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THE CURRENT STATE AND PROBLEMS OF THE RUSSIAN CENTRAL FOREST-STEPPE WETLAND ECOSYSTEMS

Czernyszew A. A., Kazakow S. G. Współczesny stan i problemy ekosystemów wodno-bagiennych w Centralnej Strefie Lasostepowej Rosji. Artykuł traktuje o obszarach wodno-bagiennych Centralnej Strefy Lasostepowej Rosji, które należą do najbardziej niestabilnymi typów ekosystemów. Ich rozwój zachodzi pod wpływem złożonych i oddziałujących na siebie czynników naturalnych i antropogenicznych. Badano stopień zależności różnorodnych ekosystemów wodno-bagiennych od stanu tworzących je rzek i potoków, analizowano podstawowe charakterystyki hydrologiczne rzek oraz dane klimatyczne za okres 1936–2012. Wyróżniono kilka grup czynników antropogenicznych, negatywnie wpływających na zasilanie rzek, które razem z ciepłą i suchą fazą klimatyczną, jaka pojawiła się na przełomie wieków, potęgują degradację praktycznie wszystkich współczesnych typów ekosystemów wodno-błotnych na obszarze lasostepów.

Чернышев А. А., Казаков С. Г. Современное состояние и проблемы водно-болотных экосистем Центральной лесостепи России. Статья посвящена водно-болотным угодьям Центральной лесостепи России, которые являются наиболее неустойчивыми типами экосистем. Их формирование проходит под влиянием сложной взаимосвязанной совокупности естественных и антропогенных факторов. Были исследованы степень зависимости состояния различных водно-болотных угодий от состояния сформировавших их водотоков, основные гидрологические характеристики водотоков за временной период с 1936 по 2012 год и климатические характеристики за тот же временной период. Выявлено нескольких групп антропогенных факторов, отрицательно влияющих на питание рек, которые вместе с наступившей межвековой тепло-засушливой климатической фазой усиливают деградацию практически всех типов сегодняшних водно-болотных угодий лесостепи.

Key words: wetlands, Russian Central Forest-Steppe, Kursk region, climate change

Słowa kluczowe: ekosystemy wodno-bagienne, Centralna Strefa Lasostepowa Rosji, obwód kurski, zmiany klimatu

Ключевые слова: водно-болотные угодья, Центральная лесостепь России, Курская область, изменение климата

Abstract

Article focuses on the Russian Central Forest-steppe Wetlands which are the most unsustainable ecosystem types. Their formation takes place under the influence of a complex set of interrelated natural and anthropogenic factors. Authors investigated the degree of dependence on the state of various wetlands on the water courses which formed them, the main hydrological characteristics of streams in the time period from 1936 to 2012 and climatic characteristics for the same time period. The combination of several groups of anthropogenic factors, having a bad effect on rivers nourishment with the set-in intercentury warm-dry climatic phase, enhances the degradation of virtually all the types of the present day forest-steppe wetlands.

INTRODUCTION

The forest-steppe zone of European Russia is a part of Central Russia, located in Central Russian Upland, which is mostly situated within the Russian Platform.

A forest-steppe is regarded to be a type of natural biome, which is characterized by the primeval state interchange of closed, mainly leafy forests on the grey forest soils and forb steppes on the black earth soils. The originality of the forest-steppe and its identification as a separate type of the natural zone, which was formed during the Neogene and replaced savannahs, were corroborated by a number of scientists, who suggested several independent theories (BERG, 1947; DOKHMAN, 1967; MILKOV, 1977 et al.). The special feature of the forest-steppe as the type of natural biome is unstable relationship between

forest and steppified formations, caused by the changeable radiative dryness index (photo 1).



Photo 1. The typical Russian Central Forest-Steppe (phot. by A. A. Chernyshev)
Fot. 1. Typowy widok Centralnej Strefy Lasostepowej Rosji (fot. A. A. Czernyszew)

F. N. MILKOV (*Fiziko-geograficheskoe rayonirowanie...*, 1961) distinguishes nine physiographic regions in the territory of the forest-steppe province of the dissected Central Russian Upland, six of which refer to a typical forest-steppe. Administratively these physiographic regions occupy a part of the Orel region, the whole Kursk region, parts of the Belgorod, Lipetsk and Voronezh regions. This land area is also called the Central Forest-Steppe (fig. 1). The majority of this area is occupied by the physiographic regions, catchments of which refer to the rivers of the Dnieper River Basin, the most significant of which are the Seym river¹ and the Pszol river², running in Kursk region and forming the main types of wetlands.

