Anthropogenic transformation of the valleys of small rivers of the Chuvash Republic

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Abstract. The object of the study is the valleys of small rivers of the Chuvash Republic. The type of economic use, the degree of anthropogenic contamination, modern slope processes are analyzed. The need for research is justified by the deterioration of the ecological state of the landscapes of river valleys, water quality in the watercourses of the Chuvash Republic. In order to collect factual material on the current state of the landscapes of river valleys, expeditions were conducted to the rivers Tsivil, Kubnya, Kirya. Lyulya. The choice of the selected key objects is explained by the fact that they are typical for the physical and geographical regions of the region: the Kubnya River - the Southeastern and Zasursky districts; the Lyulya and Kirya rivers - the Prisursky and Zavolzhsky districts; the Tsivil River – the Volga and Central districts. The data obtained were interpreted for the entire territory of the Chuvash Republic. The analysis of the collected material made it possible to conduct zoning of the region according to the ecological state of river valleys. Four districts were identified: Volga, Central, Forest, Steppe. These areas differ in the degree and types of economic development. The valleys of the Volga region are industrial and agricultural territories, intensively developed. The valleys of the Central District are experiencing an average anthropogenic load from industrial enterprises and irrational agriculture. The valleys of the Forest zone are distinguished by the preservation of natural landscapes and the absence of negative slope processes. The river valleys of the Steppe region are experiencing critical indicators of agricultural development: plowing up to 90% of agricultural land, the absence of natural steppe landscapes. Individual recommendations were developed for each district to improve the ecological state of river valley landscapes and prevent the development of negative processes and emergencies.

1 Introduction

The river network with adjacent territories plays an important role in human economic activity. In fact, the entire land is divided into basins and river valleys. The valleys of large and small rivers perform a number of natural (environment-forming, ecological, sanitary-hygienic) and economic (material-forming, energy-forming) functions that are fundamental for human life. Water resources are the most important factor in the allocation of production forces and socio-economic development of society. At the same time, watercourses are an

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element of productive forces, representing an object of influence in the process of economic activity. Active diverse development of river valleys leads to deterioration of their condition, destruction of indigenous geosystems. The valleys of small rivers are the most vulnerable in this regard. Therefore, in recent years, there has been a significant increase in interest in the detailed study of the ecological state of small rivers in the regions.

The valleys of the rivers of the Chuvash Republic are distinguished by a high degree of economic development. A characteristic feature is a dense network of rural settlements confined to river valleys. The share of settlements from the total area of the valleys can reach up to 20%. Most of the share of rivers is actively used for pasture animal husbandry. In the valleys of the Volga, Sura, Civil, Bula rivers there are plots of arable land. Intensive use of the river valleys of the Chuvash Republic has led to a profound transformation of landscapes, a decrease in the species diversity of flora and fauna, and the degradation of unique geosystems. In order to optimize the ecological state, detailed systematic observations in river valleys, the development of a complex of environmental and land management measures are necessary.

2 Materials and methods

In the course of the research, traditional (expeditionary, descriptive, cartographic, comparative geographical) and modern (modeling, remote (aerospace), geographical monitoring, GIS technologies) were used. The work was carried out in two stages: 1) field study of the state of the valleys of small rivers; 2) analysis of the data obtained and their interpretation for the entire territory of the Chuvash Republic. During the expedition observations, water quality, exodynamic processes in river valleys, the degree of disturbance of landscapes and the type of economic development of the territory were described. The desk stage involved interpolation of the data obtained for the valleys of small rivers in the region as a whole. Zoning was carried out on the basis of traditional [7] and modern methods [8, 11]. The state of river valleys was assessed by several parameters: the ecological state of geosystems [10], the magnitude of anthropogenic load [6], the density of industrial facilities and infrastructure [5] As the initial cartographic material, topographic maps and satellite images available in the public domain were used [1]. To process satellite images, the SAS.Planet viewer was used, which allows analyzing high-resolution images from the services of Yandex.Maps/eAtlas/GoogleMaps/Satellite Images/YahooMaps/Virtual Earth. Thematic maps were created using the geographical information system "Axiom".

