reservoir overflow.

Even a long distance from the reservoirs does not help against the flow change; the flow decrease can be seen clearly.

The river flow decreased significantly for the period of 1965–2006. The average annual consumption of water for the town of Ishym has fallen by 34.52 m^3/s, or 1.62 times. The maximum river water consumption has fallen twice, or by 449.48 m^3/s, against the potential volume. This tendency has grown for the past few years. The minimum consumption for summer and autumn has also changed. Its decrease can be seen in the environment and economic activities dependent on watershed. The decrease is by 2.27 times, or 15.8 m^3/s.

Water lowering has changed the river habitus. The riverbed has acquired islets and shallows, willow shrub formations have covered the bank line. Newly formed islets get overgrown. In summer some shallows allow walking across the river.

So, the low water content and huge anthropogenic pressure are the main reasons for the river channel deformations, overgrowing and upsilting both in the areas under study and for the whole of the river.

The morphometric characteristics of the riverbed changed during the period of 1859–2009. The width of the riverbed suffered 10–20 m and in some places 40 m changes. The previous river ancon located within the town area stopped evolving because of anthropogenic activities when the riverbed was aligned in the 19th century.

The two parts of the Ishym River in the Voronino village—Larikha village and Simanovo village—Laikovo village areas showed the ancon changes for 40 years. Near Larikha village the bed width changed by 5–10 m, the ancon radius—by 20–30 m, the ancon curve—by 40 m, the meander belt width—by 25 m. In Voronino village area the riverbed width changed by 5–7 m, the ancon radius—by 12–20 m, the ancon curve—by 80 m, the meander belt width—by 50 m. The river dead arm width in the middle decreased by 20 m near Voronino village. The deformation took place in the part of the river in the Simanovo village—Laikovo village area: the bank line shift is 10–30 m. The ancon loop being a chain of small lakes linked by small canals between each other and the main stream near Simanovo village in 1968 turned into a range of separate small lakes as shown in the 2009 image.

All the observed parts of the river are characterized by the bed overgrowing and upsilting. The current deformations are being caused by active engineering works (those that influence the bed life greatly).

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