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## Transformation of Gullies and Ravines Systems under Conditions of Agricultural to Residential Land Transition.

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### ABSTRACT

Urban settlements appeared in places where the conditions were most attractive to human life. One of the main factors in the development of human settlements is relief. However, as a rule, for historical and current reasons, a number of cities formed in the conditions of difficult terrain. The complexity of the terrain is characterized by a number of indicators, which will certainly include the presence of gullies and ravines network. Cities that develop in complex terrain either significantly modify and transform it or adapt to it. The article features the transformation of gullies and ravines systems at their integration into the urban areas. Gullies and ravine systems themselves, being within the plain landscapes the most physiognomic element of natural complexes, largely determine both location of settlements and their subsequent development. The results of comparisons of morphometric analysis of three gullies and ravines systems in relation to the nature of the changes in the boundaries of the city of Naberezhnye Chelny (Russia). Overwhelming relief type of interaction of the city with gullies and ravines systems was detected. This type of interaction is caused not only by reduction of surface runoff, but also by the active involvement of the territories of gullies in architectural and planning system of the city.

**Keywords:** city, relief, gullies and ravines system, interaction, types

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## **INTRODUCTION**

Localities originally appeared in the places that are most attractive to human life with the necessary conditions for that - biological, labor, economic, social, and others. [1, 2]. However, a number of cities arises and develops in complex terrain, that certainly comprise gullies and ravines network (GRN).

The emergence and development of individual settlements in difficult terrain is conditioned by a number of objective prerequisites. These aspects are studied by many experts in geography of cities [3, 4, 5]. Particular attention is given to the geographical location of the region (its location is determined by the functional purpose and role in the system of residential areas), its micro location in a particular area of land (usually corresponding to the most convenient site among the many that are suitable for development of town in the area) [6]. Here are the two main reasons for the emergence and development of cities in difficult terrain. Firstly, historic ones: the need to establish bases in the strategically important land and water areas; desire to create a city- refuge in a remote area. Secondly, acting ones: creating an easily navigable deep-water port, development of mineral deposits, development of tourism, treatment in the mountainous region, etc. Current causes of difficult terrain appearance in urban area, in our view, can also include an increase in area of the city. The increase in the urban area usually occurs by the way of including the suburban areas that are not always suitable for agricultural development - inconvenient lands subject to gullies and ravines erosion, etc.

The development of any locality with GRN on its territory is closely connected with it: it is either placement of buildings depending on the type and set of relief erosion forms or its almost complete conversion in accordance with the needs and logistical capabilities of the city.

## **MAIN PART**

The study was conducted on the territory of the city of Naberezhnye Chelny, located on the left terraces of the Kama river, in the forest-steppe zone of lowland landscapes of the eastern Zakamye. The study area was selected due to the fact that this city is very young and thriving and growing. This led to "capture" of new territories by the city, previously assigned to agricultural land. When determining morphometric parameters that characterize the gullies and ravines cities, one used topographic maps of scale 1:25 000 and 1:50 000 that reflect state of GRN in the initial stage of development of the city (1954) and in 1997, when the city planning structure has taken shape. In addition, the General Plan of the city of Naberezhnye Chelny was used. [7]

## **METHODS**

Analysis of large-scale topographic maps at different times allowed us to determine the change of morphometric parameters of the test GRN city. Identification of the types of interaction between GRN and the city was carried out according to the classification proposed by Kovalev S.N. [8]. Depending on the nature of interaction with relief or corresponding stage of this interaction, that go one by one with successive growth of city and technology, all settlements are divided into four types: a) subject to relief (all types of buildings are located, depending on the type and landform of relief) b) subordinated to relief (most of the buildings in the settlements are inserted in relief), c) subordinating relief (localities where during construction partial conversion of relief throughout the site or in its substantial part happens), d) suppressing relief (settlements or their parts, big industrial enterprises, where in the process of growth or on design stage features of relief are not taken into account and construction is carried out with complete conversion of the territory depending on the needs).

