

Boundary delimitation of Chelyabinsk agglomeration

V V Bolshakov

Architecture, South Ural State University, 76, Lenin Avenue, Chelyabinsk 454080, Russia

E-mail: bolshakovvv@susu.ru

Abstract. The article is devoted to the theme of boundary delimitation of Chelyabinsk city agglomeration. For this purpose, a method of determining functional urban areas was used. This methodology is international and has been applied repeatedly for definition of agglomeration boundaries around the world. Applying this method makes it possible to compare obtained results with other world analogs of agglomerations, and also to understand the nature of development of agglomeration under study. The result of the study is a map with marked boundaries of agglomerations and a list of municipalities that entered zone of the core city influence. It was concluded that there is a significant degree of centralization of Chelyabinsk agglomeration (75% of the labor force) and an incomplete formation of the suburbia. Satellite cities and areas of their influence on suburban areas were identified. This study was a part of architectural and planning section of the research paper "A Strategy for the Development of Chelyabinsk agglomeration," carried out in 2018. The study helped to understand and trace distribution structure of urbanized areas within the agglomeration, to focus on compactness of the settlement system and to exclude proposals for excessive expansion of agglomeration boundaries by including agricultural municipalities.

1. Introduction

The study on the boundary delimitation of Chelyabinsk agglomeration was a part of architectural and planning section of the large research work "A Strategy for the development of Chelyabinsk agglomeration", carried out in 2018 [1,2]. According to the assignment, it was necessary to delimitate boundaries of the urban agglomeration by a certain method of determining functional areas.

This method was not considered in Russian scientific literature [3] in the framework of the problem of determining the boundaries of agglomerations. Existing approach was based on three basic principles of delimitation: transportat [4], administrative-territorial [5] and a combined one [6]. Also there were some author's techniques [7].

In the process of carrying out this scientific work, proposed methodology was also tested by transport and administrative-territorial principle, in order to approximate a true understanding of the phenomenon. The ring, presenting the territory of transport accessibility equal to 1 hour (comfortable time for spending on pendulum migration, according to Ch. Marchetti [8]), covers several municipal districts. However, these regions have an extremely low level of urbanization, in view of which, it is inappropriate to include them in the agglomeration boundaries. On the contrary, the decision to include poorly urbanized municipalities was dictated by proximity to the core city and by peculiarities of municipal work, where the powers of decision-making are owned by municipalities, but not by individual settlements that are included in them.



In those cases when it was not possible to use some statistical data that is not collected at all, an expert method was used, based on the facts of periodically repeating phenomena fixed by researchers.

2. Body

Determination of the functional urban area of Chelyabinsk agglomeration [Figure 1] is in accordance with the methodology presented in the study "Definition of Functional Urban Areas (FUA) for the OECD metropolitan database" [9]. When using the methodology, deviations from the type of source data presented in the study are permissible, if a justification is given that this will not have a significant impact on results of the study.

The proposed methodology for definition of functional urban areas (FUA) was developed by the Committee for Territorial Planning Economic Co-operation and Development (OECD) Committee in order to provide a common basis for comparing the development of megapolises [10]. Definition of urban areas uses population density to determine the urban cores (urbanized areas) and labor migration for hinterlands (suburban areas), the labor market of which is strongly connected to the core.



Figure 1. Determination of high-density urban clusters of agglomeration area.

The methodology consists of three main stages:

1. Identification of the main municipalities through gridded population data:

At the first stage of the procedure, gridded population data are used to identify urbanized areas or "high-density urban clusters" throughout the territory, ignoring administrative boundaries, since urban cores are defined through the population grid (1 km²). An urban core consists of a high-density cluster of adjacent grid cells of 1 km² with a density of at least 1500 inhabitants. A lower threshold of 1000

people per square kilometer is used in Canada and the United States, where megapolises develop in a less compact manner.

When defining clusters with a density of more than 1000 inhabitants per square kilometer, there have been identified municipalities with a high percentage of urbanized areas: Chelyabinsk city district [11], Kopeysk city district [12], Korkino city settlement [13], Yemanzhelynsk city settlement [14], and municipal districts – Sosnovsky [15], Yetkulsky [16], Krasnoarmeisky [17], where these areas are located in a suburban area. At the same time, the location character of urbanized territories, although not numerous, in Argayash [18], Chebarkul districts and Chebarkul city district [19], obviously does not have the attraction towards the core of the agglomeration, even in the status of a satellite [Figure 2].

