STREAM FLOW DISTRIBUTION BETWEEN THE SUB-CHANNELS WITHIN THE MIDDLE-AMUR PLAIN

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The Amur River has the biggest drainage area among the Pacific rivers and flows on the border of nature zones. These river specifics together with a number of natural and anthropogenic factors determine unstable water runoff regime, river-bed process intensity, temperature and ice regimes peculiarities. That is why water and terrain Amur ecosystems are highly dynamic and weakly withstanding external (including anthropogenic) impacts. Intensive economic activities in the Amur Basin in the last 50-60 years sharpened many ecological problems.

The proportion of river flow between the sub-channels is mostly unstable within the flat areas, characterized with a wide floodplain and main river-stream division into numerous sub-channels. Even moderate economic activities in these areas cause the disturbance of the existing balance and redistribution of water flow between the channels (Chalov, Puleva, 2001; Chalov, 2001).

In is known that rivers near big cities suffer different impacts of water-related needs and activities. Different hydraulic constructions (embankments, dams, water reservoirs, etc.), river-bed straightening and deepening, material extraction from the river bottom for construction purposes significantly effect riverbed process dynamics. Besides, most anthropogenic impacts on the river take place near the cities and big towns as they pollute the river with industrial and sewage waters.

The Amur passage under our studies is situated within the Middle-Amur Plain, which stretches north-west for 650 km (between the Khingansky and Komsomolsko-Kiselevsky narrowings). Its maximal width is 200 km and total area is 92.3 thousand km^2. The Amur floodplain, up to 30 km wide, is in the center of the plain. The rest of the plain is covered with flat depressions of ancient lakes, plane patches of river accumulation and alluvial cones of big river drifts (Ussuri, Anui, Gur, Tunguska, etc.), inclined towards the river. The plain is spotted with separate high mountain massifs up to 950 m above the sea level, hilly uplifts with gentle slopes (near Pereyaslovka village, along the Amur from Knyaze-Volkonskoe village to Sarapulskoe village) and single hill outliers. Most of the plain surface is swamped (Encyclopedia.., 1995).

The Amur Valley from Khabarovsk to Komsomolsk-on-Amur is characterized with interchange of river narrowings and floodplain expansions, where the main river stream is split into numerous sub-channels of different configuration and size (Kim, Makhinov, 1991; Chalov, 2001). These peculiarities determine water regime specifics at different stages, such

as flood wave spreading, intensive stream flow redistribution between the sub-channels, plain flooding regime.

Floodplain massifs undergo intensive erosion and accumulation processes. Lateral shifts of the riverbed, formation of sand bars and attachments to river islands, meandering of subsidiary channels, and sediment accumulation on channel banks contribute to the floodplain relief diversity (Makhinov, Kim, 1993). All these factors make the pattern of water stream redistribution very complex.

There are several floodplain expansions in the Middle-Amur Plain.

The present studies are focused on the three of them, situated near Khabarovsk, Amursk and Komsomolsk-on-Amur.

The floodplain expansion near Khabarovsk begins from the Khazakevicheva sub-channel juncture and ends at the bridge across the Amur at Khabarovsk. The Amur here has a wide floodplain (maximal width is 20 km), cut with many sub-channels. Upper and lower the expansion the floodplain is much narrower. The passage under study is characterized with several sub-channels and a big number of islands. The sub-channel system of this expansion is called the Khabarovsky hydrosystem.

Two big tributaries join the Amur in this expansion, namely the Ussuri from the right and the Tunguska from the left.

The last expansion within the Middle-Amur Plain is 35 m long with maximal width of 15 km. Near the City of Amursk the river splits into a great number of sub-channels of different water-carrying capacity. Besides the main Amur stream the biggest sub-channels are Padalinskaya, Old Amur, Galbon, Dippinskaya, Sandinskaya. The biggest tributary joining the Amur here is the Gur River. Big floodplain lakes, such as Bolon, Khummi, Ommi, Padali, Mylki, Khorpinskoe can be found in this expansion.