The wetlands of the Central Forest-Steppe are the least stable types of ecosystems, that are formed under the influence of the interrelated complex of natural and antropogenic factors. The combination of these factors determines the main hydrologic characteristics of water bodies themselves, to which permanent and temporary streams as well as pieces of water formed by streams (floodplain lakes, floodplain

¹The Seym river, the left tributary of the Desna river. The overall length is 748 km, average water discharge in the mouth is about 100 m³/s. The river basin area is 27, 5 ths. km². The length within Kursk region is 490 km, the river basin area is up to 20 ths. km². Average water discharge in summer-time at the town of Rylsk is 30 m³/s.

²The Pszol river, the left tributary of the Dnieper river. The overall length is 717 km, average water discharge in the mouth is 55 m³/s. The total river basin area is 22,8 ths. km². The length within Kursk region is about 170 km, with about 5 ths. km² of the river basin area. Average water discharge at the village Krupets in summer-time is about 6 m³/s.

and flood swamps) or created by people (impounded bodies, quarries, tailing dumps, basin-coolers) in these physiographic regions refer.

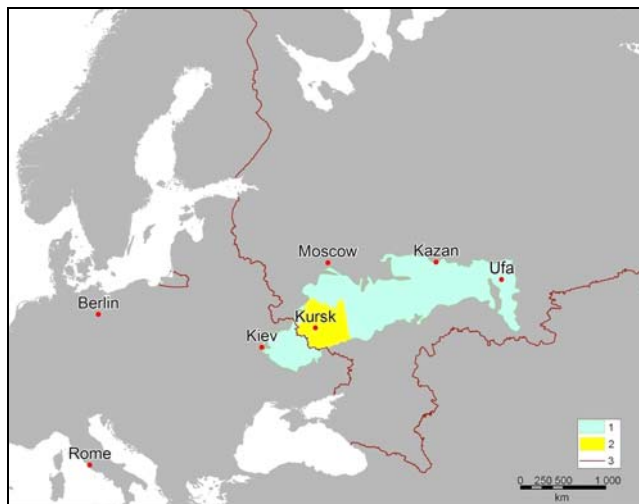


Fig. 1. The location of Russian Central Forest-Steppe: 1 – East European Forest-Steppe, 2 – Russian Central Forest-Steppe, 3 – state border of Russia

Rys. 2. Lokalizacja Centralnej Strefy Lasostepowej Rosji: 1 – strefa lasostepowa Wschodniej Europy, 2 – Centralna Strefa Lasostepowa Rosji, 3 – granica państwowa Rosji

Besides water areas of permanent and temporary water bodies the whole floodplain type of locality should be referred to wetlands as habitats of living organisms, because short-time presence of aquatic medium on the floodplain is enough for the necessary development of many types of both animals and plants (photo 2).



Photo 2. Wetlands in the forest-steppe (the place of two rivers confluence and floodplains) (phot. by A. A. Chernyshev)
Fot. 2. Tereny wodno-bagienne na obszarze lasostepu (rzeki i terasy zalewowe) (fot. A. A. Czernyszew)

In the hierarchy of the wetlands and aquatic ecosystems backbone relations the avifauna plays an important role. Birds are characterized by mobility and their inherent nest conservatism at the same

time, which determines particular species and groups fidelity to specific habitats. This allows to use the avifauna as a model bioindication group in the studies of the forest-steppe zone wetland ecosystems state.

So far, the main living organisms of the forest-steppe zone wetlands have been quite sufficiently studied, their quantitative and qualitative characteristics have been defined (RAVKIN, 2003), their variation tendencies in accordance with the dynamics of the wetlands principal characteristics have also been revealed (KRIVENKO, 1991; ZYKOV, ULITIN, 2000; AVILOVA, 2008; CHERNYSHEV, 2010 et al.).

Therefore the main objective of the research was to determine the significance of separate factors, defining water bodies hydrological regime, as well as the complex of these factors, in the end leading to the formation of typical wetlands and their development in space and in time.

