Quantitative estimation of genetic components in the seasonal runoff of a small river by the graphoanalytic and isotopic method

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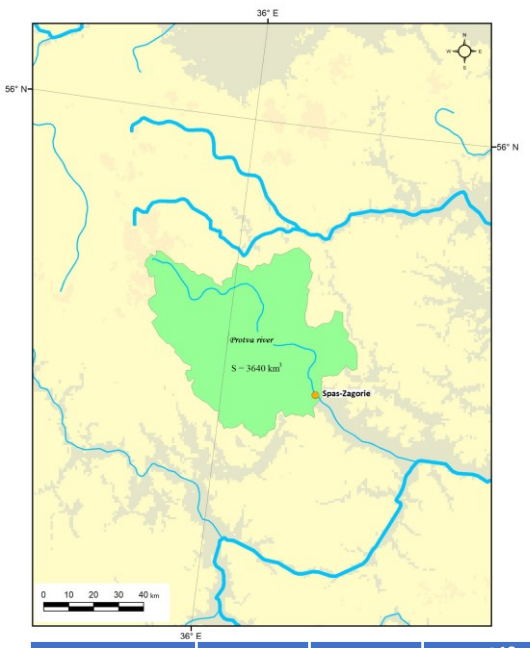


The use of new model for separating runoff into genetic components was verified by isotope hydrograph separation for Protva River in the central part of the East European Plain.

Isotope hydrograph separation

$Q_c = Q_г + Q_{oc}$

$C_cQ_c = C_гQ_г + C_{oc}Q_{oc}$

$\delta^{18}O$ VALUES OF GROUNDWATER

2009	2010	2019
-12,9	-12,3	-11 (April)
-13,1		-12,3

$\delta^{18}O$ VALUES OF PRECIPITATION

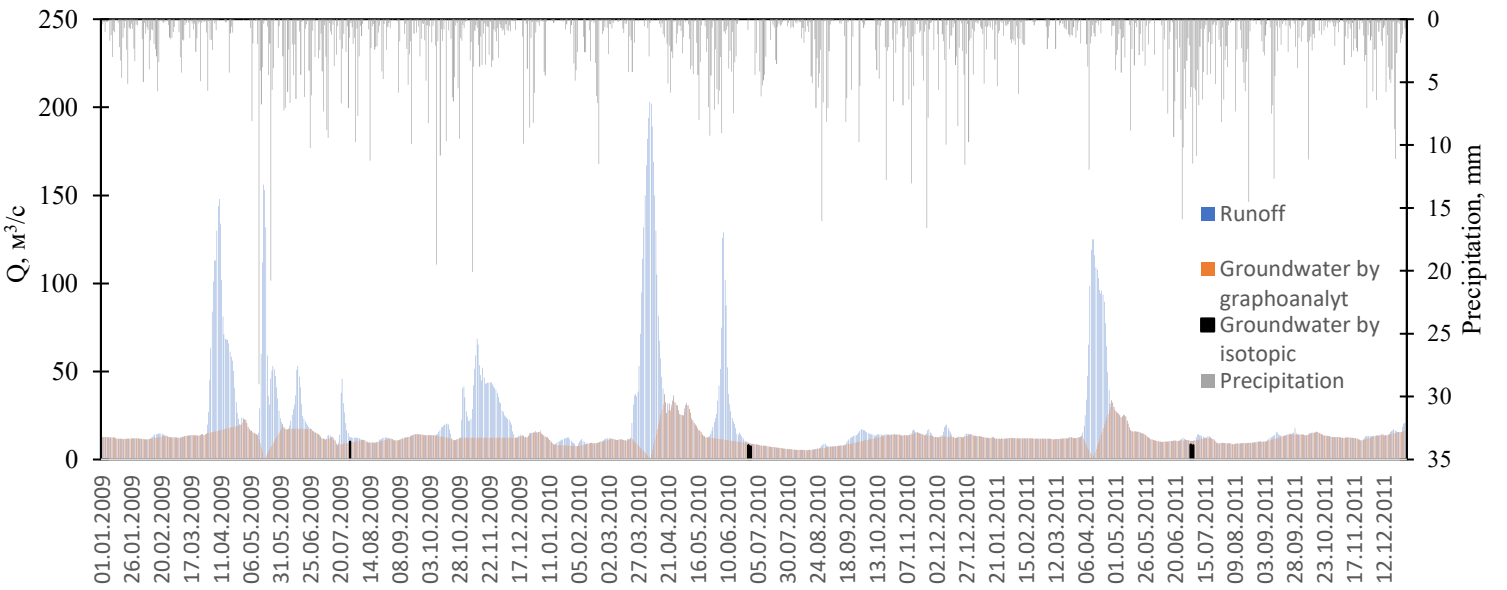
	June	July	August
2014 [1]	-9	-5	-7,7
2015	-6	-7	-7
Mean GNIP	-7,7	-7,2	-8