In 2007 the Amur water content was comparatively not high (Fig.1). After a rather low winter-low-water point (-150 cm above the "0" mark on the Khabarovsky water measuring station graph) the water level due to spring floods rose up to 224 cm by the end of May (May 31). Then a comparatively short (about 20 days) summer low water period was observed. Minimal water level dropped to -47 cm (July 19). Summer and autumn rain-flood period in August and September showed two peaks of moderate capacity (171 cm above the "0" mark on the Khabarovsky water measuring station graph, observed August 4 and September 7) and lasted for about a month and a half. Than the water level gradually and smoothly decreased and reached its minimum before the river-freezing.

Redistribution of the stream flow between the sub-channels is a rather complex process, especially in the Khabarovsky hydrosystem as the riverbed here undergoes constant morphologic changes. Constant expansion of the Pemzenskaya sub-channel is coupled with the Kazakevicheva sub-channel clogging and the Amur shallowing near Khabarovsk. In December 2005 dams were constructed on the Pemzenskaya and Beshenaya sub-channels reducing their water flow, especially in winter. Thus the water flow in the main stream increased, causing in some places bank washing out and river bottom deepening.

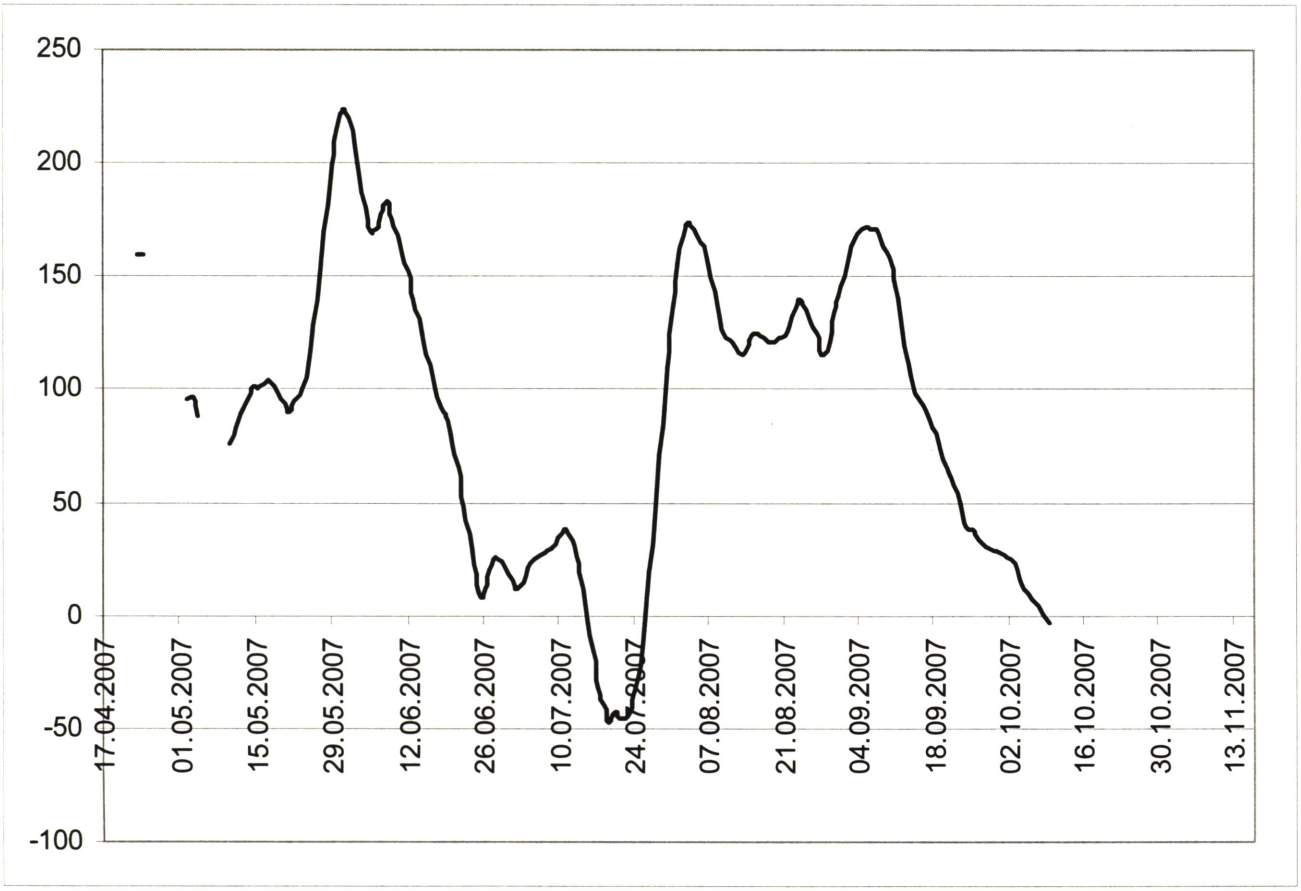

Fig. 1. A Graph of Amur Water Level Fluctuations near Khabarovsk in May – October 2007.

