Resources and Opportunities for the Functional and Spatial Development of the Kama Agglomeration

A Dembich¹, Y Zakirova¹, M Latypova¹
¹Department of urban planning and planning rural areas, Kazan State University of Architecture and Engineering, Kazan, 420043, Russia

E-mail: latypovamary@gmail.com

Abstract. The main objectives of the study presented in the article are to study the prerequisites for the formation of the Kama agglomeration, to identify factors and trends in its spatial development, and to identify features of the formation of the urbanized framework of the territory. Strategic materials of socio-economic development of settlements that make up the agglomeration and documents of territorial planning are studied. A principal model of the functional and spatial structure of the Kama agglomeration is proposed.

1. Introduction

Agglomeration has been the most common form of settlement since the 30s of the twentieth century. Its key characteristics are the concentration of resources, diversity of services, mobility, and high adaptability to changing economic, social, and demographic processes. In a number of publications, in the last ten years, the authorship of the concept of "agglomeration" in relation to architectural and urban planning is attributed to the French economist Marcel Rouget in 1977. In fact, the concept of "agglomeration" (and conurbation as its varieties) in architectural and urban planning was first introduced by the Scottish biologist, sociologist, geographer and urban planner, sir Patrick Geddes (1854-1933), author of the books "Development of the city" (1904) and "Cities in development" (1915). Under the influence of the evolutionist Herbert Spencer (1820-1903), he transferred the concept of biological evolution and the theory of economic zoning of the territory of Pierre Le Pleu (1806-1882) to the structure of the functional and spatial organization of the territory, thus creating the basis for modern urban thinking and planning.

P. Geddes ideas had a significant influence on the urban planning ideas of the functionalists in the first half of the twentieth century, grouped around the "modern movement architecture", contributed to the implementation of the proposals of Le Corbusier made at the IX Congress of CIAM in Eco-EN-Provence (1953, Congress theme "Habitation"), used for super-large cities, the concept of "agglomeration of people" [1]. Since that time, the concept of "urban agglomeration" has become increasingly used in urban planning science and practice. It should be noted that the spread of this urban planning term was also promoted by Doxiadis project practices and ideas of his theory of "ekistics", which offered their own urban planning terminology for such urban formations (dynametropolis, megalopolis), emphasizing the inevitability of urban enlargement and territorial expansion. In Russian science and literature, the term "agglomeration" was preceded by other definitions until the 1970s: "economic district", "economic city", territorial production complex, etc. One of the foundations of the formation and spatial development of agglomerations in the Soviet era
was the theory of “Group system of populated places” (GSPP). The main economic goal of the formation of the GSPP is to create urban planning prerequisites for the intensification of production as part of territorial production complexes of various types and to increase the efficiency of investment in urban and rural production.

The theory of agglomeration development is extensive. Modern Russian research in this area is actively engaged in The Institute of city Economics [2]. It is also necessary to note the classic scientific works of Russian experts ekonomgeografov Lyubov V. Ya [3, 4], Pertsik E. N. [5] and Neshadina A. A. [6], which reveal the concept of agglomeration, define the main stages of agglomeration formation. Also considered are the works of Apo G. M. [7], Maloyan G. A. [8], Kolodin A.V. [9], Kolyasnikov V. A [10] studying the structure of urban agglomerations, their main structural elements and types of formation.

Studies aimed at studying certain aspects of spatial development of agglomerations are considered. So on the issues of formation and development of transport-communication framework studied the work of Vuchic, V. R. [11], Blinkin, M. [12], and on the formation of natural recreation framework of the study Lyapin A., Druzhininna I. [13], Krasnoshchekova [14], also considered the issue of improving the cultural environment of the agglomeration [15]. The authors also got acquainted with the works that study the formation of polycentric structures at the level of agglomerations [16, 17].

To date, the concept of agglomeration in Russia is not enshrined in the Urban planning code, so officially such territories do not require urban planning documentation. But according to the Federal law on strategic planning, every municipality on the territory of the Russian Federation must have a strategy for socio-economic development, and in these strategies, regions and some municipalities already prescribe the formation and development of agglomerations. In very rare cases, an organization of inter-municipal management of an agglomeration territory is created. This imperfection in management affects urban planning and creates contradictions between urban planning documents. For example, some municipalities include the agglomeration factor in their documents and take it into account when developing the master plan, while others leave it out of the scope as optional and not legally binding.