The object of the study was the river valleys of the Chuvash Republic. According to the scheme of physical and geographical zoning of Russia, the territory of Chuvashia is included in two provinces: the southern taiga of the low-lying Trans-Volga region (the Trans-Volga region of Chuvashia) and the forest-steppe province of the Volga upland with deciduous and coniferous forests, forest-steppe and steppe. These provinces, in turn, are part of the area of erosive uplands and plains of the physical and geographical country - the Russian Plain. There are 6 physical and geographical regions on the territory of Chuvashia: Zavolzhsky, Privolzhsky, Central, Zasursky, Prisursky, South-Eastern.

The Volga region of Chuvashia is part of the natural zone of the taiga, the southern border of which runs along the Volga. The relief of the Volga region is a low-lying plain. The absolute heights here do not exceed 150 m . The valleys of the rivers flowing through the Volga region have a developed appearance. Coniferous forests on podzolic soils are widespread in the Volga region.

The Privolzhsky district is distinguished by a high-plain relief. There are flat or hollow-wavy watersheds, deeply divided by an erosion network. Slope processes are ubiquitous. Almost the entire territory of the subdistrict is occupied by agricultural land, with the exception of islands of oak forests.

The central physical and geographical area extends from the banks of the Sura to the Big Civil, to the east it occupies the space between the Big and Small Civil and the right bank of the Small Civil to the eastern border of the republic. The relief is characterized by the alternation of low plain watersheds and asymmetric river plains. The soils are gray forest. The area is characterized by high development and almost ubiquitous distribution of agricultural land on the site of reduced forests. Only patches of oak forests have been preserved.

The southeastern region is characterized by shallow erosion fragmentation and the development of wide watersheds. The river valleys are wide, the root banks are flat. The density of the river network is less than 0.1 km/km2. A characteristic feature of the district is that agricultural land is ubiquitous on the site of meadow steppes.

The Prisursky district is represented by a hilly plain descending to the Sura valley. The depth of the erosion incision is 25-60 m, and in the southeast - up to 100 m. The Sura Valley is asymmetrical and has four above-floodplain terraces of Quaternary age. Dune relief is widely developed on the watersheds. Under the coniferous massifs, which cover almost the entire territory of the district, the soils are podzolic and sod-podzolic.

The Zasursky district is represented by an elevated plain, slightly inclined to the east. Watersheds are higher from the erosion base by 140-150 m . The forests have been reduced almost completely, and the territory is occupied by agricultural land. Soils are leached and fatty chernozems [4].

The Kubnya, Tsivil, Kirya, and Lyulya rivers were selected as key sites for a detailed field survey (fig. 1).

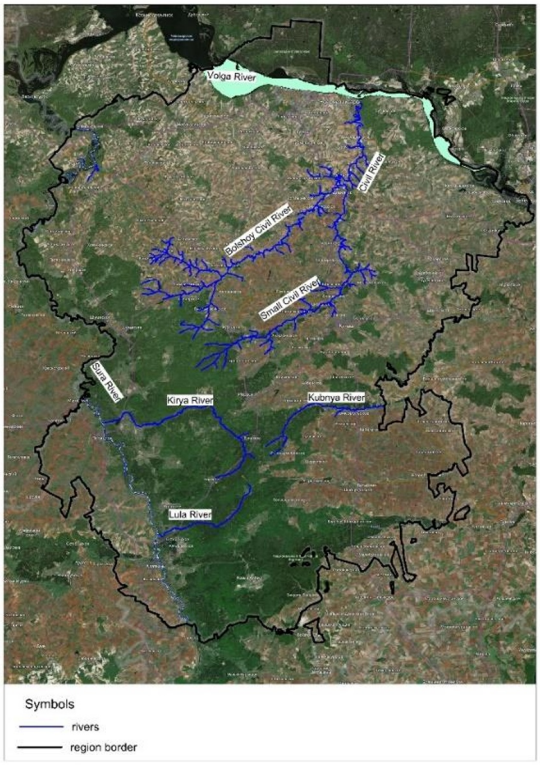

Fig. 1. Key sites on the territory of the Chuvash Republic

The choice of rivers was due to the fact that they are confined to different physical and geographical areas, with different intensity of development [2]. This allows you to interpolate

the received field data for the entire territory of the region. According to the landscape and ecological features and the nature of the economic use of the territory, the selected key sites are the most typical for the following areas: 1) the Kubnya River is confined to the settled zone and is typical of the Southeastern and Zasursky physical and geographical areas; 2) the Lyulya and Kirya rivers flow through coniferous plantations on sandy soils and are typical of the Prisursky and Zavolzhsky districts; 3) the Civil River flows through two physical and geographical areas - Volga and Central.