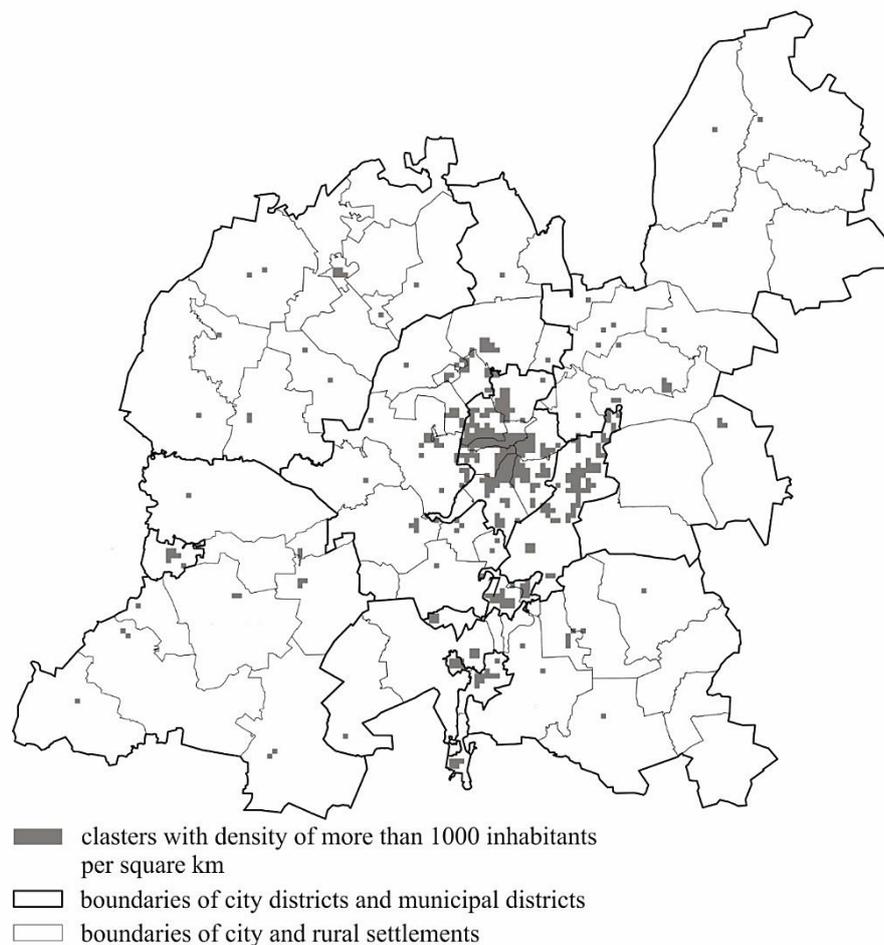


Figure 2. Definition of the urbanized agglomeration area.

2. Inclusion of adjacent territories belonging to the same functional urban area.

It is established that the urban cores, determined in 1 km² cells, are good approximations of adjacent, densely built regions. However, not all urban areas are characterized by contiguity in territory development.

Many of them develop in a polycentric way, containing densely populated cores, which are physically separated, but economically connected. At this stage, the adjacent urbanized areas are filled according to the rule of "majority" - if at least five out of eight clusters surrounding the territory belong to the same high-density cluster, the cell will be added. This is repeated until all the cells are added.

Small clusters (accommodation of less than 50 000 inhabitants in Europe, the USA, Chile and Canada, 100 000 inhabitants in Japan, Korea and in Mexico) are being dropped.

When applied the "majority" rule to these territory clusters, urbanized areas are defined without taking into account administrative boundaries of municipalities.

Small clusters with aggregate population of less than 50,000 inhabitants are not discarded to illustrate the co-scale of urbanized areas and their distribution, and also because the urban settlements of Korkino and Yemanzhelinsk are the part of the overall urbanized mining system [Figure 3].