In order to accomplish the objective the following aspects have been studied: a) the degree of different wetlands state dependence on the streams which formed them; b) main hydrologic characteristics of the streams over a period of time from 1936 to 2012; c) climatic characteristics over the same period of time; d) concluding the rivers hydrologic characteristics correlation dependence on climatic factors, including also the period of climatic phases; e) defining the significance of anthropogenic factors; f) prognosticating the development of the wetlands and the living organisms inhabiting them.

METHODS

Comparative analysis of the main streams hydrologic characteristics and of the climatic peculiarities was performed on the basis of the data from 1936 through 2012, given by the State Institution "Kursk CGMS-R" (Kursk City Center of Hydrometeorology and Monitoring of Environment). Some data were obtained in the course of personal research, including temporary bench marks setting and their further levelling. The structuring change of the floodplain wetlands and agricultural land was determined both by personal research of many years as well as with the help of map material and remote sensing data.

The bioindication method, during which the avifauna was the main object of research, was also used. The fauna and habitancy of birds data were obtained with the help of the transects method during the nesting and postnesting periods, as well as using records during the seasons of phenological migrations. The main characteristics were as follows: the species composition of the ornithocomplex;

total population density of birds; population density of each species of birds; the participation quota in the population of each species of birds, obligatorily taking into account a mathematical error; population density and participation quota in the population of the birds of each ecological-faunistic group.

THE SIGNIFICANCE OF STREAMS FOR THE FORMATION AND DEVELOPMENT OF WETLANDS

Almost the whole area of natural and the most part of anthropogenic wetlands of the typical central forest-steppe landscapes is formed by streams activity, first of all due to flood and spring flood time.

The most significant is flood time, causing the formation of a number of the most important structures of wetlands: floods of low and high floodplains (the width of the floodplains in the lower and middle courses of the Seym river comes up to 4–6 km, in the upstream of the Psyl river – up to 3,5–4 km), which leads to the presence of flooded shallow water areas with the interim period from 7–10 to 20–25 days; permanent flood and flush of the floodplain lakes which were formed before; the formation of the new negative landforms and their ponding; the river-channel alluvium carry-over onto the floodplain; gradual river-channel straightening due to river bends breaching and the formation of the oxbow lakes; total structuring change of the shoreline; destruction of valley sides, terraces above floodplains, which were formed before; the change of plant communities, first of all, of the lignosa on the shoreline.

The same phenomena, though with less effectiveness, occur during seasonal floods. Besides, the constantly continuing processes, connected with the so called "breaching" of large rivers beds in the middle and lower courses and their silting in the upper one, as well as with permanent silting of minor streams channels, are observed (KUMANI, 2003). Therefore, detecting the reasons, causing the changes of the main hydrologic characteristics of the streams, i.e. water discharge and a level, is the most significant.

DEFINING THE SIGNIFICANCE OF CLIMATIC FACTORS FOR RIVERS NOURISHMENT

The data, obtained from the main water posts in the territory of Kursk region, after performing the comparative analysis, allow us to use the figures of the water post on the Seym river (the town of

Rylsk) (coefficient of correlation with the other water posts is 0,76–0,92) as a basis.

According to the data, given for the period of long-term observations, the nourishment of the streams is distributed as follows: 50–55% are the share of snow feeding, rain feeding – 10–20%, ground water supply – not more than 30–35%.

The main factor, influencing the nourishment of rivers, has been the climatic one, which was also based on the cycling climatic changes, with the interchange of warm-dry and coolly damp phases of interdecadal and century-long character. These cycles, in turn, are separated onto time parameters as 3–4 years, 7–10 years, 25–30 years etc. (KRIVENKO, 1991).

After processing the data according to the climatic constituent in the territory of the Central Forest-Steppe and Kursk region in particular, since 1896, with the help of GIS, the temperature and rainfall maps, showing the clearest tendencies of warmth and moisture territorial differentiation, have been made. The data till 1968 were given by 68 meteorological stations and meteorological observation posts, as for the data of late, they were obtained from 19 stations and posts (taking into account their total reduction since 1990).

Considering geographic location of the region, peculiarities of its relief, "Kursk" meteorological sta-

tion, which gives average readings within the region, was chosen as the reference point.