3 Results and discussion

3.1 Description of the Civil River

The Tsivil is a river in the Chuvash Republic, a right tributary of the Volga. Originates in the Sumerlinsky district. It flows through the Vurnarsky, Krasnoarmeysky and Tsivilsky districts. Near the town of Tsivilsk, it merges with the Maly Tsivil River. Then, as a Civil, it flows along the border of Cheboksary and Marposadsky districts and flows into the Volga. The total length of the river is 172 km, the basin area is 4690 sq. km, the average annual flow volume is 0.92 cubic km. The absolute mark of the source is 130,4 m, the absolute mark of the mouth is 53 m. The Civil River is typical for the northern part of the region, providing intensively developed areas with mosaic landscapes. The river is conditionally divided into two parts: from the source to the city of Tsivilsk – these are the rivers Bolshoy and Maly Tsivil, downstream – the river is called Tsivil. The first part of the valley belongs to the Central physical and geographical region, the lower part belongs to the Volga region. The basin of the Civil River is a tree-dendric type, has the greatest development in the middle part. There is an active pollution of the water of the river Tsivil (B. Tsivil, M. Civil) animal husbandry waste, as evidenced in particular by very low transparency indicators, high water temperature in the hot period. At the same time, this high uniform anthropogenic load by itself does not lead to the degradation of existing ecosystems, which is confirmed by the study of plankton, bottom hydrobionts, ichthyofauna, high oxygen content in water, that there is and sometimes there is a risk of a crisis anthropogenic impact on the ecosystem of the Civil River. Examples of such crises are salvo discharges of the contents of manure storage facilities, enterprises processing agricultural products, industrial effluents of such settlements as the village of Vurnary, the city of Tsivilsk, especially the city of Novocheboksarsk (Khimprom, CHP-3), etc.

The anthropogenic load on the Civil River basin is determined by the level of human economic activity. The general direction of economic activity and economic development of the main branches of the national economy have developed in accordance with the agricultural specialization of the basin territory. The characteristics are given for 4 agricultural areas. The industry is concentrated in 5 cities: Cheboksary, Novocheboksarsk, Kanash, Vurnary, Tsivilsk. It is necessary to emphasize the special load on the estuarine part of the basin. In addition to the city of Novocheboksarsk with a population of about 130 thousand . people, there are large factories of both the 1st and 2nd groups, sewage treatment plants of the cities of Cheboksary and Novocheboksarsk, the landfill of industrial waste of JSC "Khimprom". The territory of the river basin is characterized by a strong development of planar and linear erosion. In the soil cover, gray forest soils are mainly common, clay and heavy loamy in mechanical composition, only sandy and sandy loam soils in the upper reaches of the river

Thus, a rather tense, but still relatively stable environmental situation in the normal mode of functioning of the economic sphere is often interspersed with crises. The consequences of

such emergencies, when their frequency is low, although with losses for natural resources, are still smoothed out due to self-restoration of the ecosystem.

The sanitary and technical condition of the Civil river was assessed as unsatisfactory and not corresponding to all types of water use (fishing reservoirs and for cultural and domestic use).

3.2 Description of the Kubnya River

The Kubnya River is a left tributary of the Sviyaga River, located in the following eastern regions of the republic: Urmarsky, Yantikovsky, Kanashsky, Ibresinsky, Komsomolsk, Yalchik. The length of the entire river is 193.5 km (55 km of them in the Chuvash Republic). Originates in the forest, southwest of the village of Lipovka, Ibresinsky district. The catchment area is 2480 sq. km. The absolute mark of the source is 200.0 m, the absolute mark of the mouth is 53 m. The basin belongs to a weakly woody-subdendric river system. Denudation-accumulative processes play the main role in the formation of the basin relief. The relief is characterized by flatness and softness of forms. The northern part of the basin somewhat retains the features of the ravine plateau, gradually acquiring a wide-wave character to the south. The slopes of the valleys are asymmetrical.