Thus, in 2016, a strategy for social and economic development for the period up to 2030 was developed for the Republic of Tatarstan. it was adopted as a local law. The document States that there are three economic zones and corresponding agglomeration formations on the territory of the Republic of Tatarstan – the Kazan agglomeration, the Kama agglomeration and the Almetyevsk agglomeration.

The object of research is the Kama agglomeration, which has a polycentric structure. Its population at the beginning of 2020 was about 950 thousand people. Today, the formation of a strategy for the spatial development of the Kama agglomeration is particularly relevant, since a master plan is being developed for one of its key centers, the city of Naberezhnye Chelny. Since the Kama agglomeration includes settlements of a single-profile type, the works analyzing the state and problems of development of single-profile cities and towns in Russia are considered. The identification of possible ways to improve the rehabilitation of monoprophilic formations is reflected in the works of Lyubovnya V. Ya. [18], Mikryukov N. U. [19]. Issues of transition to neo-industry are considered in the work Pilyasov A., Zamyatina N. [20], Akhmedova E. A., Solodilov M. V. consider the architectural and urban planning structure of special zones, territories and complexes aimed at the modernization of large industrial centers [21].

2. Materials and methods
The study sets the following tasks: 1) to study the prerequisites for the formation of the Kama agglomeration; 2) to identify factors and trends in its spatial development, features of the formation of the urbanized framework of the territory.

The materials for the study are:
1) strategic planning documents of the Republic of Tatarstan, municipal districts and cities that are part of the Kama agglomeration,
2) urban planning documents of core cities and municipal districts (master plans, territorial development schemes),

3) field surveys of the territory,

4) Federal and national statistical data and reports on the socio-economic, environmental status and development of the territory.

As part of the study of the current state and directions of development of the Kama agglomeration, normative and strategic documents of territorial planning, state reports of the Republic of Tatarstan for 2016-2019, as well as analytical data of the state statistics service of the Russian Federation were analyzed.

The study uses general scientific methods of analysis – analysis and systematization of data based on the study of various aspects of the spatial and territorial development of the Kama agglomeration. The possibilities and limitations of spatial and territorial development of the main urbanized settlements of the Kama node were considered. Features of development of municipal districts that are part of the Kama agglomeration are revealed. A General analysis of the entire territory of the Kama agglomeration was also carried out on the parameters 1) transport and communication framework of the territory, 2) natural complex, 3) cultural facilities, 4) medical facilities, 4) shopping and entertainment facilities, 5) educational facilities.

3. Results and Discussion

Kama agglomeration is a polycentric, industrial agglomeration. According To the strategy of social and economic development of the Republic of Tatarstan until 2030, the zone of active development of the Kama agglomeration includes the city district of Naberezhnye Chelny and 4 municipal districts (tukayevsky, Nizhnekamsk, yelabuzhsky, Mendeleevsky). On the territory of the agglomeration are located the cities of Nizhnekamsk, Yelabuga, Mendeleevsk, large settlements – p.Krugloe Polye, p. Betki, p. Bolshoe afanasovo. In the future, the Kama agglomeration will include small industrial cities: Menzelinsk, Mamadysh, Zainsk (figure 1). The population of the Kama agglomeration is about 950 thousand people, while there are no millionaire cities. There is a migration outflow, mainly to Kazan, as well as to the Central part of Russia. The main migration outflow of the population is young people (17-19 years), This is due to the lack of qualified higher education institutions in the Kama agglomeration. At the same time, the urban population of the agglomeration is being fed by migration from municipal areas.

![Figure 1. The city as part of the Kamsky agglomeration.](image)
Kama agglomeration has a favorable economic and geographical position. The location of the agglomeration between the Urals and the center of Russia, proximity to the centers of product sales, ensures its industrial development. The Kama economic zone borders the Udmurt Republic to the North, the Republic of Bashkortostan to the East, and the Kirov region to the Northwest. The Western and southern parts of the economic zone are located on the territory of the Republic of Tatarstan and border with the Kazan and Almetyevsk economic zones, respectively. The Kama river is the natural and ecological core (axis) of the territory of the Kama agglomeration.