During the analysis of the annual precipitation and annual air temperatures since 1936 (since the beginning of data acquisition from hydrologic observation posts) the authors determined warm-dry and coolly damp phases. As expected, the phases of 3–4 years were the clearest, 7–10 years – more rarely. The phases from 1976 to 1988 (coolly damp) and from 2005–2006 to 2012 (warm-dry) were maximally determined through the whole period of time.

It should be remarked, that during these periods of time the temperature amplitudes were more intense, but not the rainfall amount ones, especially, during the period from 2005 to 2012 (table 1).

Previously the rainfall in the region was influenced by the interchange of the Atlantic cyclones and anticyclones coming from the east. The maximum rainfall was detected during two periods – November-January (up to 18% of the annual rainfall) and the second half of June–July (up to 23% of the annual rainfall), when up to 50% of mean yearly rain falls for five months. The minimum rainfall was detected during the periods from February to the middle of June (up to 20 mm) and from August to the middle October (up to 90 mm).

Table 1. The ratio of average annual temperatures and annual precipitations during different climatic phases
Tabela 1. Średnie roczne temperatury i roczne sumy opadów w różnych fazach klimatycznych

Climatic phase	Annual climatic indexes t (°C) / precipitation (mm) during the climatic phase			Average annual climatic indexes from 1935 to 2012	Relation to the mean value in %
	Min.	Max.	Average.		
1. Coolly damp					
a) 1950–1953	5,2/575	5,8/800	5,4/643	5,7/607	94/105
b) 1968–1971	4,1/554	5,9/754	5,3/613	5,7/607	93/124
c) 1976–1988	3,8/548	6,9/857	5,2/668	5,7/607	91/110
d) 1996–1998	5,6/583	6,0/775,1	5,7/682	5,7/607	100/112
2. Warm-dry					
a) 1937–1939	6,4/410	7,3/631	6,7/494	5,7/607	118/81
b) 1960–1963	4,9/403	6,3/472	5,8/491	5,7/607	102/81
c) 2005–2012	6,4/496	8,3/682	7,5/586	5,7/607	132/97

THE CHANGES OF WATER DISCHARGE AND LEVELS OF THE RIVERS IN DIFFERENT CLIMATIC PHASES

For comparison the following data were taken: average annual rates from the meteorological stations of Kursk; seasonal rates from the meteorological stations of Kursk; annual and seasonal rates from the meteo-

rological stations and posts, which are situated in the territory of the of the river catchments. Authors also made GIS-maps for more complete and accurate detection of temperature condition and rainfall quantity according to phenological seasons across the whole region (fig. 2).

In the course of the comparison of climatic indexes and hydrologic characteristics of the rivers it