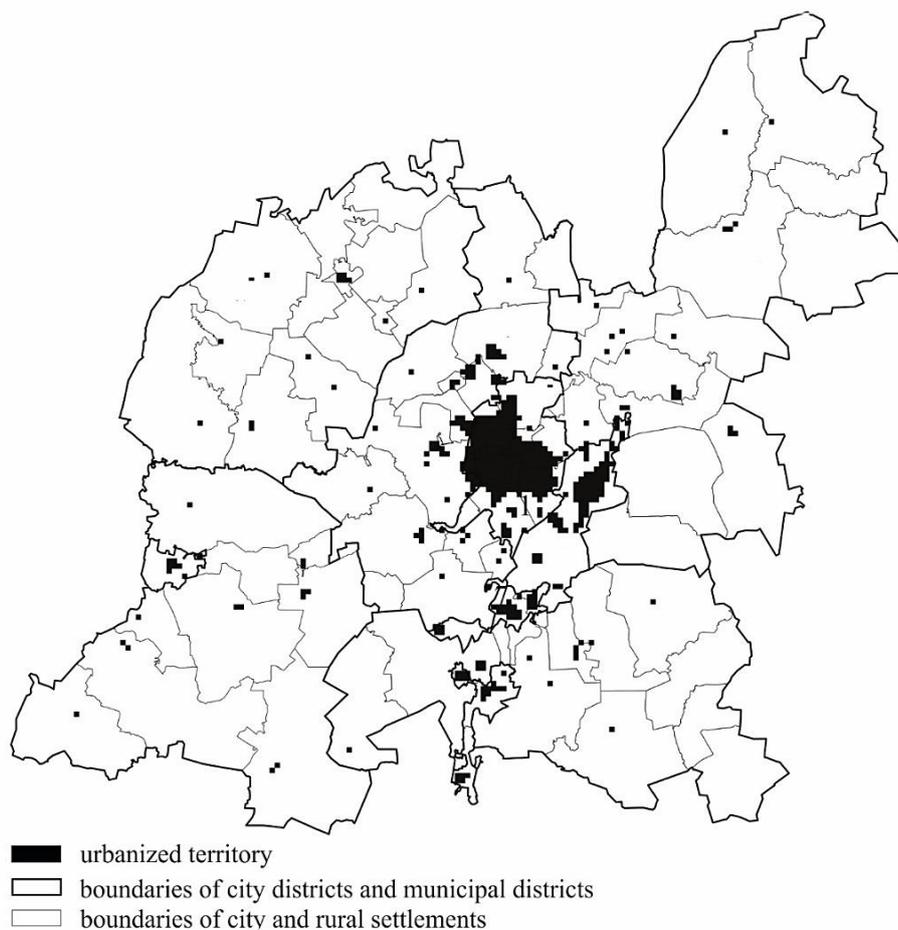


Figure 3. Determination of the agglomeration boundaries.

3. Identification of hinterlands (suburban areas).

After densely populated municipalities are aggregated to form urban cores (urbanized areas), the final stage of the methodology is to determine the hinterlands of agglomerations (suburban areas). "A hinterland" can be defined as a zone of labor pendulum migration, outside the densely populated core. The size of hinterlands in relation to the size of the core gives an understanding of the influence of the city on the surrounding areas.

Urban hinterlands are defined as all municipalities with at least 15% of employed inhabitants working in a particular urban core. Municipalities, surrounded by a single functional urban area, are included, and non-contiguous municipalities are discarded.

Application of the method to delimitate Chelyabinsk agglomeration was carried out taking into account the following parameters and methodological deviations:

- determination of population density for a cluster of 1000 people per km², which considers features of the general established settlement system of the country;

- clusters that are not adjacent to the main core are not discarded (which is required by the method), to illustrate distribution of settlements along the proposed agglomeration area;
- in addition, the type of municipalities of the suburban agglomeration area with a low population density, but entering in the hinterlands of the core, is included;
- also, the zones of the predominant location of the agglomeration population were identified.

Delimitation of Chelyabinsk agglomeration is determined by the boundaries of municipal formations - settlements that are part of the core of the urbanized territory, on the basis of involvement of more than half of the able-bodied population in the daily labor pendulum migration. In addition, there are the municipalities noted which have a low degree of urbanization and population density, but are included in the agglomeration boundaries due to the proximity of the agglomeration core and the prospects for participation in agglomeration processes through the high transport connectivity and favorable location [Figure 4].