Officially, according to the strategic documents, the priorities for the development of the Kama cluster are industrial and innovative components. According to the Strategy of the Republic of Tatarstan-2030, the perspective vision of the Kama economic zone is the leader of industrial and technological development, the territory of "new industrialization" and the development of high technologies.

The breakthrough in the territorial development of the Kama agglomeration occurred in the second half of the twentieth century. During the construction of new industrial cities, the connectivity of the territory increased due to the Nizhnekamsk hydroelectric power station and transport corridors that have survived to this day. Active industrialization on the territory of the USSR assumed the formation of "territorial production complexes" in the economic regions of the country, one of which was the Nizhnekamsk industrial district. In 1960-65, the project to create the Nizhnekamsk industrial district was approved. The district was based on the largest petrochemical complex in Europe, which was supposed to process oil produced in the South-East of the Republic (and produce new types of plastics, synthetic rubbers, and other hydrocarbon raw materials for further chemical processing). According to the draft district plan in 1959, the General plan of the city of Nizhnekamsk was created for the estimated number of 170 thousand people, which was approved in 1960. In 1965 Giprogor developed a draft regional planning Naberezhnye Chelny industrial area, which envisaged the further development of the enterprises of the Nizhnekamsk promote with the inclusion of additional new production lines. Then in 1969 the Kama automobile plant was built, and in 1972 another large industrial city – Naberezhnye Chelny-was built almost from scratch. In the General plan of Naberezhnye Chelny was laid a few key ideas: 1) linear city strip with clear functional zoning, 2) a basic urban planning unit in the enlarged microdistrict, 3) "constructor" of elements of prefabricated housing, 4) a representative of the centre as a sacred place of festive marches and demonstrations, 5) "platform" – as a second ground level, 6) transport-oriented planning and transport-oriented livelihoods.

Today, the city of Naberezhnye Chelny is the leading core of the development of the Kama agglomeration. It should be noted that an important structural element of the Kama agglomeration is also the special economic zone "Alabuga", which is located in the Yelabuga district of the Republic of Tatarstan – 10 km from Yelabuga, 25 km from Naberezhnye Chelny, 40 km from Nizhnekamsk. It covers an area of 3903.5 hectares. The official website presents 34 existing industrial and production enterprises, 5 under construction and 20 in the project. For 2019 the Alabuga special economic zone is the largest and most successful industrial-type special economic zone in Russia.

Almost all cities of the Kama agglomeration, according to the decree of the government of the Russian Federation on the list of single-industry towns (last correction August 2019) are settlements of the single-industry type. The city of Naberezhnye Chelny is assigned to 1 category-a single-industry city with the most difficult socio-economic situation (including in relation to the problems of functioning of city-forming organizations). The cities of Yelabuga, Mendeleevsk, and the village of Kamskiye Polyany are classified in category 2. These are single-industry towns that have risks of deterioration of the socio-economic situation. The city of Nizhnekamsk is included in category 3-a single-industry city with a stable socio-economic situation. In the future, the list of single-industry settlements is planned to be adjusted based on the results of economic activity of municipalities within the framework of the Federal program of support for single-industry towns. In 2016, Petrochemical and oil refining enterprises in Nizhnekamsk, automobile manufacturing plants in Naberezhnye Chelny, chemical production in Mendeleevsk, the Alabuga special economic zone and a number of other
industrial sites were merged into the Innokam production cluster. Currently, the industrial development of the Kama agglomeration shows positive results. But basing the socio-economic development of the territory solely on production of a similar profile creates risks. The high production load on the territory of settlements and the congestion of personal and cargo vehicles create an unfavorable environmental situation in cities and the immediate environment.

