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Basin Approach in Geomorphological Studies of Klyazma River Basin Structure

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Abstract – **This work is devoted to geomorphological studies of the structures of the Klyazma River basin and factors of modern exogenous morphogenesis in the river basin and its morphological parts. The landscapes of the basins of small rivers have been experiencing anthropogenic load for a long time, so the processes of relief formation have their own specifics. To create a geomorphological model of the transformation of landscapes of the Klyazma River river basin with the aim of ecological forecasting and monitoring, the data were obtained on the dynamics of exogenous processes, among which the most common are: karst, hydromorphism, gully and lateral erosion, landslide formation.**

Keywords – component; formatting; style; styling; insert

I. Introduction

The structure of the river basin reflects its physico-geographical, geological, tectonic, geomorphological conditions and processes [1] and is considered with use of morphometric characteristics. R. Horton for the first time has revealed and described regularities of a structure of river basins with the purpose of the analysis of their origin, evolution and history of development using the system of division of water currents into forms [2]. Horton's ideas were developed in the works of A. Strahler, V.P. Filosofova, N.A. Rzhanitsyna, I. N. Harzman, A. Scheidegger, R. Shreeva and in several other works [3].

The morphogenesis of the territories of the European part of Russia is described at the level of physico-geographical regions and administrative entities. Gorky T.I., Moskvitin A.I. and others pointed out the influence of quaternary glacial deposits on the formation of the modern relief [4]. In the IV volume of the Geology of the USSR, a huge amount of factual material on the geology of the center of the European part of the USSR, including the territory under investigation, is summarized [5]. Shchukia I.S. 1973, reflected the general features of the geomorphology of the region [6]. Trifonova T.A. also developed a basin approach for the functioning of small river basins for mountain areas and for lowland rivers [7, 9]. A wide and detailed description of the Klyazma River basin and its tributaries is being conducted at the Department of Biology and Ecology of the VlSU under the direction of Dr. T.A. Trifonova.

II. Methods and materials

With the use of remote, statistical, mathematical methods and GIS technologies, the selection of sites for the imposition of geomorphological profiles was carried out on the basis of analysis of space images of different resolution and analysis of the conjugated data of the studies. The obtained results served as a basis for creating geomorphological mapping models of landscape transformation that form modern relief formation in the existing system of nature use in the Klyazma river basin (Figures 1, 2, 3).

III. Results

The genesis of the relief forms of the Klyazma River basin, the geomorphological foundations of its formation are directly related to geological processes and large tectonic structures. The investigated territory of the Klyazma River basin is located in the center of the European part of the Russian Federation, belongs to the Volga Basin, which is part of the closed Caspian basin. The total catchment area is about 42.5 thousand km2, which is about 17.5% of the area of the Oka river basin and more than 3% of the Volga basin. The Klyazma River, the largest left tributary of the Oka River, originates from the Smolensk-Moscow Upland. The length of the river is 686 km.

The territory of the Klyazma River drainage basin is located within the central part of the Russian plate of the Precambrian platform, which largely determines the geological structure and relief of the basin. The valley of the river is

confined to the oldest cracks in the foundation, covered by thick sedimentary rocks. The territory of the basin was subjected to three glaciations: Oka, Dnieper and Moscow. In the geology of the Klyazma River basin, the marginal zanders of the last two, fluvioglacial and lacustrine-glacial deposits, moraine, which formed the basis for the formation of new forms of relief, are well represented [4]. Modern deposits are represented by alluvial sands, sandy loams, and also marshy sediments of peat and loam. In the places of limestone distribution of Permian and Carboniferous sediments, karst forms of relief (hollows, craters, dips and subsidence) are represented and artesian aquifers are accumulated. Underground waters have outflows to the surface in the form of numerous springs along river valleys and deep ravines. Economic activity of man has a great geological influence on the relief, as a result of which anthropogenic forms are formed: quarries, excavations, embankments, etc.

Modern exogenous geological processes are widely developed within the study area and affect the functioning of small watersheds. According to the results of field research and cartographic analysis, these processes are most intense in the flat basin of the Klyazma, in contrast to extinct tectonic processes. Among these the most developed are erosion and suffosion processes. They are distributed into the following sequence according to the degree of their manifestation: karst, increased hydromorphism, gully and lateral erosion, landslide formation.

