

## SHORT COMMUNICATIONS

### **Floristic Description of Parts of the Khoher River Upstream and Downstream of the Potlovskaya Dam and Water Quality Assessment by Hydrochemical Indicators**

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Received 14 July 2019, revised 21 August 2019, accepted 10 September 2019

Katsman E. A. Floristic Description of Parts of the Khoher River Upstream and Downstream of the Potlovskaya Dam and Water Quality Assessment by Hydrochemical Indicators. *Povolzhskiy Journal of Ecology*, 2019, no. 4, pp. 524–528. DOI: <https://doi.org/10.35885/1684-7318-2019-4-524-528>

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In the modern world, increasing importance is attached to the formation and preservation of surface water quality, which is recognized as one of the leading factors in maintaining human health and well-being. In the 2000s the water quality in the Khoher river was considered as one of the best in Europe, but now the waters have become more polluted, and flow regulation (even with a low-pressure dam) may cause declension of their condition due to disruption of the water exchange process. The aim of the study was to evaluate the river flow regulation effect on the floristic diversity of vascular aquatic plants and the water quality in the vicinity of the Potlovskaya Dam near the source of the Khoher River (Penza region, Russia). The content of nutrients in water was estimated since their concentration and ratio determine the trophic status, water quality, and the state of aquatic vegetation, which is important in assessing the status of the environment of a particular region. Water chemistry and plants were sampled at two sites, one being upstream of the Dam, the other one being downstream. We have found that flow regulation by this small hydraulic installation causes some changes in the hydrochemical regime but does not affect the floristic diversity.

**Keywords:** Khoher River, Potlovskaya dam, macrophytes, floristic diversity, hydrochemical regime, biogenic compounds.

DOI: <https://doi.org/10.35885/1684-7318-2019-4-524-528>

In the modern world increasing importance is attached to the formation and preservation of surface water quality, which is recognized as one of the leading factors in maintaining human health and well-being. UNESCO has had an International Hydrological Programme (IHP), which launched new World Water Quality Portal provides information on freshwater quality at the global scale using remote sensing data UNESCO (2018). These measures make clear the importance of surface water quality research tasks.

# FLORISTIC DESCRIPTION OF PARTS OF THE KHOPER RIVER

Potlovskaya Dam – a small hydraulic installation on Khoper river in Staraya Potlovka village (Kolyshley district, Penza province, Russia), was built by residents for recreational purposes in the 1990s without supervisory authorities permission. The backwater formed upstream the Dam has been used for swimming, fishing, cattle watering. A overflow waterspill has been used as waterfall to entertain vacationers. The aim of the study was to reveal the impact of river flow regulation on floristic diversity and water quality.

Vascular aquatic plants were studied in spots of Khoper river up – and downstream of Potlovskaya Dam on August 17, 2016, simultaneously with the collection of hydrochemical samples. Floristic diversity and cenotic significance of individual plant species were determined following by P. F. Mayevsky (2006) and V. G. Papchenkov et al. (2003). The study of phytocenoses was carried out by the route accounting method.

The chemical measurements were carried out using the Ecotest 2020 photocolormeter by determining the transmittance and optical density of solutions by standard methods with further recalculation of the solution concentration using colorimetric curves by Certified measurement procedures methods of Join stock company Christmas+ (Christmas+, Russia). The determinations were done in triplicate.

In the Table below a generalized floristic list for the studied spots with systematic affiliation to the vascular plant family, ecological group, and representation on the pre- and after Dam spots are presented.

**Table 1.** The list of finding higher vascular plants of Khoper river spots up- and downstream of the Potlovskaya Dam (August 2016)