On the territory of the Kama agglomeration there are cities of different historical periods with different historical and cultural values. Cities with a rich historical and cultural heritage are the Mendeleevsk and Yelabuga. Yelabuga is one of the best preserved small historical cities in Russia. This is one of the most important and popular points in the tourism policy of the Republic of Tatarstan. According to the State Committee for the Republic of Tatarstan for 2019 Yelabuga was visited by 506 thousand people. The city is characterized by a harmonious combination of the environment, natural landscape and architecture, a complex historical building, an organic combination of numerous museum objects, historical and cultural monuments. The protected area of Yelabuga occupies 490 hectares, where about 700 objects of historical and cultural heritage are located, 184 of them are officially under state protection. The second historical city of the agglomeration is Mendeleevsk. There are 19 objects of cultural heritage that are protected by the state. These are natural, historical and culturally significant objects and territories (historical, cultural and natural territory "Ushkov Estate", the Old factory site and a number of local objects). Also in rural localities of the district there are objects of cultural heritage represented by monuments of civil and industrial architecture (houses of famous people, religious sites, factory school buildings, etc.). Also expand the geography of cultural tourism in Mendeleevsky district contributes to the holding of cultural events (Russian "Oskovskii's reading", "Pasternak's reading ", created Park "Oskovskii island", "Peter reading" in the village of Moncheva and others). Currently, tourist destinations in Mendeleevsk and Mendeleevsky district are not developed, and the tourist infrastructure in the city and district is not formed.

The main structural element and core of the natural and ecological framework of the Kama agglomeration is the "Lower Kama" national Park, created in 1991. The total area of the Park is 26460 hectares. The territory of the Park is located within two administrative districts – Tukayevsky and Yelabuzhsky. Within the Park there are six main groups of landscape complexes: water, coastal-water, swamp, meadow, upland-ravine-beam and forest. The territory of the Park is located at the junction of two natural zones: forest and steppe. On the territory of the Park "Lower Kama" there are 6 excursion ecological routes, 1 walking and 1 water tourist routes.

Today, the main transport hub of the Kama economic zone is the city of Naberezhnye Chelny, where railway, road, air and water routes converge. The main highway is the Federal highway M7, which connects the capital of Russia and the capital of the Republic of Bashkortostan. A lot of cargo and passenger transportation is carried out in this direction. Air transportation is carried out from Begishevo international airport located in Tukayevsky district, 19 km from Nizhnekamsk and 27 km from Naberezhnye Chelny. The airport serves the Kama economic zone and is also a priority for residents of the Udmurt Republic. The territory's railway lines operate for both passenger and freight traffic. The main destinations are the Volga economic zone, as well as direct connections to Moscow, Kazan, Ulyanovsk, Izhevsk, Bugulma, Adler, Perm, Volgograd, Saratov, Krasnodar. Domestic routes connect the economic zones of the Republic of Tatarstan and are mainly used for cargo transportation. The Nizhnekamsk hydroelectric power station and the Nizhnekamsk reservoir have been built on the Kama river, and there are railway and road crossings along the dam.

The analysis revealed the main problems of spatial development of the territory of the Kama agglomeration:

1. Unformed transport and communication agglomeration framework, lagging development of transport infrastructure from the development of production (lack of 30-minute accessibility between the core cities, the presence of a single road and rail crossing over the Kama river-Nizhnekamsk hydroelectric power station).
2. Each city of the Kama agglomeration has its own separate transport and logistics infrastructure, which in the process of functioning poorly coordinate their actions with the immediate environment. In particular, the logistics centers and warehouses of Naberezhnye Chelny are significantly removed from the main roads (road, rail, river), which significantly complicates the process of organizing transportation using modern innovative centers such as intermodal and multimodal. Transport logistics does not provide a proper level of transportation of people and goods due to the remote location of logistics centers and transfer hubs from the main intercity and international transport corridors, which makes them unclaimed, and the presence of access roads for only one type of transport - cars. The capacity of ground transport between the core cities of the agglomeration has been reduced. There is a low quality of river transport due to the deterioration of the infrastructure of inland waterways, high wear and tear of river transport, and more dynamic development of land transport.

3. Non-diversified production base of agglomeration, monospecialty cities. Today, production and industry are the main factors that determine the territorial and urban planning of settlements in the Kama agglomeration. Sanitary protection zones cover large areas within cities, which is why there is a shortage of land resources for housing construction. The single-industry nature of the city-forming enterprises of the cities of the Kama agglomeration is one of the reasons for the migration outflow of the population. However, the Russian Federation is currently implementing a program to support the development of single-industry towns in various areas (improving the quality of the urban environment, diversifying production), which allows us to get federal funding.

