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Satellite estimation of river water level on base of shoal monitoring: case of transboundary River Ili (Central Asia)

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Lowland rivers flowing through the loess carry suspended materials and experience active processes of meandering. As a large number of result a of sediment deposition, shoals exist in the river beds. These shoals often change, especially during periods of high water. Such rivers do not have stable hydrological profiles, so satellite estimates of their water content are of great practical interest. During periods of low water, the morphology of the riverbed is relatively stable, and the shoals are in a semi-submerged state. Under these conditions, the proportion of flooding of shoals is very sensitive to the river water level, which creates favorable conditions for the development of satellite methods for assessing water levels. The study examined the Ili River in Central Asia, with an annual outflow of about 12 km3, which is the main tributary of the large lake Balkhash. The informative value of Sentinel-2 (resolution 10 m) data in the task of assessing the water level in the river in conditions of relative low water was shown. The 179 cloudless Sentinel-2 satellite images were selected for the period from April 2018 to November 2022. An additional criterion for choosing the image was the water level at the hydrological station of Kazhydromet "Ile-Dobyn" being less than 280 cm, which was typical for about 80% of the time during the low-water period 2018-2022. The River Ili riverbed on the border of China and Kazakhstan, with a length of about 40 km, was used

to create the shoal (sediments) mask with a total area above 4 km2. The MNDWI1 (Modified Normalized Difference Water Index) water index and its threshold value of +0.25 were used to identify the "water" class on the shoal mask. The proportion of flooding of shoals was compared with ground data on the water level during the satellite passes. For the period April-November, linear dependences were obtained between the proportion of shoals flooding and the river's water level. The reliability of the linear approximation for seasonal data was high, varying from R2=0.83 (2022) to R2=0.96 (2020). The entire period (2018-2022) of the analysis was characterized by R2=0.93. The use of the linear regression equation as a model for predicting the water level in the river based on the proportion of flooding of test shoals provided a sufficiently high value (0.74) of the Nash–Sutcliffe hydrological forecasting efficiency parameter, indicating the practical significance of the developed methodology.