

Geoecological Changes in the Structure of the Anthropogenic Landscape in Kazan (Russia) for XVIII-XXI Centuries

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Abstract– In this paper we present the result of assessment of ratio between built-up area and green area of urban landscape of Kazan (Russia) for XVIII-XXI centuries. Research was made by georeferenced 9 old maps and recent satellite imagery and calculated the area of different functional zones. Through the research we have identified that increasing area of green territory is primarily attributable to integrated of large forests into the city territory. Increasing in the number of formal gardens started only at the end of the XX century. Also the development of Kazan infrastructure was unevenly and is attributable to the overall development of the level of production, because enterprises required more labor supply that had led to the creation new camps for workers. The most parts of the city composed of Built-up areas, which is in general, between 40% and 70% and include territories of industrial enterprises. Roughly equal share of the city's territory borrowed by Green zones and Undeveloped areas.

Key words– *anthropogenic landscape, transformation of the environment.*

I. INTRODUCTION

The formation and development of cities always multifaceted and is therefore not only relevant as historical processes but also as a case study of sustainable development of urban territories [2]. In that regard the geoeological aspects of urban development have come to the fore and cities are studied not as compact residential areas, but as point of interaction between society and environment.

Sure, the formation of city is closely linked to large transformation of the Nature. The urbanization entails set of negative impacts including total destruction of some ecosystems [5].

The study of urban development dynamics usually was in spotlight of economists and architects. Moreover there are very

little generalized data of urban development dynamic for Russian cities. In fact, the study of urban development remains within the history of cities and history of construction technology [11].

The trends of area and population change of the cities are common found in scientific publications. In some cases, information also supplied on assessment of sophistication of particular aspects of urban performance [6, 7].

As for Russia, aspects of environment transformation are usually considered during studies of biotic components of ecosystems.

Several sources relevant to analysis of urban territories development can be cited. For example, analysis of urban landscapes of several towns in southern Russia shows that development which ignored the orographic and climatic conditions of territory determined a large number of ecological problems [17].

Most frequently researches on the biotic components of urban ecosystems have a classification of urban environment as a result. Usually they are based on intensity or length of human impact. For instance, prof. Karaseva with co-authors identified 4 zones of Moscow from center to outskirts which are different from each other of species composition and species structure [8]. Similar work had being done for Kazan [1, 15].

Another scientific approach based on division of urban territory into functional areas. In this way human impact can be considered more comprehensive [10]. So it make possible to assess the changes of urban ecosystem by a degree of hemeroby [20]. This way is often using for study of biotic components [16; 18; 9].

In cases where the study focuses on inanimate components of ecosystem usually describe of local objects such as water objects [14] or landfills [13], and there are only low number papers which devoted to comprehensive research the territory.

The concept of sustainable development needs a broad approach, but most publications, in our view, focused on the following themes:

- The dynamic of population and the migration processes [3].
- Socio-economic aspects of cities [4].

These ones are very important scientific problems, but we believe that there are equally important questions:

- How we should planning future expanding the city, given the needs of sustainable development?
- On what basis we can choose the land parcels for different types of use?
- Which ones of land parcels are have a most value for keeping the biodiversity and landscapes?

Previously we tried to assess the dynamic of area and population of Kazan (Russia) [19]. This article is the continuation of that theme and focused on the trend in build-up/green areas.

II. MATERIAL AND METHODS

The Kazan city located in Middle Volga region of Russia has over 1000 years of development history [12] and specific conditions of territory evolution. The specific conditions mean low bank of Volga, because other cities of Volga region is located on high bank of Volga river) that determines large number of small lakes and wetlands with the relevant biotope. In this work we made a spatial analysis of development of Kazan city during over 500 years in order to determine changing of the ratio between functional zones of city throughout his history. We stored and processed geographic information and produced custom-tailored cartographic outputs through the conversion of old maps, lists of geographical objects and satellite imagery in digital format. For description of the process of territory development as historical sources were used the historical essay «Sputnik po Kazani» («The guide of Kazan»), scientific monograph: «Istoriya Kazani» («History of Kazan»), «Istoricheskaya geographia Kazani» («Historical geography of Kazan»).