Water and bottom sediment sampling and discharge measuring were carried out in several Amur River passages in September 2007. Water discharge measurements are presented in Table 2.

Water discharge was measured in time flood decrease and its values are not high.

At Khabarovsky hydrosystem the biggest share of the stream flow (over 80%) belongs to the Amur main stream, where high water velocity values are registered (1.15 m/sec). 20% of the main stream flows through the Amurskaya sub-channel and velocity values reduce to 0.51 – 0.55 m/sec. Hydraulic engineering facility construction significantly reduced Pemzenskaya sub-channel flow but water velocity values remained high (1.19 m/sec). In the Beshenaya sub-channel the water flow was not noticeably reduced. Hydraulic engineering facility construction did not impact water runoff in the Amurskaya sub-channel.

In the floodplain expansion near Amursk the biggest share (57.7%) of the stream flow belongs to the main Amur stream. About one third of it is directed into the Padalinskaya sub-channel and a little more than 10% flows through the Old Amur, which is being intensively sedimented in the last decade. Maximal velocity values were registered in the main river stream (1.02 m/sec) and in the Padalinskaya sub-channel (1.00 m/sec). In the Old Amur sub-channel they reduced to 0.60 m/sec.

Table 2. Measured Hydrologic Characteristics

№	River, station	Water discharge, $м^3$/sec	Effective cross-section area, $м^2$	Mean water velocity, м/sec	Turbidity, $g/м^3$	Suspended matter discharge, kg/sec	Stream flow share, %
1.	Amur - 19 km	8710	7580	1.15	46.6	406	80.5
2.	Amurskaya sub-channel - mouth	1450	2830	0.51	28.3	41.0	13.4
3.	Chumnaya – sub-channel - mouth	666	1220	0.55	47.1	31.4	6.15
4.	Pemzenskaya sub-channel - lower the dam	3080	2580	1.19	32.0	98.5	28.5
5.	Beshenay sub-channel - lower the dam	820	1360	0.60	40.0	32.9	7.58
6.	Amur – Dippy village	7670	7490	1.02	48.4	371.2	57.7
7.	Padalinskaya sub-channel – Lower the entrance	4060	4050	1.00	44.3	180.0	30.5
8.	Old Amur sub-channel – Padali lake	1520	2520	0.61	63.1	96.1	11.4
9.	Unnamed sub-channel – Padali lake	152	279	0.54	26.8	4.07	1.14

Quite a long passage of the riverbed in the Amur lower reaches is formed in the conditions of evident riverbed transformations. This riverbed is of a multi-channel type and is characterized with several channels of different size and length that form a complicated hydrographic system. The morphological analysis revealed in the Middle-Amur Plain an interchange of river passages with highly split channels and passages with few channels, repeating every 40-50 km. Maximal width of the split-channel passage is 30 km.

The field research undertaken in 2007 and earlier data obtained by the IWEP FEB RAS on assessment of stream flow redistribution into sub-channels, river-bank dynamics near Khabarovsky hydrosystem and Komsomolsk-on-Amur, as well as suspended matter discharge allowed revealing new information on current conditions of riverbed processes in the middle and lower reaches of the Amur.

The construction of dams at the entrance of the Pemzenskaya and Beshenaya sun-channels changed the direction of the riverbed process dynamics near Khabarovsky hydrosystem. Still, due to high summer floods and the time after the dam construction being short, the changes of the riverbed and banks structure in the Amur main stream lower the hydraulic facilities are not significant. At the same time, a noticeable decrease of erosion processes below the dams on the Pemzenskaya and Beshenaya sun-channels is observed.

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