Within the eastern part of the basin, all three types of karst are represented: mixed, sulfate, covering the largest areas, carbonate. The main forms of karst occurrence in the study area are funnels, lakes, marshes and wetlands. Strong and very strong area damage of the territory is characterized by the coefficient of karst occurrences. The activity of karst processes was displayed in October 2017 in the Vyaznikovsky district, when the collapse of the arch of the underground cavity under Lake Sakantsy occurred. In the spring of 2018, the funnel of the collapse was filled by silt masses, and by now the lake was filled with thawed snow and rainwater by more than 1/3 of the initial volume. Groundwater and interplastic water do not play a role here in filling the lake basin, because, several dozens of meters from the lake are old gaps unfilled with water, the depth of which is more than 20 meters.

Increased hydromorphism is observed almost everywhere in the Klyazma basin, but it is most developed in the Mescher lowland, the Balakhna and Klyazma-Nerlin lowlands, on the floodplains and terraces of river valleys. Wetlands occupy at least a third of their area. Modern physical and geographical processes on the rivers of these territories continue to smooth the relief, further leveling it and smoothing it. Gully erosion and landslide formation is typical for the elevated sections of the Opole basin, where the small river basins of the Klyazma river tributaries located.

In the formation of the relief of the basins of the small rivers Kamenka, Rpeni, Sodyshki and Lybedi, a significant role belongs to the processes of modern morphogenesis. The rivers flow in well-developed valleys, have a modern floodplain and Upper Quaternary terraces above the floodplain. The processes of relief formation have their own specifics in each basin. The natural landscape is modified, as the territory of the basins is old-developed and the current change in the types of nature use is accompanied by a further transformation of the landscapes. The swimming pool of the Rpen' is located in the natural area of Opole. The Rpen' is the left tributary of the Klyazma (the Volga basin), the length is 44 km, the catchment area is 273 km². The height difference in the basin is more than 60 m. At the same time, the relative heights of the slopes of the hollow-wavy hills and ravines do not exceed 15-25 m. The entire territory is represented by anthropogenic landscapes. It is characterized by intensive suffosion and erosion processes. Gullies and beams are limited in their development, formed by forest belts, as well as intensive overgrowing of post-agrarian territories. The river basin experiences the most diverse complex of anthropogenic impacts, at the same time preserving a diverse range of sustainable ecosystems.

Tributaries of the Rpen' - r. Lybid and r. Sodyshka reflect different vectors of development of the river basin territories. Lybid - a river in the city of Vladimir, also a left tributary of the Klyazma. length - 4,5 km, incl. 2.5 km in the reservoir, catchment area - 7 km². The Lybidi Valley is a man-made urban landscape. The river has flowed in the collector since the last century; its runoff is regulated by ponds. The areas of natural ecosystems in the river basin have declined and changed as a result of mass housing construction by multi-storey apartment houses with accompanying communications and construction of motorways in its valley.

Sodyshka is a river flowing through Sobinsk and Suzdal districts of the Vladimir region and along the western outskirts of the city of Vladimir; its length is 22 km, the catchment area is 82.7 km². The Sodyshka River valley is a highly altered anthropogenic landscape with a reservoir, gardens, arable lands and quarries. The river itself is a reservoir of cultural and household water use.

The river valley of the Kamenka is a historical and cultural agrolandscape. The Kamenka is the right tributary of the Nerl River; its length is 47 km, the pool area is 312 km². The plowing of floodplain meadows has been carried out since the late 60s of the twentieth century. At the present time there is intensive water logging of the river banks, raising the level of groundwater, threatening the preservation of architectural monuments of the city Suzdal.