There is contamination of the water of the Kubnya river by animal husbandry waste, very low transparency indicators, high water temperature in the hot period. At the same time, a high uniform anthropogenic load by itself, as in the case of the Civil River, does not lead to degradation of existing ecosystems, which is confirmed by the study of plankton, bottom hydrobionts, ichthyofauna, high oxygen content in water. At the same time, serious manifestations of salvo crisis pollution of the aquatic environment are observed, accompanied by the death of benthos along a significant stretch of the Kubnya River (a strict connection with the most likely sources of salvo pollution, such as the Ibresinsky treacle plant, PC Cooperator, some farms of the Komsomolsk district with large volumes of accumulated manure could be established only as a result of more systematic inspection control and/or automatic monitoring of the state of the environment). Moreover, more mobile plankton communities had recovered by the time of the expedition and showed "moderate pollution" of the waters, while less mobile benthic organisms did not have time to recover. Siltation of rivers is also facilitated by the removal of suspended material in the spring along the ravine slopes into the riverbed, washing away the surface layer of soil with the appropriate steepness of the slopes and sufficient fragmentation of the territory and incorrect (along the slope) plowing of land [9]. Therefore, plowing should be carried out across the slopes, taking into account the direction of the horizontals.

There is a moderately tense, but still relatively stable environmental situation in the normal mode of functioning of the economic sphere, often interspersed with crisis phenomena. The consequences of such emergencies, when their frequency is low, although with losses for natural resources, are still smoothed out due to self-restoration of the ecosystem.

3.3 Description of the Lula River

The Lula River and its tributaries belong to the Sura River basin. The Lula River is 47.9 km long . The basin area is 367.1 sq. km. The absolute mark of the source is 226.0 m, the absolute mark of the mouth is 78.6 m. The average fall of the river is 2.3 m/km. The main part of the river valley is occupied by woodlands and floodplain meadows of the Prisursky forest area. A small proportion of the catchment area is located on agricultural land (upper reaches and estuarine areas). Roads and railways crossing the river valley can be distinguished from man-made objects. In the valley of the Lyulya River in the village of Youth in 1972 a drainage

system was built, which is currently not working. Of the negative processes, it is possible to distinguish the erosion and destruction of the banks in small areas. Seasonal monitoring of the state of landscapes is recommended.

3.4 Description of the Kirya River

The length of the Kiri is 91.2 km, the catchment area is 820 sq. km. The absolute mark of the source is 191.0 m, the absolute mark of the mouth is 78.6 m. The average width at the confluence of the Large and Small Kirki reaches 4-5 m, at the confluence with the Sura – 20-25 m. The Kiri riverbed is very winding. During the spring flood, the river changes its course, forming small lakes-staritsa. The upper and middle parts of the Kirya River valley are confined to coniferous plantations of the Prisursky forest on sandy soils. In the estuary part (about 10 km) – these are floodplain meadows. The analysis showed that the river valley has a low level of anthropogenic impact. In terms of water quality, the watercourse belongs to Class 2 (clean waters). From the negative consequences of economic development of the territory, it is possible to distinguish the presence of an insignificant amount of household waste in the lower reaches.

The Lyulya and Kirya rivers are typical for poorly developed territories of the Amur forest area and the Volga region. Economic activity in these areas is not developed due to the predominance of sandy soils. This has led to the preservation of typical natural landscapes.

The description of the ecological state of the valleys of the rivers of the Chuvash Republic by key areas made it possible to classify the territory of the region by type of economic development (fig. 2).

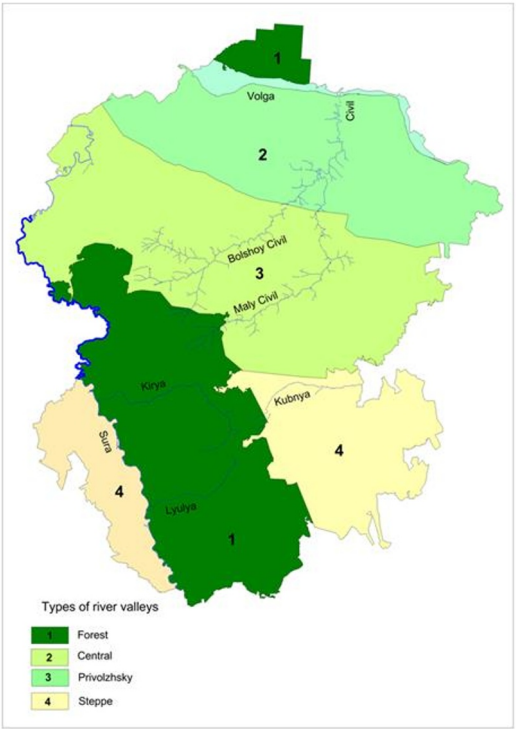

Fig. 2. Types of river valleys of the Chuvash Republic

4 types of river valley development were identified:

1) Privolzhsky district. Industrial and agricultural intensively developed river valleys of the northern part of the region. Watercourses of this type are polluted (both by suspended particles and chemically active substances). River valleys are characterized by a high degree of development and economic development. The share of rural and urban settlements in river valleys reaches 50% of the total area. There is a dense network of linear industrial facilities: highways, power lines, pipelines. The presence of industrial enterprises in the river valleys (in the cities of Cheboksary, Novocheboksarsk, Tsivilsk, Yadrin, Mariinsky Posad, Kozlovka) leads to emergency discharges and pollution of watercourses with phenols, heavy metals, etc. This type of river valleys is characterized by large height differences and actively developing slope processes. This is facilitated by intensively developed agriculture, plowing of sloping areas, terraces of rivers. It is for this type of valleys that the plowing of vulnerable and unique terraced landscapes and high floodplains is characteristic: the rivers Civil, Sura, Anish, Volga.

To optimize the condition of river valleys, it is necessary to implement the following measures:

– improvement of water quality due to better control over regular and emergency discharges into river valleys of industrial facilities;

– thickening of a network of stations for monitoring water quality in urban settlements in river valleys;

– reduction of the intensity of erosion flushing and slope processes due to the organization of surface runoff and planting of forest belts;

– creation of protective forest belts and buffer zones between industrial facilities and natural landscapes;

2) Central district. Agro-industrial intensively developed valleys of the center of the region. Water bodies of this group are distinguished by average pollution. These territories are distinguished by a dense network of rural settlements and a high proportion of agricultural land. The vast majority of river valleys are used as pastures. The share of settlements from the total area of the valleys is up to 20%. The landscape and ecological state of river valleys is influenced by factors: overgrazing, runoff of livestock complexes, intensive erosion washout, siltation of riverbeds. Intensive economic development has led to the activation of the processes of destruction of the banks, slope processes. This began to threaten economic facilities, lead to a reduction in agricultural land. In order to improve the condition of geosystems, the following measures are necessary:

– reducing the amount of contamination by livestock products and mineral fertilizers;

– reduction of the area of pastures and their partial transfer to reforestation;

– shore protection measures;

– opening of additional hydrometric posts on small rivers;

– construction of sewage treatment plants, manure storage facilities and liquid collectors.

3) Steppe region. The third group includes the river valleys of the southeastern and southwestern parts of the region, agricultural intensively developed. These are territories experiencing critical indicators of agricultural development: plowing up to 90% of agricultural land, the absence of natural steppe and forest landscapes. Due to the increasing water consumption, it is necessary to regulate surface runoff by building ponds, especially on those tributaries where there is already a shortage of water when it is taken from the live stream of rivers. It is necessary to carry out measures to clean up rivers polluted by industrial, household and agricultural effluents (mechanical, biological purification, filtration fields). An important problem is the cleaning, disinfection and disposal of wastewater. Preventive measures should be taken to prevent the ingress of harmful substances into rivers and contribute to the preservation of the purity of reservoirs.

4) Forest area. The fourth group includes the valleys of rivers flowing in the forested areas of the Amur region and the Volga region. These rivers are clean in terms of water quality.

The economic development of the valleys is observed in insignificant areas and is permissible. In order to preserve the existing ecological state, it is necessary to conduct seasonal monitoring of water bodies. It is recommended that these areas be assigned a special environmental status [3].

4 Conclusion

In the course of the study, the valleys of small rivers of the Chuvash Republic were described according to the following indicators: the type of economic development of the territory, the degree of anthropogenic load, the ecological state of landscapes, negative natural and anthropogenic phenomena. The most typical river valleys located in different physical and geographical regions of the region were selected as key sites. These are the rivers Civil, Kubnya, Kirya, Lyulya. Interpolation of the data made it possible to divide the territory of the Chuvash Republic into four districts according to the peculiarities of development and economic use of river valleys: Volga, Central, Forest and Steppe. A system of measures to improve the ecological situation was developed for them: coastal protection measures, thickening of a network of stations for monitoring ecosystems, creation of forest belts, cleaning of household waste, construction of reservoirs, organization of runoff, etc.

5 Acknowledgments

The study was carried out within the framework of an internal grant of scientific schools of the Chuvash State University No. 16-22 "Resistance of the rivers of the Chuvash Republic to anthropogenic load".

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