4. Unfavorable environmental situation.

5. Poor quality of the urban environment, deformed urban spaces, loose buildings, monotony of public spaces and the urban environment.

6. Lack of cultural and leisure facilities and higher education facilities.

For further sustainable, coordinated and flexible development of the Kama agglomeration, it is necessary to preserve the polycentric structure of the territory. This requires the development and formation of a single agglomeration transport and communication framework, the identification and strengthening of the leading (profile) functions of settlements and cities based on their resource potential, as well as the development of the service sector, for the transition to the post-industrial stage of socio-economic development.

The strategic documents of territorial planning set global goals for the transformation of the region's transport system. At the municipal level, there is no unified vision of transport and territorial planning, and there is no connection between transport and territorial solutions at various large-scale levels. The formation of the transport framework model of the region should meet the current economic stage of the region's development, as well as take into account the prospects for urban development. The inevitable growth of people's employment in the service sector, the decline in employment in the industrial sector, the emergence of new facilities and growth points in the post-industrial sector will change the nature of urban mobility. The priority directions of forming the transport framework are the development of internal agglomeration links through public transport, the development of external links that contribute to the connectivity of municipal districts, improving the quality of logistics infrastructure, and the development of intermodal transport logistics. The presence of one of the main waterways of the country, the Kama river, which provides access to the Azov, Black, Caspian, Baltic, and White seas, is one of the main advantages. All cities of the Kama agglomeration are located on the banks of the Kama river, which contributes to the development of water transport, both for passenger and cargo transportation. The availability and demand for intra-city rail transport in Naberezhnye Chelny and Nizhnekamsk suggests the possibility of its further development for the implementation of pendulum migrations between cities. The existing railway and automobile network connecting large industrial centers and the availability of water resources makes it possible to place multimodal transport and logistics centers in the agglomeration.

The city of Naberezhnye Chelny is developing as a key core in the structure of the Kama agglomeration. Among the new objects, it is necessary to provide territories for the formation of a Polytechnic educational cluster (Polytechnic University, colleges, technology parks). In the field of
neoindustry, it is necessary to identify sites for possible placement and development of small and medium-sized businesses not related to the automotive industry, including for food and light industry enterprises, various industries based on the development of object design. It is also necessary to provide for the creation of agglomeration service facilities and ensuring their "connectivity" with external transport infrastructure – the formation of two transport hubs as a new "city gate": the Vostochny and Zapadny transport hubs on the basis of the existing railway station. It is also necessary to create a transport hub in the cities of Nizhnekamsk (the first transport hub on the site of the existing bus station, the second in the industrial zone, to reduce the availability time, as well as improve the labor market due to pendulum migration), Mendeleevsk, Yelabuga and the special economic zone "Alabuga". It is necessary to form and develop inner-city recreation on the coastal territories of the Kama river. The cities of Yelabuga, Mendeleevsk and Kamsky Polyany form the tourist and recreational core of the agglomeration. Thus, the results of the study allow us to form a basic model of the functional and spatial structure of the Kama agglomeration.

4. Conclusions
The existing way of life of residents of the Kama agglomeration is still determined by the paradigm of industrial development. The strategic documentation also defines the industrial development of the agglomeration area as the leading one. But it should be noted that there are signs of the change of economic structure – the closure of a number of major industries, environmental changes, manifested in increasing of public spaces, the emergence of new services. The study identifies the main limitations and resources of spatial and territorial development of the Kama agglomeration. As the main resources best econo-geographic the territory (the best neighborhood, or the proximity to the regions with potentially attractive markets); the availability of on-site competitive city-forming enterprises; - investment attractiveness of the territory; the presence of large natural-ecological cores; rich historical and cultural potential. The main limitations in the territorial development of the agglomeration are the following: monospecialization of cities, unstable and unformed transport and communication framework, unfavorable environmental situation due to petrochemical plants, lack of free land resources within the boundaries of core cities, monotony, neglect of the urban environment, deformed urban spaces.

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