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## Drainage Degradation Influenced by Anthropogenic Load in Different Landscapes of the Forest-Steppe Zone (in terms of the Region of Belgorod).

MA Petina\*, AN Petin, YG Chendev, MG Lebedeva, and VG Belevantsev.

Belgorod State University, 85, Pobedy Str., Belgorod, 308015, Russia.

### ABSTRACT

Historical-cartographic analysis using geoinformational technologies showed that the degradation of river network in the Pena basin (the Dnieper basin) at the end of XIX century was 27%, and at the end of XX century - 29% as compared to the end of XVIII century. In the Chernaya Kalitva basin (the Don basin) these values were 67% and 75%, respectively. Maximum indicators of the degradation of the Chernaya Kalitva basin can be traced for the period of the years 1780-1880. In both considered basins most were exposed to the degradation of the rivers of 3-5 orders as a result of magnitude information to the middle of the XIX century in the significant part of ravine forests in their areas of source and practically complete farming development of natural steppes in the eastern territory.

**Keywords:** historical and cartographic method, geoinformational technologies, river basin, river network, degradation of the rivers, anthropogenic effect.

*\*Corresponding author*

## INTRODUCTION

One of the regions exposed to active agricultural development and intense anthropogenic changes of natural environment is the southern part of the Central Russian Upland. Defining quantitative and qualitative indicators of natural components in the initial and subsequent stages of economic development of the territories makes it possible to estimate the degree of man-induced burden and the ways of minimizing negative effect on the components of natural environment.

Environmental condition and its anthropogenic transformation in the south of Central Russian Upland have been explored by many scientists [1-5 and others]. But the works in which the problems of degradations of the river network of the Belgorod region are highlighted are considerably fewer [6,7].

### The Objective of This Research

Is the reconstruction of the river network of the region of Belgorod and historical and cartographic analysis of its changes with regard to two river basins: in the western part of the region – the Pena River (the basin of the Dnieper) and in the eastern part – the Chernaya Kalitva (the Don basin).

## MATERIALS AND METHODS OF RESEARCH

Written sources used for reconstruction of environmental condition and its anthropogenic changes for the period of late 200 years are not sufficient and scattered. The most complete information about time changes of different components of geosystems is possible to be obtained by means of studying the maps of the periods of General (the end of XVIII century) and Special land surveying (the middle – end of XIX century), and also the other cartographic sources of the Russian Empire in the context of their comparative analysis by means of the present maps.

In this research, for the most part, historical and cartographic method, practical importance and efficiency of its use highlighted by a number of authors [8, 9, 5, 10-16] and geographic information technologies [17, 18] have been applied here.

The key materials of the investigation are the maps of General land surveying of different periods [4, 19-25].

By means of the geoinformational system the maps have been processed including their numeralization, setting of the examined components and calculations of their quantitative indicators on the maps. The «BelSIS» [26] software was used by processing the materials. As a result, it has been determined the river network characteristics in the Pena and Chernaya Kalitva basins stated at the end of XVIII, at the end of XIX and at the end of XX centuries.

## THE RESULTS OF THE RESEARCH

The analysis of the river network state in different historical periods allows to view substantial distinctions in the speed of river degradation of the Belgorod region in its different parts, for example, the analysis of the basins of two rivers – the Pena and the Chernaya Kalitva that are of approximately equal area and length (fig. 1).

In the region of Belgorod the areas of the river basins to be analyzed are: the area of the Pena – 1066 km<sup>2</sup>, the area of the Chernaya Kalitva – 1276 km<sup>2</sup>. The river network of the Pena basin had exceeded the Chernaya Kalitva 9% in length by the initial period of analysis (the end of XVIII century).

By the end of XVIII century the length and density of the rivers in the Pena basin had amounted to 345 km and 0.32 km/km<sup>2</sup>, respectively. By the end of XIX century those data had amounted to 253 km and 0.24 km/km<sup>2</sup>, and by the end XX century - 244 km и 0.23 km/km<sup>2</sup>, respectively. Shrinkage of length and density of the rivers in the Pena basins was 27% in the period from the end of XVIII century to the end of XIX century, and by the end of XX century measures of the river network degradation had accounted for 29% compared to the end XVIII century. The maximum reduction of above-mentioned measures took place within the period

of the end of XVIII and the end of XIX centuries.

In the Chernaya Kalitva basin the length and density of the rivers had amounted to 315 km and 0.25 km/km<sup>2</sup> by the end of XVIII century, respectively. By the end of XIX century those measures had been equal to 104 km and 0.08 km / km<sup>2</sup>., and by the end of XX century - 79 km and 0.06 km / km<sup>2</sup>, respectively. If in the period of the end of XVIII century up to the end of century decreased length and density of the river network was 77%, then by the end of XX century the gradation measures accrued to only 75% as compared to the level of the end of XVIII century, that is, the degradation of the rivers in the considered basin in XIX-XX centuries had reduced the length and density of the river network to 4 times in comparison with the measures of the end XVIII century (table 1).