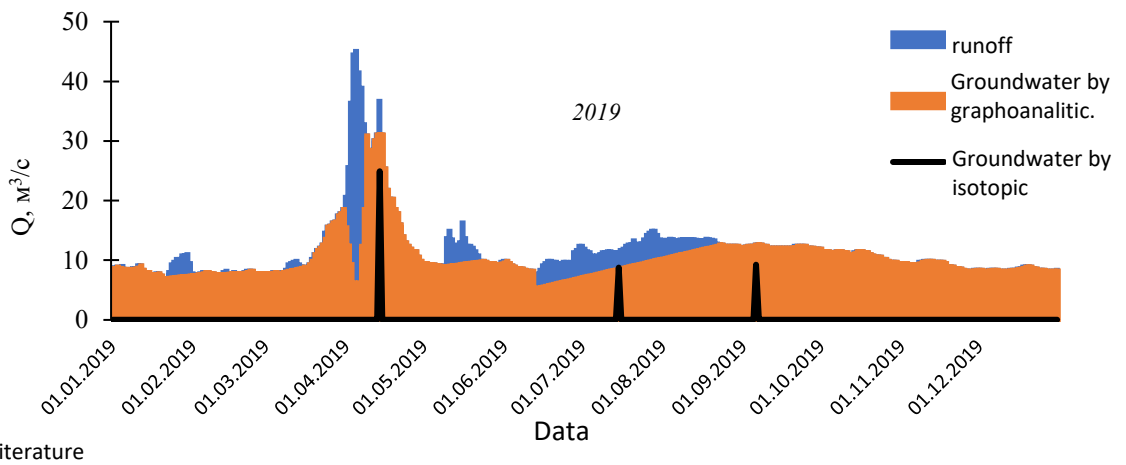
Data	Discharge, m^3/c	$\delta^{18}O$	The $\delta^{18}O$ values of component		Contribution		Groundwater input in river runoff, m^3/c	
			f-1 groundw.	f-2 precip.	f-1 groundw.	f-2 precip.	Isotopic method	Grapho-analytic
28.07.2009	13	-11,24	-12,9	-7,2	0,71	0,29	10,14	9,6
27.06.2010	9,95	-10,74	-12,3	-6,15	0,75	0,25	8,25	9,35
29.06.2010	9,39	-10,49	-12,3	-6,15	0,71	0,29	7,41	9,16
03.07.2011	10,8	-10,56	-12,3	-4,15	0,79	0,21	8,53	10,8
05.07.2011 в 12:30	10,6	-10,86	-12,3	-6,15	0,77	0,23	8,16	10,6
14.4.2019	36,6	-12,64	-11	-16,2	0,68	0,32	24,9	31
15.7.2019	11,2	-11,14	-12,3	-7	0,78	0,22	8,74	8,44
6.9.2019	12,5	-11,44	-12,3	-9	0,74	0,26	9,25	12,5

The input of precipitation to Protva river runoff in mid-summer is from 16 to 34% according to the isotope hydrograph separation. Contribution of groundwater in the summer of 2009 estimated by isotopic method was 71%, which is equivalent to 10.4 m^3 / s. In the graph-analytical method, groundwater contribution estimated to 9.6 m^3 / s. Thus, the error (uncertainty) between the two methods is 4% of the river discharge.

For 2010 and 2011 summer seasons, the difference between the estimates of groundwater contribution between the isotope hydrograph separation and graphoanalytic method reached 21% of the total river discharge. For 2011 this is due to the graphonalytic method, calculated 100% the contribution of the groundwater component.

In 2019, estimation of genetic components in the seasonal runoff by isotopic method showed very good convergence with the graphoanalytical method for the July.





Observations at the local site of the Protva River catchment in summer seasons showed that over 9 years (in 2009-2010 and in 2019), the groundwater component little change its isotopic characteristics around $\delta^{18}O$ = -12.3‰[1]. The intra- and interannual fluctuations associated with different amounts of atmospheric precipitation entering the upper groundwater horizon practically did not shift oxygen isotope composition of water. In 2014, the weighted average annual value $\delta^{18}O$ of the precipitation for Moscow was -12.1‰[2]. The $\delta^{18}O$ value of precipitation in the summer months varies from -3 to -10 ‰. For isotope hydrograph separation the $\delta^{18}O$ value of precipitation from GNIP Database or direct sampling was used. In April 2019 $\delta^{18}O$ value of snow in catchment was used for separation.

During the spring flood (April 14), according to isotope hydrograph separation, the input of groundwater to runoff was 68%, which seems to be a more accurate estimate. Despite the fact that 2019 is extremely low-water, with extremely weak spring flood (the maximum discharge in spring flood in 2019 was 44 m^3/s compared to 125-202 m^3/s in previous years), a snow cover formed in the basin. The melting of the snow was obviously reflected in the formation of the flood.

The first preliminary estimates of the differences between the isotopic and graphoanalytical methods for hydrograph separation once again focus on the problems of modeling river flows, on which there are no regular observations.

Literature

1 Chizhova Ju. N., Budantseva N.A., Efimova L.E. et al. Oxygen isotope composition of precipitation and water in the middle Protva River system // *Vestnik Moskovskogo Unviersiteta, Seriya Geografiya*. 2013. No. 2. P. 84–93.

2 Chizhova Ju.N., Eremina I.D., Budantseva N.A. et al. Concentration of ^{18}O in precipitation over Moscow in 2014 // *Russian Meteorology and Hydrology*. 2017. Vol. 42, no. 1. P. 54–63.

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