No.	Specific Latin name of the plant	Biological family	Ecological group	Upstream the Dam	Downstream the Dam
1	2	3	4	5	6
1	<i>Alisma plantago-aquatica</i> L.	Alismatáceae	hygrophytes	+	+
2	<i>Bidens cernua</i> L.	Asteráceae	helophytes	+	+
3	<i>Bidens tripartite</i> L.	Asteráceae	helophytes	+	+
4	<i>Butomus umbellatus</i> L.	Butomaceae	hygrophytes	+	+
6	<i>Caltha palustris</i> L.	Ranunculáceae	hygrophytes	+	+
7	<i>Carex acuta</i> L.	Cyperáceae	helophytes	+	+
8	<i>Carex pseudocyperus</i> L.	Cyperáceae	helophytes	+	+
9	<i>Carex rostrata</i> Stokes	Cyperáceae	helophytes	+	+
10	<i>Carex vesicaria</i> L.	Cyperáceae	helophytes	+	+
11	<i>Carex vulpine</i> L.	Cyperáceae	helophytes	+	+
12	<i>Ceratophyllum demersum</i> L.	Ceratophyllaceae	hydatophytes	+	+
13	<i>Elodea canadensis</i> Michx.	Hydrocharitáceae	hydatophytes	+	+
14	<i>Equisetum fluviatile</i> L.	Equisetaceae	helophytes	+	+
15	<i>Galium palustre</i> L.	Amaryllidáceae	helophytes	+	+
16	<i>Hydrocharis morsus-ranae</i> L.	Hydrocharitáceae	hydatophytes	+	+
17	<i>Juncus conglomeratus</i> L.	Cyperáceae	hygrophytes	+	+
18	<i>Lemna minor</i> L.	Araceae	pleistophytes	+	+
19	<i>Lemna trisulca</i> L.	Araceae	pleistophytes	+	+
20	<i>Lycopus europaeus</i> L.	Lamiáceae	helophytes	+	+
21	<i>Lysimachia nummularia</i> L.	Primuláceae	helophytes	+	+
22	<i>Lysimachia vulgaris</i> L.	Primuláceae	helophytes	+	+
23	<i>Mentha arvensis</i> L.	Lamiáceae	helophytes	+	+
24	<i>Myosotis palustris</i> L.	Boragináceae	helophytes	+	+

**Table 1.** Continuation

1	2	3	4	5	6
25	<i>Persicaria amphibian</i> L.	Polygonaceae	hygrophytes	–	+
26	<i>Potamogeton crispus</i> L.	Potamogetonaceae	hygrophytes	+	+
27	<i>Potamogeton lucens</i> L.	Potamogetonaceae	hygrophytes	+	+
28	<i>Potamogeton natans</i> L.	Potamogetonaceae	hygrophytes	+	+
29	<i>Potentilla anserine</i> L.	Rosaceae	helophytes	+	+
30	<i>Rumex hydrolapathum</i> Huds.	Polygonaceae	helophytes	+	+
31	<i>Sagittaria sagittifolia</i> L.	Alismataceae	hygrophytes	+	+
32	<i>Scirpus lacustris</i> L.	Cyperaceae	hygrophytes	+	+
33	<i>Scutellaria galericulata</i> L.	Lamiaceae	helophytes	+	+
34	<i>Symphytum officinale</i> L.	Boraginaceae	helophytes	–	+

The list of found higher vascular plants includes 34 species belonging to 17 families. The floristic diversity of the spots is almost identical: 2 species (*Symphytum officinale* L. and *Persicaria amphibian* L.) are found upstream the Dam. By the number of species, the families Cyperaceae ( $n = 7$ ), Potamogetonaceae ( $n = 3$ ), and Lamiaceae ( $n = 3$ ) are leading; the remaining families are represented by 1–2 species.

The representation of plants with different coenotic significance in the plots for the above reason (floristic similarity) also does not differ. As a whole, in both spots 19 species of helophytes, 7 types of hygrophytes, 6 types of hydathophytes, 2 species of pleistophytes were found. In the pre-dam upstream area, duckweeds cover the entire water surface.

The degree of overgrowing of the pre-dam upstream spot can be characterized as high, with a pronounced tendency to waterlogging. The overgrowing of the area downstream the Dam is medium.

Observation of Khoper river water quality on hydrochemical indicators in the area around Potlovskaya Dam was carried out at the same spots. The concentrations of the following biogen ions in water were determined: dissolved ammonia – ammonium ion – ( $\text{NH}_4^{4+}$ ), nitrite ions ( $\text{NO}_2^-$ ), nitrate ions ( $\text{NO}_3^{2-}$ ), phosphate ions ( $\text{PO}_4^{2-}$ ), chloride ions ( $\text{Cl}^-$ ). The table below presents the averaged results. The bottom line of the table shows the maximum permissible concentration (MPC) of these substances for surface water of land having fishery value according to sanitary and epidemiological rules (Hygienic Requirements..., 2000).