Firstly, we determined the current territorial boundaries of Kazan as a boundary of the explored territory. Then we georeferenced 9 old maps and recent satellite imagery which describe one of the historical periods: XVIII cent., XIX cent., XX cent., XI cent.

We divided the territory into three functional zones, which illustrate the main trends of the transformation of the territory:

- Built-up areas which include Residential zones, Industrial zones and Business districts;
- Green zones including forests, parks, gardens, lawns, etc.;

- Undeveloped, which include roads, unused zones and Water objects.

Figures for urban zones were calculated by QGIS geographical information system according to this definition. These statistics enabled estimation the main parameters of urban areas:

1. The specific built-up area;
2. The specific green area;
3. The specific undeveloped area.

These parameters were calculated as ratio between combined area of each functional zones and total area of the city. Also, we were drawing comparisons between the areas of different zones in same time. It allowed comparing features of development of the territory in different stages of history of the city.

III. RESULTS AND DISCUSSION

As mentioned at the outset territory of Kazan city has increased by 10 times during XVIII-XX centuries and nowadays it's spanning about 560 sq.km. So there was a corresponding increase in area of the Green zones, but the ratio of Green zones remained at 15-20% of total area.

TABLE I. CHANGE IN AREA OF KAZAN FOR THE RESEARCHED PERIOD

	1768	1848	1887	1913	1940	1966	1988	2003	2017
Green zones, sq.km	1.7	2.0	4.8	11.1	51.4	32.3	52.8	92.8	125.7
Built-up areas, sq.km	5.7	12.4	10.6	14.3	39.4	74.5	118.0	175.6	211.7
Undeveloped areas, sq.km	2.6	4.6	7.8	5.9	59.7	109.0	67.3	103.9	218.4
Total area, sq.km	10.0	19.0	23.2	31.3	150.5	215.8	238.1	372.3	555.8

Kazan has been faced with an intensive increase in the area since the early 20th cent. In 1913 11 settlements were included to the territory of Kazan and the city area had spanned about 31.3 sq.km, representing 35% increase compared to 1887. In this period the city had 9 public gardens and boulevards, their area amounted more than 35% of total city area. There was the greatest increasing of city area in 1940, when there provided space for industrial enterprises as a result of intensive industrial development, it caused increasing the area by 5 times to 150 sq.km, but the share of Green zones remained the same – about 34%.

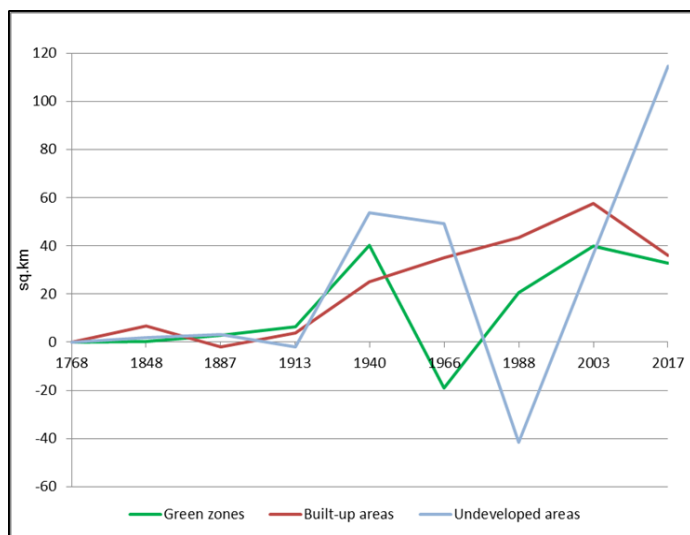


Fig 1. Changing of area of different functional zones of Kazan (Russia)

In the post-war period there was significantly increasing of population. Built-up areas and Undeveloped areas almost doubled their areas. But the total area of the city was only 216 sq.km in 1966, it representing approximately 143% of 1940. In addition the Green zones of the city decreased twofold by 1966 (figure 1) and accounted for 32% of total area. Therefore increasing of Built-up areas was formed by Green zones. This dynamics is associated with the post-war period, when the industrial development and residential buildings were priority.

