Functional role of rivers in the ecological structure of the region (the case of the Chuvash Republic)

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Abstract. The article discusses the role of valleys of small rivers in the formation of the ecological structure of the territory. We studied the functional features of small rivers as part of the ecological structure of the region and analysed their ecological status and their ecological role. In this article we identified and described the valleys of the rivers serving as green corridors. In conclusion, we propose strategies to optimize their ecological status.

1. Introduction
Human economic activities, currently affecting large areas, have led to a landscape fragmentation into natural, natural-anthropogenic and anthropogenic patches. High patchiness of landscapes hinders the process of preserving and restoring biodiversity, information, matter and energy exchange. This problem is most acute in highly developed regions. Chuvash Republic, with its anthropogenic landscape transformation, is a good example of such highly developed regions. Such regions feature agricultural landscapes, forestry and water management landscapes, urban and other residential, recreational, industrial, transport and nature conservation landscapes. Among anthropogenic landscapes, the largest area is occupied by agricultural landscapes, further subdivided into field, garden, horticultural and meadow and pasture landscapes. The smallest area is occupied by residential, transport and industrial types of landscapes, but it is this area that features radical transformation of all components of the natural environment, and this area is characterized by the most fragile geoeconomic condition in the Republic. Geographical landscapes of Chuvashia increasingly suffer from human-induced impact. This problem is supposed to be solved by developing ecological structure (connectivity) of the territory (first, at the level of individual administrative regions, and later on within much larger territories) [1].

The ecological structure of the territory is a system of preserved natural landscapes, connected by natural corridors for the exchange of matter, energy and information [2]. The basic lands of the ecological structure in the Chuvash Republic are the Prisursky and Zavolzhsky woodlands, which are considered specially protected natural territories. However, intensive economic development has led to the formation of patched natural-territorial habitats and loss of connectivity between the preserved natural geosystems. Therefore, the most pressing issue today is the ability to design effective green corridors so the ecological structure could function properly [3-4].

There are 2,356 small rivers in the Chuvash Republic. This hydrological system permeates the entire region and all significant landscapes [5]. That is why the valleys of small rivers are the main
territorial units for creating ecological corridors. The positive aspects of this choice are: significant linear extensiveness, preservation of tree plantations in river valleys, low plough-disturbance of the territories under consideration - leading to preservation of the original soil cover and associated plants [6].

The purpose of the study is to identify the role of the river valleys in the Chuvash Republic in the ecological structure of the territory. To achieve this goal, we formulated the following tasks: to identify and characterize the current state of the river valleys of the studied region, to identify and justify the role of individual rivers in the ecological structure of the Chuvash Republic. To do this, we used the following methods: cartographic, geoinformational and analytical methods, expert assessments and others. Actual information was collected by interpreting aerial photographs and analysing library materials.

2. Materials and methods
Many scientists [7-10] were engaged in studying the role of various natural-territorial habitats in the functioning of the ecological structure of the territory. Most scientists argue that the choice of optimal territorial units should be preceded by a comprehensive assessment of the ecological status of geosystems. The present state of the valleys of small rivers was estimated using the combined methodology of B. Kochurov and P. Didenko. The applied method analyses the state of landscapes by the ratio of individual lands to the total area of the territory. In conducting this study, the ratios of the following lands were used: arable land, pastures, residential area and forests. The total ratio of the lands under consideration to the total area of the analysed geosystems, their ratio to the recommended and critical indicators allowed to categorize them according to their ecological status. In total, 4 categories were identified according to the indicators of human impact:
- low impact – from 0,0 up to 1,35;
- satisfactory - from 1.35 up to 2.7;
- unsatisfactory - from 2.7 up to 4.0;
- critical - above 4.0.

3. Results and discussion
The results of the study showed that most landscapes of the river valleys of the region are in a poor state. This is due to their widespread use as pasture and grasslands or due to the fact that most settlements are located in the valleys of small rivers (33% of the total area of settlements). The low stability of the river valley geocenoses aggravates the situation. The above-mentioned factors have led to a high human impact on this type of terrain: 18 out of 21 administrative districts of the Chuvash Republic have critical indices of landscape state of river valleys; Alatyrsky, Ibresinsky and Shemurshinsky districts have unsatisfactory indices.

Table 1. Green corridors of the Chuvash Republic [11].

| Name of the corridors | Location | Status     |
|-----------------------|----------|------------|
| Nizhnee Prisurie (1)  | Valley of the Sura river | Satisfactory |
| Kanash-Komsomolsky (2)| Tree belt areas and upland forests | Satisfactory |
| Poretsky Stepnoy (3)  | Valleys of small rivers in the southwest of the region | Unsatisfactory |
| Tsivilsky (4)         | Maly and Bolshoy Tsivil rivers valley | Unsatisfactory |
| Tsentralny (5)        | Upland and slop landscapes | Unsatisfactory |
| Anishsky (6)          | Anish river valley | Critical |
| Alatyrsky (7)         | Upland and slops of Alatyrsky District | Unsatisfactory |
| Unga-Tsivilsky (8)    | Unga and Sredny Tsivil rivers valley | Satisfactory |
| Steppe corridors of the southeast (9)| Carla and Bula rivers valley | Critical |
No valley geosystems with a low human impact index have been identified. Critical indices of the landscape state of the valleys are observed even in those administrative areas where other natural habitats have a satisfactory level of human impact: in Shumerlinsky and Poretsky districts.

The project of the ecological structure of the region includes 7 basic lands and 9 green corridors. 6 out of the 9 green corridors are completely confined to the river valleys (table 1).

![Figure 1. Green corridors confined to river valleys.](image)

Legend:
- Ecological frame cores
- Ecological corridors
- Border of the Chuvash Republic

Only 2 out of the shown 6 green corridors along the river valleys are capable of performing the transport function between the basic lands of the ecological structure, because their environmental status is stable. The remaining 4 require remedial measures to improve their ecological status.

4. Conclusions
Due to extensive tilling of upland and the slope type lands, the valleys of the rivers in the Chuvash Republic are extremely important in the overall functioning of the ecological structure of the territory. In total, there are 9 green corridors in the region, 6 of them are confined to river valleys. Only 2 out of the mentioned 6 green corridors along the river valleys, are capable of performing the transport
function between the basic lands of the ecological structure, because their environmental status is stable. The remaining 4 green corridors require remedial measures to improve their ecological status.

Remedial measures should include tree planting, restriction of economic use and rezoning of these lands. Application of the proposed restoration measures will depend on the landscape features of a separate green corridor and the degree of geosystems preservation. Considering river valleys of steppe areas (green corridors (3), (9) (see table 1)) - restoration measures shall include prohibition of cattle grazing, restriction of haymaking and the isolation of certain “ecological rest” areas to preserve the steppe species. Considering river valleys of the forested part of the region (ecological corridors (4), (6)) - restoration measures shall include the creation of phytomelioration forest belts and buffer zones that limit the influence of the residential zone on the geosystems of the green corridors [12].

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