**Table 2.** The concentration of ions of nutrients in the waters of the Khoper river in the area of the Potlovskaya Dam 17 August 2016

Spots	C, mg/liter				
	$\text{NH}_4^{4+}$	$\text{NO}_2^-$	$\text{NO}_3^{2-}$	$\text{PO}_4^{2-}$	$\text{Cl}^-$
Upstream the dam	18.32	1.48	13.12	0.06	9.08
Downstream the Dam	5.52	0.74	7.39	0.05	8.72
MPC	0.5	0.08	45	0.02	300

A comparison of concentrations of biogen ions obtained in the Potlovskaya Dam area with the maximum permissible concentrations according to fishery standards has shown that the concentrations of ammonium, nitrite ion, and phosphate ion are much

higher than the maximum permissible concentrations. Moreover, in the pre-dam part all indicators were higher in comparison with concentrations in downstream of Potlovskaya Dam.

This pronounced effect can be explained by the cumulative role of the reservoir formed upstream of the Dam. The hydrological regime in this area is weakly varying in all seasons of the year, and a drainage flow slowed down due to the functioning of the Dam: surface waters saturated with highly humidified surface runoff from settlements and agricultural lands are taken into the reservoir. The upper layers of water that underwent natural purification as a result of sedimentation and aeration are given away, leaving through the crest of the dam. Of particular note is the relatively high concentration of nitrite ions, which are rapidly degradable substances (Miniovich M., Miniovich V., 1979), whose presence in water bodies is normally transient. The presence of these substances in an increased amount indicates a high biogenic load on the water body and can disadvantageously affect hydrobionts since nitrite ions in high concentrations are carcinogens.

Conducting estimation of biogen ions concentrations in middle summer is explained by the case of the most high values of this parameters at this time in general.

Under current conditions, bottom sediments with a high content of nutrients may produce in the bottom sections of the pre-dam part of the Khoper river, which leads to accumulation of humic substances that reduce water quality and gradual swamping. The initial stages of which can also be noted by the presence in the floristic composition of a high proportion of plants of swamp complexes.

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**ФЛОРИСТИЧЕСКОЕ ОПИСАНИЕ УЧАСТКОВ ТЕЧЕНИЯ р. ХОПЁР  
ВЫШЕ И НИЖЕ ПОТЛОВСКОЙ ПЛОТИНЫ И ОЦЕНКА КАЧЕСТВА ВОДЫ  
ПО ГИДРОХИМИЧЕСКИМ ПОКАЗАТЕЛЯМ**

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Поступила в редакцию 14.07.2019 г., после доработки 21.08.2019 г., принята 10.09.2019 г.

Katsman E. A. Floristic Description of Parts of the Khopec River Upstream and Downstream of the Potlovskaya Dam and Water Quality Assessment by Hydrochemical Indicators [Кацман Е. А. Флористическое описание участков течения р. Хопёр выше и ниже Потловской плотины и оценка качества воды по гидрохимическим показателям] // Поволжский экологический журнал. 2019. № 4. С. 524 – 528. DOI: <https://doi.org/10.18500/1684-7318-2019-4-524-528>

В современном мире все большее значение придается формированию и сохранению качества поверхностных вод, что признано одним из ведущих факторов в поддержании здоровья и благополучия человека. В 2000-х гг. качество воды в р. Хопёр считалось одним из самых высоких в Европе, но теперь его воды стали более загрязненными, и зарегулирование стока (даже под влиянием низконапорной плотины) может привести к ухудшению их состояния из-за нарушения процесса водообмена. Задачей исследования являлась оценка влияния зарегулирования речного стока на флористическое разнообразие сосудистых водных растений и качество воды в районе Потловской плотины недалеко от истока р. Хопёр (Пензенская область, Россия). Оценивали содержание биогенных веществ в воде, поскольку их концентрация и соотношение определяют трофический статус, качество воды и состояние водной растительности, что имеет важное значение для оценки состояния окружающей среды конкретного региона. Отбор гидрохимических проб и учеты растений проводились на двух станциях: одна – выше по течению от плотины, другая – ниже по течению. Мы обнаружили, что зарегулирование потока малым гидравлическим сооружением вызывает некоторые изменения в гидрохимическом режиме, но не оказывает влияния на флористическое разнообразие.

*Ключевые слова:* р. Хопёр, Потловская плотина, макрофиты, флористическое разнообразие, гидрохимический режим, биогенные соединения.

DOI: <https://doi.org/10.35885/1684-7318-2019-4-524-528>