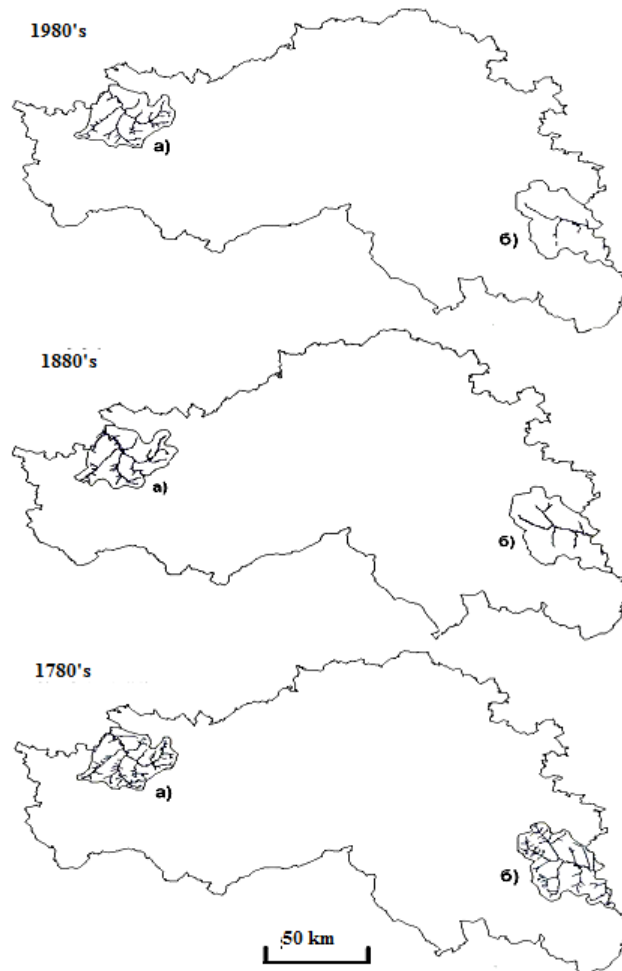


Figure 1: The river network of the basins: a) Pena and b) Chernaya Kalitva of the Belgorod region in the 1780s, 1880s and 1980s.

Table 1: The indicators of the river network change in the Pena and Chernaya Kalitva (the region of Belgorod) for 200 years.

Historical period	The Pena basin. The area of 1066 km <sup>2</sup>		The Chernaya Kalitva. The area of 1276 km <sup>2</sup>	
	The length of river network in km	The density of river network in km per km <sup>2</sup>	The length of river network in km	The density of river network in km per km <sup>2</sup>
The 1780s	345	0.32	315	0.25
The 1880s	253	0.24	104	0.08
The 1980s	244	0.23	79	0.06

The calculation data of the river lengths of different orders for three historical periods are illustrated in table 2.

**Table 2: Changes of the river network characteristics since 1780 to 1980**

Characteristics	the 1780s					the 1880s					the 1980s				
	Sequence number of the rivers					Sequence number of the rivers					Sequence number of the rivers				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
the Pena (the Dnieper basin)															
Number of the rivers	1	19	40	9	-	1	10	18	4	-	1	11	18	5	-
Length, km	58	165	106	16	-	58	136	51	8	-	58	127	50	9	-
the Chernaya Kalitva (the Don basin)															
Number of the rivers	1	19	20	14	3	1	6	1	1	-	1	4	1	-	-
Length, km	52	167	66	25	5	50	44	8	2	-	43	34	2	-	-

With equal degree of land territory in the east, as compared to the west of the region, the indicators of the network degradation are significantly greater. The Chernaya Kalitva basin ( at the border of forest-steppe and steppe native zones ), as compared to the Pena basin (in forest-steppe zone, nearer forest zone), in the period from the end of XVIII century to the end of XIX century is less in the length of the rivers, with the river network degradation at 27% and 67% . These tendencies have been preserved with the respective indicators of 29% and 75% up to the present time.

**THE DISCUSSION OF THE RESULTS**

The comparative basin analysis of the river network degradation degree (figure 1, table 2) has shown the most considerable channel length degradation in the Chernaya Kalitva basin. The rivers of the 2 order, especially the upper course and middle course of the rivers, exposed to maximum degradation. Here the rivers of 5 order have completely degraded and the rivers of 3 and 4 orders have practically exposed to complete disappearing.

Substantial degradation of water generating (3-5 orders) rivers comes to the middle of XIX century in considerable part of small forests in source steppe ravines and ploughing parts of native steppes [9, 27, 28].

**CONCLUSION**

The conducted historical and cartographic analysis made it possible to reveal that in the period of from the end of XVIII century to the end of the XX century the Chernaya Kalitva basin decreased length and density of the rivers more than four times (75%), while in the Pena basin (forest-steppe) this reduction was 29%. The reason for this degradation relate to a weak resistance of natural environment to the process of intensive use in the past centuries in the eastern, more arid zone, parts of the region of Belgorod. Forestlands are the lands accumulating moisture for long periods (the Pena basin), as compared to steppe vegetation (the Chernaya Kalitva basin).

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