## **RESULTS**

The eastern area of the Russian plain is characterized by well-developed gullies and ravines network [9, 10, 11, 12].

On the map of the XIX century GRN on the site of the modern city of Naberezhnye Chelny there were three settlements: Bereznyye Chelny, Mysovyye Chelny and Mironovka. All these settlements were located in the

valleys of small rivers: Shilna, Chelna and Melekeska. Berezhnaya Chelny was an exception, it was located directly on the coast.

For the city of Naberezhnye Chelny the problem of gullies and ravines network has arisen in connection with the expansion of the city to the east and northeast. Since the time of inclusion of Orlovka and Borovetskoe villages three large gullies and ravines systems were included in the city limits: "Bolshoy Log", "Borovetsky mezhnik" and "Gully Borovetsky."

Analysis of morphometric parameters of GRN from 1954 to 1997 showed that the construction of the city of Naberezhnye Chelny significantly changed relief (Table. 1):

1) gullies and ravines system "Bolshoy Log" ceased to exist because of its complete filling in with excavation soil and debris;

2) gullies and ravines system "Borovetsky mezhnik" was filled in in part. The rest of the system was transformed for construction of the road which at present time is called Yashlek prospekt. The slopes were lined with vegetation and strengthened. The manifestation of the erosion is absent;

3) gullies and ravines system "Ravine Borovetsky" is exposed to active influence on the part of the city. The length of the ravine has decreased by 950 m as a result of filling in the upper reaches during the area alignment for construction purposes. Of three pinnacles of left ravine tributaries and twelve right ravine tributaries only 5 biggest right ravine tributaries have left and their transformation is under way. The total length of gullies and ravines network decreased by 1,750 meters.

Active intervention of the city in the development of GRN led to significant changes in the direction of reducing the morphometric parameters of GRN: density of gullies and ravines network on the territory of modern Naberezhnye Chelny has decreased by 6.5 times, thickness - by 10 times, and gully rate by 6 times.

**Table 1: Morphometric characteristics of gullies and ravines systems (GRN) Naberezhnye Chelny**

gullies and ravines system (GRN)	1954	1997
GRN "Bolshoy Log"	Length –12 км 625 м; Water collection total area – 27,5 км <sup>2</sup> Area of GRN – 0,7 км <sup>2</sup>	0 (completely filled in)
GRN "Borovetsky mezhnik"	Length –3 км 300 м; Water collection total area – 5,5 км <sup>2</sup> ; Area of GRN – 0,1 км <sup>2</sup>	0 (completely filled in)
GRN "Ravine Borovetsky"	Length –5 км750 м; Water collection total area – 5 км <sup>2</sup> ; Area of GRN - 0,3 км <sup>2</sup>	Length –4 км; Water collection total area – 5 км <sup>2</sup> ; Area of GRN – 0,2 км <sup>2</sup>
Total	Thickness of gullies and ravines network – 0, км/ км <sup>2</sup> ; Thickness – 0,32; Gully rate – 0,006	Thickness of gullies and ravines network - 0,02 км/ км <sup>2</sup> ; Thickness - 0,032; gully rate - 0,001

**SUMMARY**

The results received for the young city territory (on an example of Naberezhnye Chelny) of gullies and ravines systems development allow us to conclude that at present time the overwhelming type of relief in the interaction of the city with gullies and ravines systems dominates. For more than 40-year history of the interaction of the city with GRN almost complete elimination of erosion forms occurred by the way of filling them with soil for construction purposes.

## CONCLUSION

Cities developing in conditions of complex terrain either significantly modify and transform it or adapt to it. Development of the city often "kills" the gullies. An example of a particular city has shown that there is a complete conversion of GRNs not only due to reduction of surface runoff, but also due to active involvement of the territories of gullies and ravines systems in architectural and planning system of the city.

## CONFLICT OF INTEREST

The authors acknowledge that the data do not contain any conflict of interest.

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