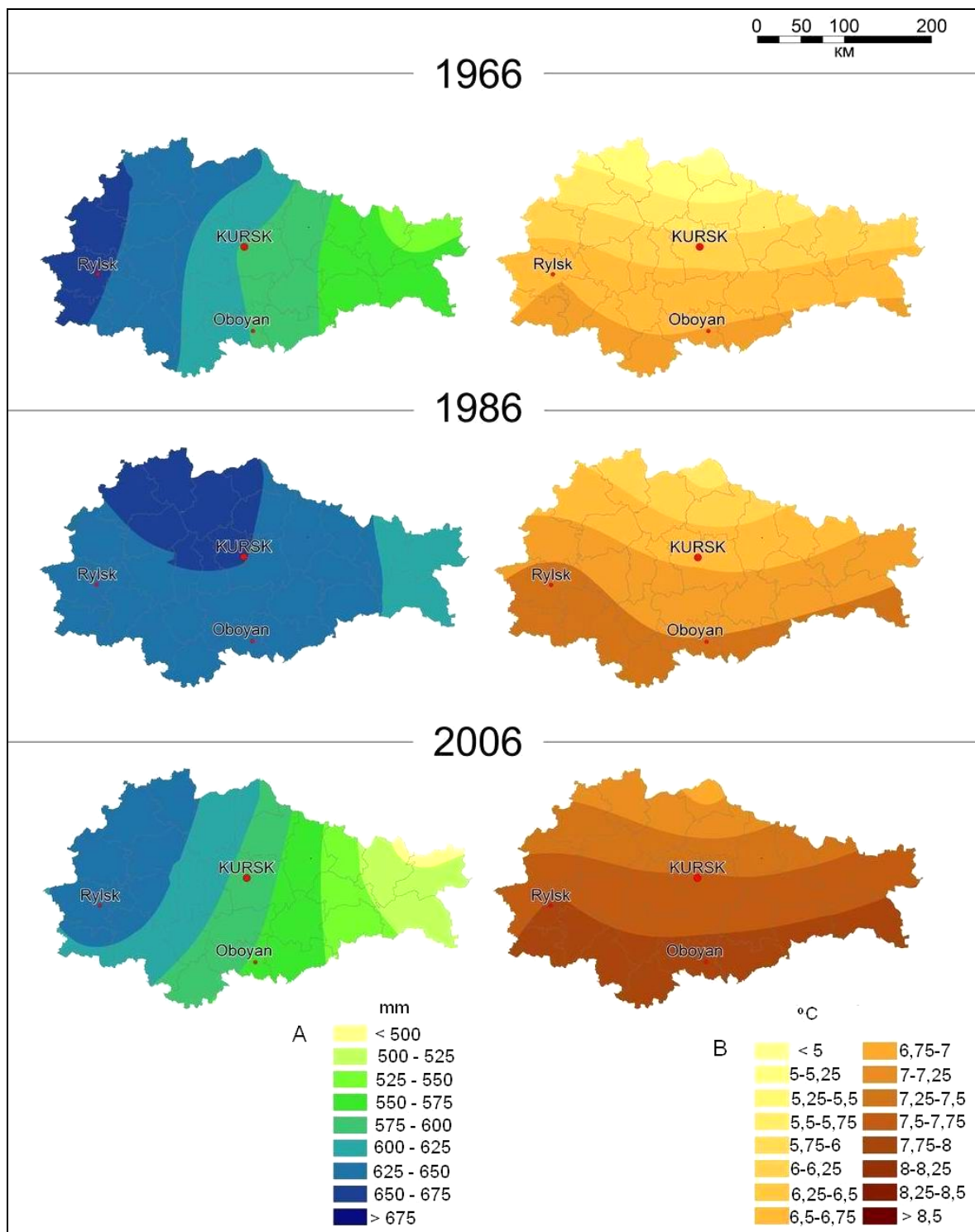


Fig. 2. Distribution of average annual precipitations (A) and annual air temperatures (B) quantity in the Kursk Region
 Rys. 2. Średnie roczne opady atmosferyczne (A) i średnie roczne temperatury powietrza (B) na obszarze obwodu kurskiego

was revealed that the water discharge fluctuations curve corresponds mainly to the climatic fluctuations curve, and the high annual water discharge is caused, first of all, by the intensive flood time.

However, during the analysis according to phenological seasons a number of peculiarities, including those in the periods of climatic phases, were discovered.

We made an attempt to link the changes of water discharge during phenological seasons in the periods of warm-dry and coolly damp phases.

Authors chose the period of time from 1936 (i.e. since the year of the first measurements of hydrologic characteristics of the rivers from the water observation posts in Kursk region) to 2012. In the course

of the climatic indexes analysis the following was detected. The periods of time, which might have been referred to be the warm-dry ones, were in 1937–1939, 1960–1963, 2005–2012. The periods from 1950 to 1953, 1968 to 1971, 1976 to 1988, 1996 to 1998 may be considered to be the coolly damp ones. According to the indexes, the longest periods of time are the following: coolly damp period from 1976 to 1988 (13 years) and the warm-dry period from 2005 to 2012 (8 years).

During the comparison of time periods with the water discharge at the check hydrological observation post (the Seym river, Ryłsk) authors obtain the following data (table 1). As is evident from the given data, the annual water discharge during the coolly damp climatic phases either exceeded the main value, or was close to it, besides, the exceeding was more typical for the 50–70 years periods of the twen-

tieth century, during which intensive works on forest reclamation were being performed, ponds were being created and the grass rotation cropping system was being implemented (KUMANI, 2003). This also explains the exceeding of the annual water discharge by 8,3% even in the period of the 1960–1963 warm-dry phase. Water discharge during this phase was almost equal to the figures of the rather long-term coolly damp phase of 1976–1988.