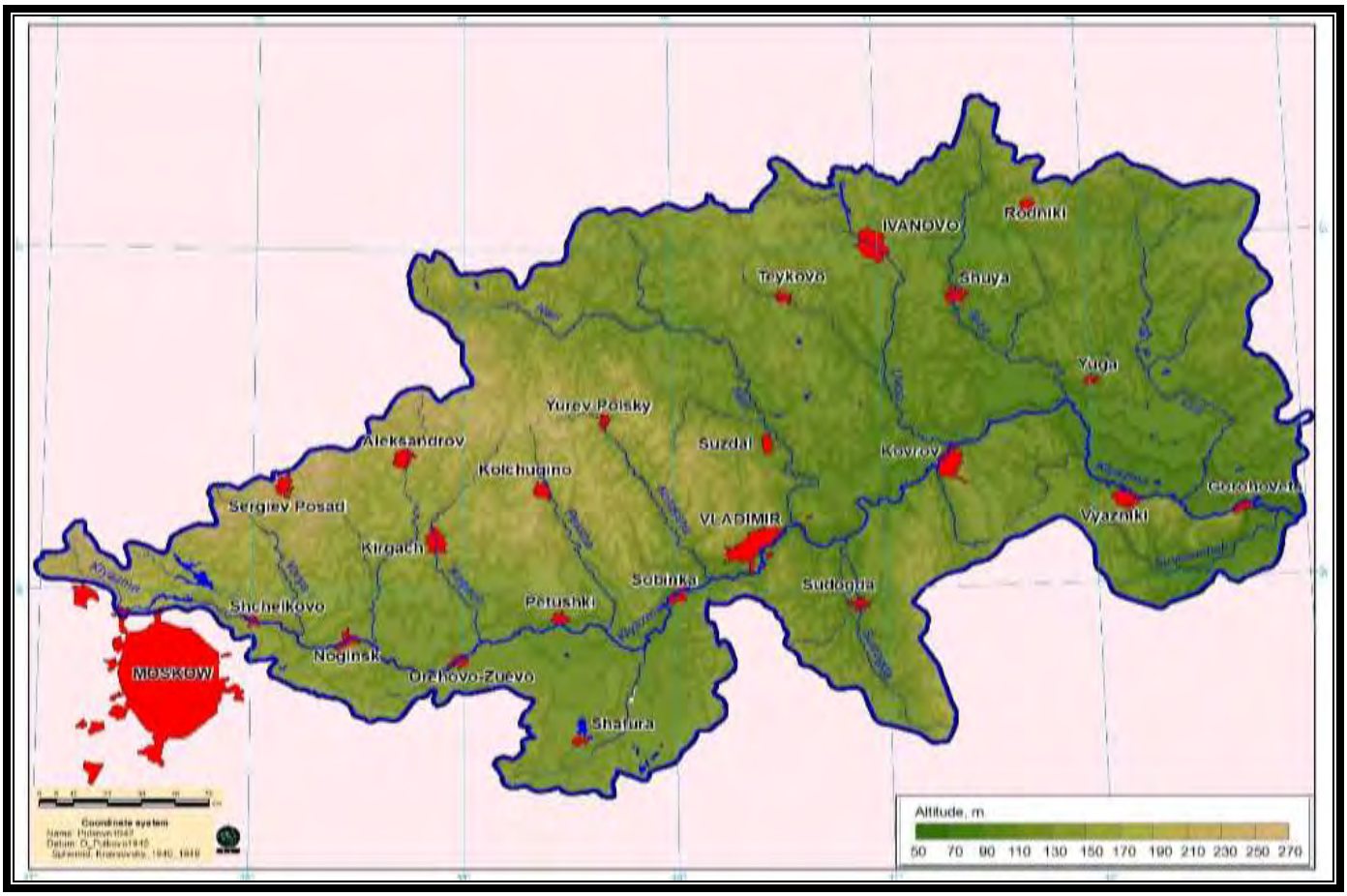

Fig. 1. Physico-geographical map of the basin of the river Klyazma

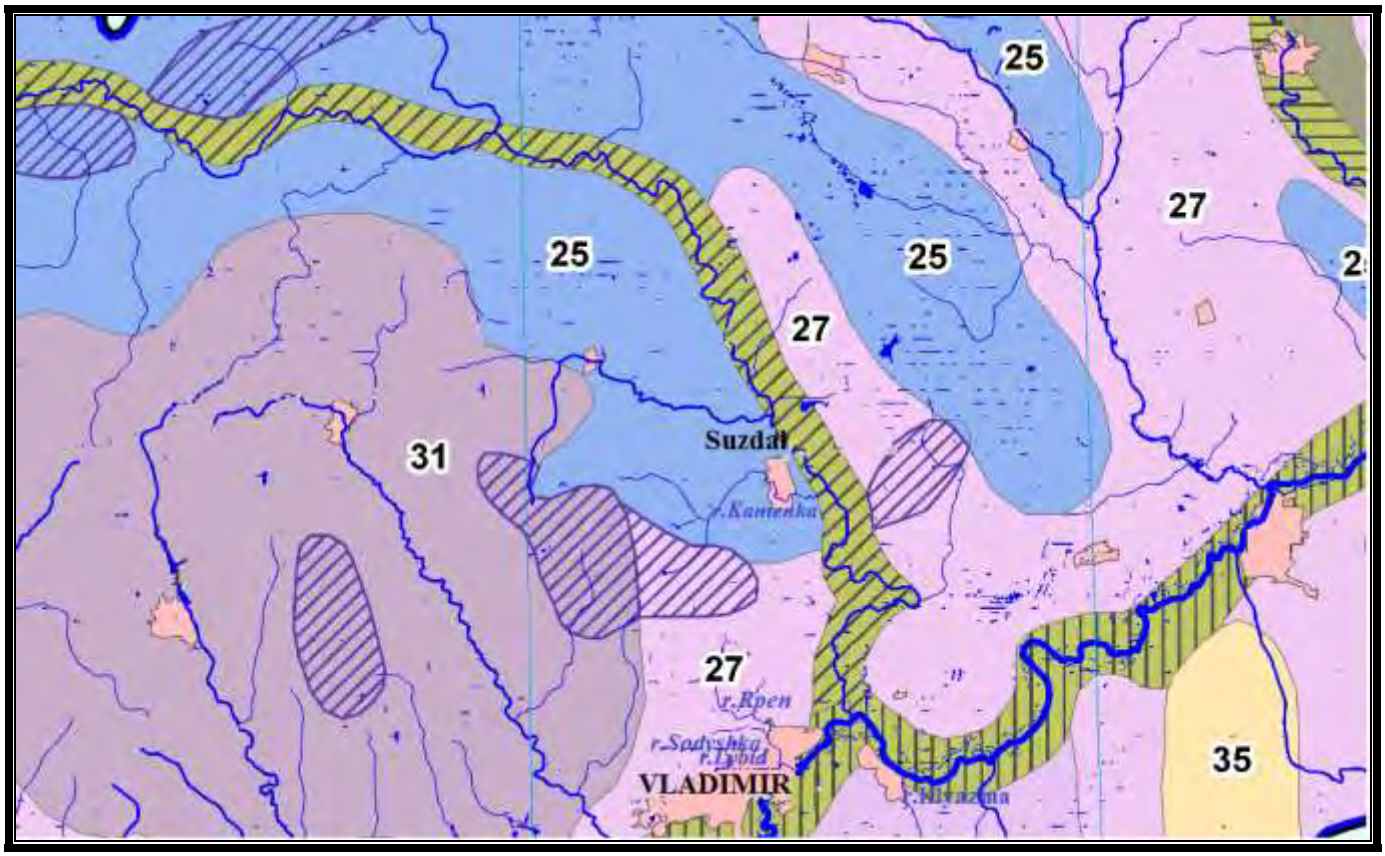

Fig. 2. Fragment of the geomorphological map of the basin of the river Klyazma

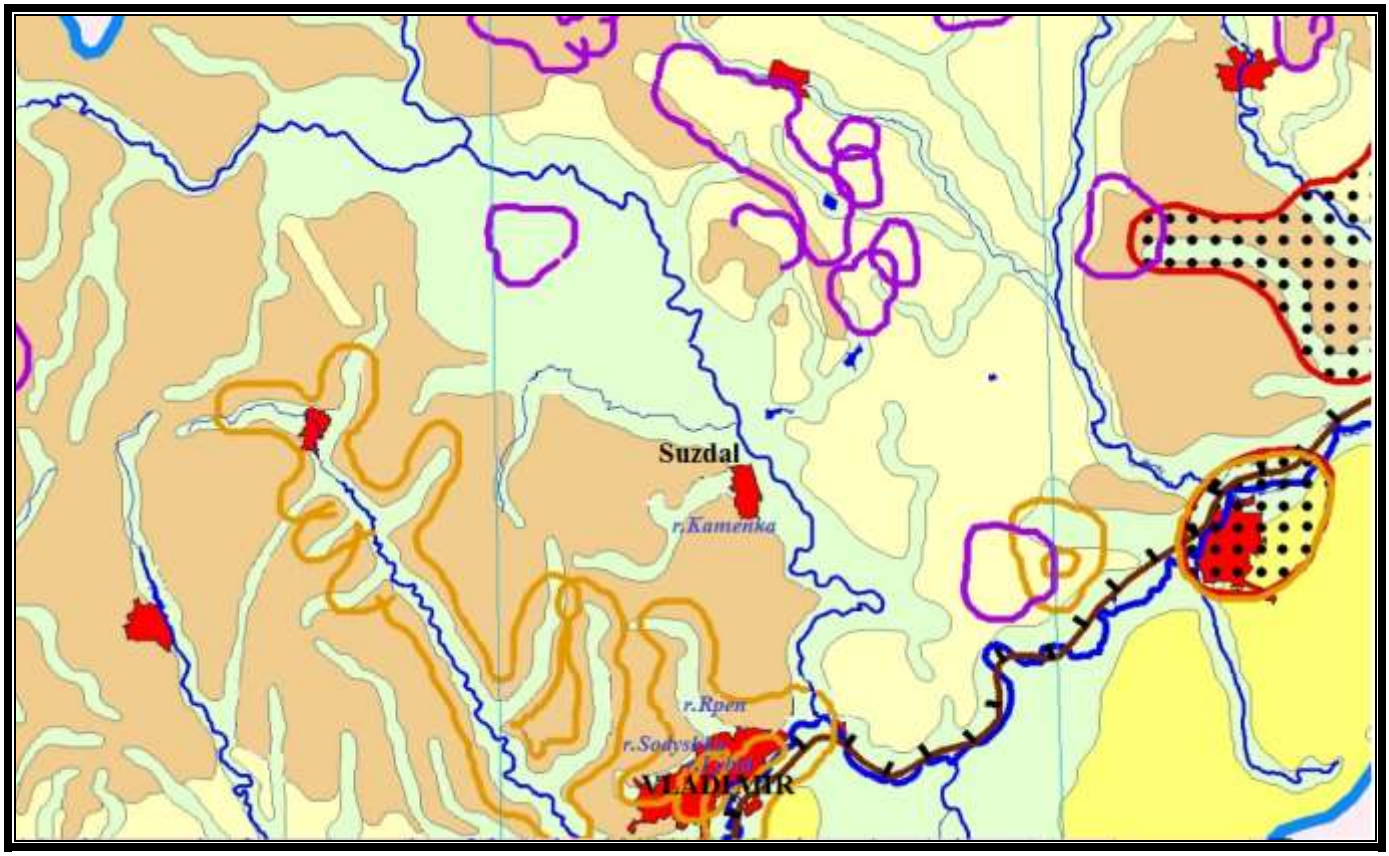

Fig. 3. Fragment of the map of exogenous processes in the basin of the river Klyazma

One of the small problems is the reduction of surface runoff. Surface runoff of the Lybed was reduced 7 times; Sedation - 1,4 times; Wheatears - 1,3 times; Frenzy - 1.15 times according to our calculated data. The reason for such intensive reduction in runoff is the technogenic change in the boundaries of catchments, the construction of sewers and storm sewage, which intercept surface runoff and precipitation. Also, there is a degradation of the channels of the rivers Rpen and Sodyshka with a high degree of pollution of surface runoff. Unlike other polluted rivers, uncontaminated rivers degrade to a lesser extent.

Thus, it can be concluded that small river basins are most prone to intense anthropogenic impact, while the smaller the catchment area, the less stable its ecosystems, especially under the influence of urbanization processes, which change the direction and speed of exogenous processes under tectonic stability conditions. In the basin of the Klyazma River, the most disturbed integral indicators of anthropogenic impact were the basin of the small river Lybid, almost destroyed by urbanization.

IV. Conclusion

All the obtained data on the dynamics of exogenous processes in various natural and natural anthropogenic conditions have been translated into an electronic form and presented as a database for creating a geomorphological model for the transformation of landscapes of the river basin of the Klyazma River for the purpose of ecological forecasting and monitoring. The patented electronic database [8] contains physical and economic-geographical, as well as ecological, information on the structure and functioning of the river basin.

Modern research methods make it possible to study the ecological state of geosystems of small river basins comprehensively with the subsequent allocation of model areas for assessing trends in contemporary morphogenesis of the study area.

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