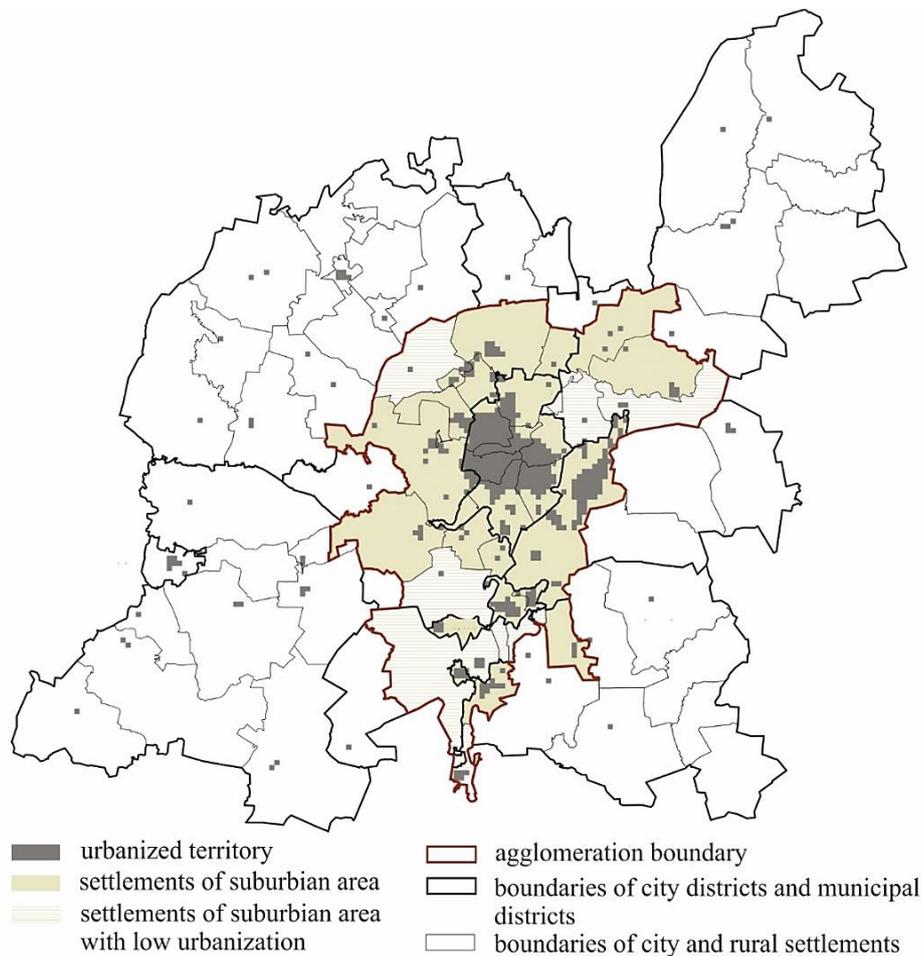


Figure 4. Distribution of population within the agglomeration boundaries.

This is an additional stage in the analysis of the agglomeration area, illustrating distribution of population within certain boundaries. Accommodation of 50 and 75 percent of the population [20] only within the main urbanized territory - the city of Chelyabinsk - proves monocentricity of the agglomeration and points to the locomotive of its economic and financial processes [Figure 5].