Whereas during the first warm-dry phases the precipitation fell in the quantity up to 80% of the average rainfall, and temperature departures were less considerable (2–18%), then during the warm-dry phase of 2005–2012 the precipitation deviation was only by 3% from the average one, but the exceeding of the average annual temperatures was by 32% (table 2).

Table 2. The ratio of water discharges during different climatic phases

Tabela 2. Przepływy w różnych fazach klimatycznych

Climatic phase	Average annual water discharge during climatic phases (m ³ /s)			Average annual water discharge from 1935 to 2012	Relation to the mean value in %
	Min.	Max.	Average		
1. Coolly damp					
a) 1950–1953	52	104	81,3	67,4	121,6
b) 1968–1971	66	130	87,5	67,4	130
c) 1976–1988	33	99	73,8	67,4	109,4
d) 1996–1998	52	89	68	67,4	100,1
2. Warm-dry					
a) 1937–1939	47	79	57,6	67,4	85,5
b) 1960–1963	48	110	73	67,4	108,3
c) 2005–2012	38,7	78	53,8	67,4	79,8

Exactly this period of time shows almost record for the rivers of the region decline of the average annual water discharge within the period of time.

Since 2006 the water discharges and levels continued declining without direct correlation with the ratio of temperatures and precipitation (table 3).

The most interesting fact is the decline of water discharge in 2009 in comparison to 2008, in spite of the lower average annual temperature (by 8%) and more precipitation (by 14%), besides, the average annual precipitation exceeded the average standard norm by 5%. Even more discrepancy is observed in 2010 and 2011. With almost equal quantity of precipitation (85% and 82% of the norm) and temperature decline by 23% in 2011, the average annual water discharge declined by 23,5%, and the level – by 6,5%.

The similar figures were also observed in 2012. With the minor increase of the average annual temperature in comparison to 2011 (by 7%) and increase of the annual precipitation quantity by 30% (112% of the norm, more than during the periods of coolly damp phases in 1950–1953, 1976–1988), the water discharge increased only by 3,5% and remained lower than the average one by 39%. The annual level almost didn't also change.

Since the end of August till October 2012 on the whole area of water collections of the Seym and the Svapa rivers from 175 to 205 mm of precipitation fell, which makes up to 34% of the annual norm, and from 200 to 300 mm of precipitation fell in the catchment of the Pszol river (up to 50% of the annual norm). The water discharge during this period of time were

Table 3. The ratio of climatic and hydrological characteristics during the warm-dry climatic phase (2007–2012)
Tabela 3. Wskaźniki klimatyczne i hydrologiczne w czasie cieplej i suchej fazy klimatycznej (2007–2012)

Year	Average annual temperature		Precipitation (mm)		Average annual water discharge		Average annual water level	
	°C	%	mm	%	m ³ /s	%	cm	%
2007	8,1	142	589	97	53	78,6	303	98
2008	8,0	140	550	91	55	81,6	271	88
2009	7,5	132	643	105	47	69,7	297	96
2010	8,3	146	516	85	54,5	80,9	300	99
2011	7,0	123	496	82	38,7	57,4	286	92,5
2012	7,4	130	682	112	41,1	60,9	288	93

23,9 m³/s (66% of the norm) at the check hydrological post (the Seym river, Rylsk), 11,7 m³/s (117% of the norm) – at the hydrological observation post of the Svapa river, 3,4 m³/s (161% of the norm) – at the hydrological observation post of the Psyol river. At the same time, the level of the Seym river was lower than the norm by 14–17 cm, the Svapa river – by 55 cm, the Psyol river – by 45–50 cm, despite the increased water discharge (photo 3).



Photo. 3. Drying of the Psyol riverbed (phot. by A. A. Chernyshev)

Fot. 5. Wysychające koryto rzeki Psioł (fot. A. A. Czernyszew)

During the sub-studies of the correlation of the water levels in the Psyol river (on the basis of the results of the temporary bench marks with the preliminary leveling positioning) it was found, that in late October after the fall of the half-year precipitation norm, the water level rise was only by 43 cm in relation to the summer runoff low, during which only 92,8 mm of precipitation fell for three months. Earlier, with the precipitation total fall (220–250 mm) the level of the Psyol river rose up to 1,2–1,4 m, and in 1997 – up to 1,7 m.