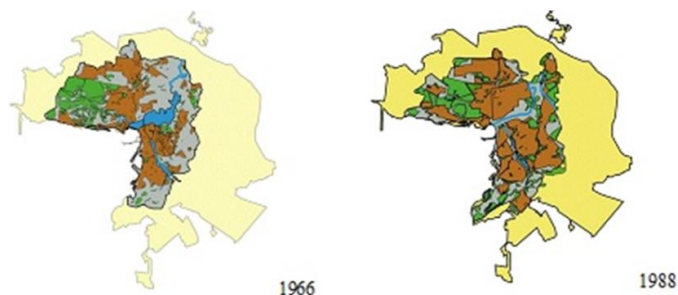


Fig 2. The position of Green zones on Territory of Kazan. Boundaries of modern city are shown as background

A slight improvement in the situation has been noted in 1988. Total area increased only 10%, and area of Green zones has increased by 48% because Central districts of the city got a large number of diffuse green spaces (figure 2).

The ratio between the different zones has remained stable over the researched period. The most parts of the city composed of Built-up areas, which is in general, between 40% and 70% and include territories of industrial enterprises. Roughly equal share of the city's territory borrowed by Green zones and Undeveloped areas (figure 3).

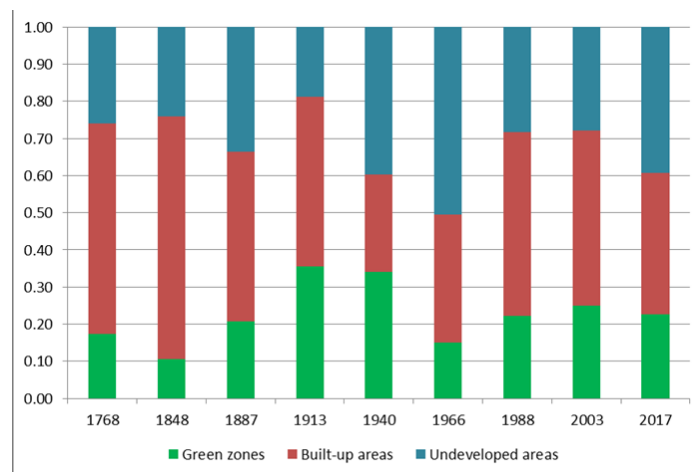


Fig 3. The ratio between the different city zones of Kazan during XVIII-XXI centuries

Since 2008, the city has intensified the construction of high-rise buildings and inner-city densification. Nowadays Kazan continues to develop and by 2017 occupies an area of 556 sq.km. This increase has come from accession of suburban areas. The Built-up area of the city in 2017 is 212 sq.km (an increase of 20 % compared to 2003). In addition the city territory includes a huge number of enterprises that form large industrial zones.

There are 138 parks, gardens and squares in 2017, also were created new Public green zones, but the ratio of the green zones currently remained at 22.6 %. Plans are under way to increase an area of green zones to 178.8 sq.km. Even then Green zones will account for just 29 % of total city area, so it wouldn't meet modern requirements and on well below 40 % which recommended by normative documents.

IV. CONCLUSIONS

The development of Kazan infrastructure was unevenly and is attributable to the overall development of the level of production. Enterprises required more labor supply that had led to the creation new camps for workers and integrating suburban settlements into the city.

Most of the city is the Built-up area including industrial zones. Green areas were of secondary importance. Increasing area of green territory is primarily attributable to integrated of large forests into the city territory. Only at the end of the XX century started increasing in the number of formal gardens in the Central districts territories which have a long history of development within the city.

Nowadays notwithstanding the efforts made to improve the comfort of urban environment and planned increase of Green zones area we have lack of green planting such as numerous small gardens.

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