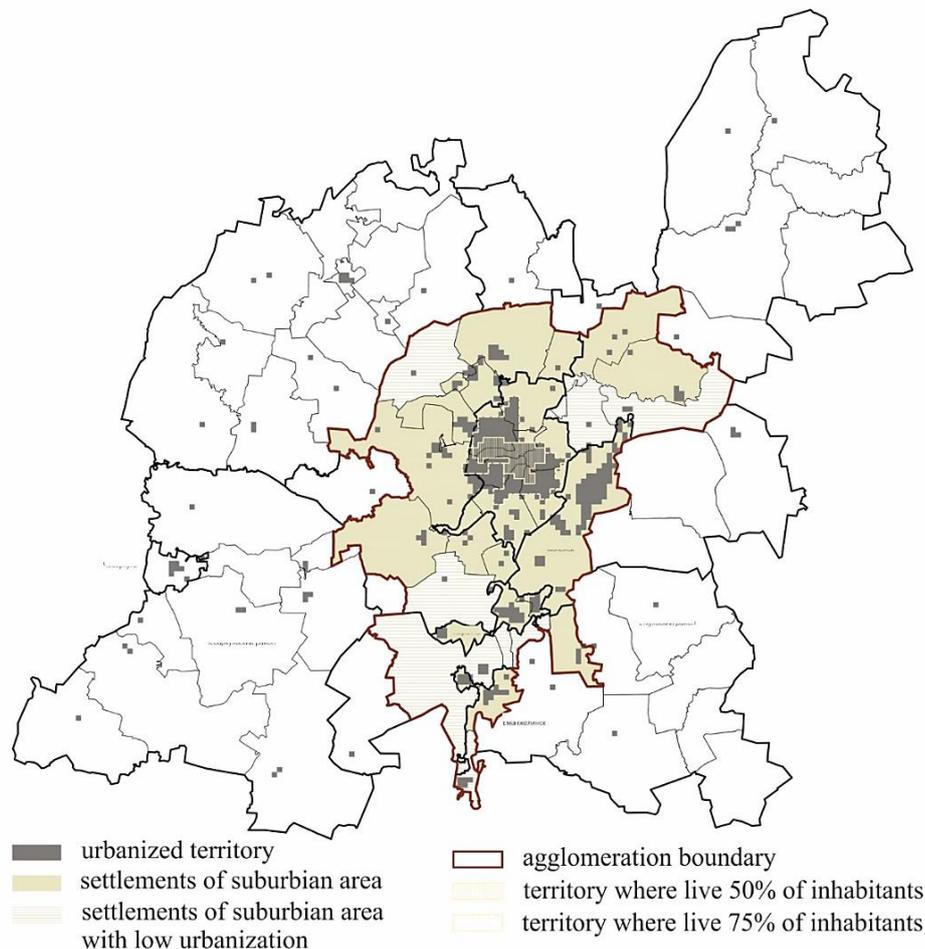


Figure 5. Determination of the agglomeration boundaries.

This means that investments in modernization and innovation projects should firstly be launched in the core of the agglomeration area – in Chelyabinsk, where concentration and diversity of human capital, industrial sites with infrastructure supply, firms, social and cultural sites are greater than in the rest of the territory. Then, due to the economies of scale, the effect of innovation will have an impact on suburban and satellite cities. However, this should not be an excuse for downsizing programs outside the agglomeration core. Infrastructure challenges should be addressed in a comprehensive manner for the entire designated territory. This requires a program for consistent implementation of projects, since simultaneous solution of the accumulated problems is impossible.

Results of application of the method of definition of functional urban areas (FUA) are:

- definition of urbanized territories which illustrate monocentricity of the agglomeration with historically formed conurbation system of satellite cities along the brown coal basin;
- identification of suburban areas of the agglomeration core, the main characteristic of which is underdevelopment and low inclusion in agglomeration processes, in view of the unformed nature of the suburbium itself, which is an indicator of formation and development of the middle class in society;
- delimitation of Chelyabinsk agglomeration and inclusion of following administrative units into its constitution at this stage.

Table 1. Administrative units of Chelyabinsk agglomeration.

City districts and municipal districts	City and rural settlements
1. Chelyabinsk city district	-
2. Kopeysk city district	-
3. Korkino municipal district	- Korkino city settlement - Pervomaysky city settlement - Roza rural settlement
4. Yemanzhelinsk municipal district	- Yemanzhelinsk city settlement - Zauralsk city settlement - Krasnogorsk city settlement*
5. Sosnovsky municipal district	- Kremenkul rural settlement** - New Kremenkul rural settlement - Esaul rural settlement - Krasnopolsky rural settlement - Roshchino rural settlement - Mirnensky rural settlement* - Dolgoderevenskoye rural settlement - Solnechnoye rural settlement - Poletayevo rural settlement** - Sargazi rural settlement - Tomino rural settlement* - Voznesensky rural settlement
6. Krasnoarmeysky municipal district	- Miass rural settlement - Lazurni rural settlement - Balandinskoe rural settlement* - Ozerno rural settlement*
7. Yetkul municipal district	- Yetkul rural settlement - Bektysh rural settlement* - Novobaturino rural settlement* - Yemanzhelinsk rural settlement*

* rural settlements with a low level of urbanization, however, general location of them and of its settlements, close to the core of the agglomeration, have the character of attraction towards the center, or are located on convenient transport routes, which increases the prospect of involving these areas in agglomeration processes.

** rural settlements, whose territories, due to their large area, are only partially in agglomeration.

3. Conclusions

1. Boundary delimitation of Chelyabinsk agglomeration is determined by the method of functional urban areas.
2. Municipal formations included in Chelyabinsk agglomeration are defined, for some of them special characteristics of entering the borders are indicated.
3. Unfounded expansion of the agglomeration boundaries using underpopulated and unurbanized territories of adjacent municipal districts was proved.
4. Compactness and supercentralization of agglomeration was proved.
5. Incorrectness of existing administrative-territorial boundaries of municipalities was identified, where territorial shifting of urbanized areas was detected naturally to the core city and of non-urbanized agricultural areas to the periphery.
6. Satellite cities of the agglomeration core are identified and their territorial independence as of self-developed urbanized objects is proved.

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