Therefore, we can make a conclusion, that since 2006 (the period of the set in intercentury climatic warm-dry phase) the changes of the streams hydrological characteristics and related to them wetlands cannot be explained just by climatic factors.

THE ANTHROPOGENIC ACTIVITY INFLUENCE ON THE STREAMS

Nowadays the main reason of the rivers ground-water supply malfunction in the forest-steppe is plant cultivation, turning into spring crops of late growth (maize, sugar beet, sunflower, soya), as well as into spring sown cereal (wheat, barley) (KUMANI, 2003). The area of these crops reaches 75–80% of the total crop rotation area, and 50% of the total Kursk region area (up to 15 000 km²). The crops of the perennial grasses are almost not noted in the crop rotation, and since the beginning of the 21st century the majority of the fallow lands area, formed in the 1990s, has been used again for plant cultivation.

These processes are virtually not under control because of the agriculture transition onto the level of the small economic agents (agricultural enterprises, peasant farm enterprises, personal subsidiary economies), which are primarily concerned about solving economical issues, rather than nature conservation ones.

This is especially related to the usage of the fields, which are situated on the slopes of 4° and up to 10°, almost falling into the ravines and gullies, for tilled crops. During these areas research the authors detected just two diked fields, while both these fields turned into fallow land. The edges of the most part of the eroded fields are either not bordered by forest shelter belts, or the location of these forest belts doesn't significantly influence in reality the degree of the sheet flood. Besides, the part of the forest belts was cut down in the 1990s, and there is almost no new planting. We had more than once witnessed the burning-out of the forest shelter belts during the fires of the stubble remains in August and September. This was mostly evident in 2009–2010.

The early ploughing of the fields after their harvesting rather badly influences soil moisture. In 2012 due to the early vegetation of grain crops and their early harvesting the fields were ploughed up again

by the 6th of July and represented the large areas with the maximum evaporating surface.

Data provided by the State Biosphere Central Chernozem Reserve by named V. V. Alekhin, support the view of increasing soil drought in Central forest, where the general trend of loss of moisture in the soil, even in protected areas varies from 16% to 34% of the average statistical indicators.

The second significant factor is the degradation of the ponds, which were created in the 50–70s of the twentieth century with the purpose of enhancing the hydrologic characteristics of the rivers, even distribution of their annual flow and solving a number of land reclamation issues. The majority of the ponds lost up to 30% of their capacity due to sludge buildups for 45–50 years, their depth also reduced, which leads to more warming up and evaporation during the warm period (SHUMAKOV, 2007).

After the transition into different property categories a number of the ponds, including even the two ones at the Kur river in Kursk, were completely drained. The leaseholders' activity causes the unpredictable water evacuation or, vice-versa, filling of the ponds, and it is also under almost no control. In some cases attempts of dams unearthing during the spring flood time were found out. It was done in order to take out remaining fish, as well as in order to save a dam from its complete destruction, as after this action there is still an opportunity to use the dam as a site, regulating the annual flow of a particular stream. This instability is present almost in all the administrative areas of the region.

The pre-existing system of pouring affluents, including milldams, is also almost absent on the main streams (the Seym, the Svapa, the Psyol rivers). There is not a single dam left out of more than 20, which still existed by the middle of the twentieth century on the Psyol river. The retaining dams of the Seym river are partially or wholly destructed. After the destruction of one of them at the town of Kurchatov, the lake Zvan, which used to have the area of about 3 ha and the depth up to 2 m, completely dried up.

CONCLUSIONS

1. The combination of several groups of anthropogenic factors, having a bad effect on rivers nourishment with the set-in intercentury warm-dry climatic phase, enhances the degradation of virtually all the types of the present day forest-steppe wetlands.
2. Economic disinterestedness of small economic agents in performing moisture preservation activi-

ties, including grassland crop rotation, causes further decrease of wetlands ecological capacity, reduction of its biological diversity, primarily, fish fauna and avifauna.

3. The deterioration of the hydrological regime of the Russian Central Forest-Steppe main streams is caused primarily by antropogenic factors. This leads to the total wetlands and their constituents degradation, which, coinciding with the climatic aspects, causes the so-called effect of "ecological resonance".

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