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This text was automatically generated on 23 July 2020.

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AUTHOR'S NOTE

Introduction

1   Russia as a post-socialist country joined global financial and economic processes only in the end of the 20th century. After 70 years of isolation, the national urban system opened to the world and as it happens in other places of the world, cities became the main drivers of globalization in Russia (Rozenblat, 2018). Being a highly urbanized country – currently the urbanization rate in Russia is 75% (Rosstat, 2019) – most of the economic activity is concentrated in cities. Taking this into consideration, we analyze what kind of definition is appropriate to evaluate the integration of Russian cities in globalization.

2   Traditionally, cities in Russia are defined according to political borders and considered as administrative units. A city in Russia is a legal status assigned by the government to a settlement that can be obtained or lost depending on different contextual factors. Interestingly, the population is not a major criterion for a city status: for example, Vysotsk in the Leningrad oblast, which has the status of "city", has only 1,115 inhabitants (Rosstat, 2018), whereas Moscow has over 12 million (Rosstat, 2018). The history and strategic position of a city is sometimes the main factor for considering a settlement as a city, but not always. Therefore, some administrative units with a city status are very small and have a clearly rural feel, whereas large industrial towns are denied in urban status. Due to this significant size-status inconsistency of Russian cities, it is impossible to compare them both between each other and with other cities on the world scale.

3   In this paper, we discuss the construction of so called Large Urban Regions (LUR) (Rozenblat, 2020 a,b), which are defined as an aggregation around a core of continuous statistical units that are economically dependent on this core and linked to it by economic amenities and strong social interdependences. Aggregating different districts ("*rayons*" in Russian) around a core city, using such criteria as population distribution, road networks, access to an airport, presence of multinational firms, distance from a core, we construct a single large urban region, which allows us to include all the area of economic influence of a core into one statistical unit.

4   An important objective of the new delimitation is to encompass areas likely to be home to multinational companies and their branches and subsidiaries, which are by basic presumption the most dependent on location near an airport. By aggregating urban areas potentially attractive for multinational companies into one LUR, the proposed delimitation is intended to improve international comparisons of Russian cities' globalization.

5   The principal objective of this research is to develop a systematic approach to characterize Russian cities in their insertion in globalization, which implies to link them to other cities of the world and, thus, to adopt an equivalent harmonized definition. Hence, the final goal of this delineation is to make cities comparable on the world scale (Rozenblat, 2020, a).

6   This article is structured as follows: in the beginning, we critically discuss existing delineations of Russian cities (part 1) and discuss why they are inadequate for global urban comparative research arguing for the need of a new urban definition (part 2). Afterwards, we explain the construction of Large Urban Regions in the Russian context (part 3.1) and illustrate it with two case studies: St. Petersburg (monocentric) (3.2a) and

Samara (polycentric) (3.2b). Based on the discussion of these two examples, we further explain the database of all 120 Russian LURs and illustrate the utility of LUR definition for economic globalization research based on the biggest Russian cities (part 4).

The Russian urban concept

7   Since the Soviet times several different methods have been developed to delineate a city depending on the purposes of geographic analysis. These initiatives aimed at measuring the urban growth in a consistent way, while the legal status of a settlement could be gained or lost within time, and over the years criteria to obtain this urban status varied considerably from census to census, which made longitudinal urban comparative research quite difficult. Therefore, most of the proposed alternative urban definitions have different terminologies for these spatial urban entities, whereas the notion of city always refers exclusively to the legal status.

8   To organize the variety of different methods of city delineation applied in the Russian context, we follow the *four principal urban concepts* introduced by Pumain et al. (1992). Each of these city concepts corresponds to different types of research questions and presents different geographical borders of a city. Below we introduce each of them and we provide examples of methods used in Russia corresponding to each of the four concepts.

Urban localities

9   Urban localities are defined by the town's administrative boundaries or by their status in law. This is the delimitation most often used in economic research on Russian cities and regions (subjects of federation) because of data availability. Rosstat[1] as a main and the biggest source of statistical information provides data only within administrative boundaries on three different levels: federal, regional and local (Fig.1).

Figure 1. Levels of political and statistical organization in Russia

FEDERAL LEVEL

FEDERAL DISTRICTS (8)
Central, North Western, Southern, Volga district, Far Eastern, North Caucasian, Ural district, Siberian
- groupings of subjects of the Federation
- not the constituent bodies of the country
- exist for convenient operation of federal services

REGIONAL LEVEL

SUBJECTS OF THE FEDERATION (85)
- constituent entities-states of the country
- top-level political divisions possessing equal rights and political power, despite differences in terms of size of territory, population, and specific national languages

Republic (22)
Республика
- Have their own constitutions and constitutional courts
- Have the right to establish their state languages along with Russian
- Have a capital city
- Ethnic principle of formation

Kray (9)
Край
Oblast (46)
Область
Different words are used because of the historical traditions of regions

Autonomous oblast (1)
Автономная область
The only Jewish Autonomous Oblast keeps its old name since the Soviet time; in fact the same characteristics are applied as to a regular oblast.

Autonomous okrug (4)
Автономный округ
- No right to establish local state languages;
- Ethnic principle of formation for indigenous peoples of the North;
- Being an independent subject of the Federation, at the same time they can be included into oblast or kray
(Examples: Nenets Autonomous Okrug is a part of Arkhangelsk oblast; Khanty-Mansi Autonomous Okrug is included in the Tumen oblast).

City of federal significance (3)
Город федерального значения
Used for the two biggest cities St. Petersburg and Moscow (city-states)
As of 2014 Sevastopol is also considered a federal city.

LOCAL LEVEL

MUNICIPALITIES (21,946)
Munitsipalnie obrazovaniya

Borough of cities of federal significance (267)
Self-governed municipalities inside St. Petersburg, Moscow (and Sevastopol since 2014)

Urban neighborhoods (588)
Gorodskoy okrug
Urban neighborhoods with internal divisions (3)
Gorodskoy okrug s vnutrigorodskim deleniem
Used for the biggest cities in a region

Communes (19)
Vnutrigorodskoy rayon
Internal self-governed divisions of urban neighborhoods

Municipal districts (1,759)
Munitsipalniy rayon

- Urban settlements (1,538)
Gorodskie poselenia
- Rural settlements (17,772)
Selskie poselenia
Self-governed political divisions

- Inter-settlement territories (80)
Mezhselennye territorii
Places with very low population density
Governed by the municipal district's administration to which they belong.

Political entities of urban status are coloured in red.
Other political entities are in black.

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Source: Rosstat, 2019

10   Basically, cities as political entities in Russia can be of three different types (written in red in the figure 1): 1) the largest Russian cities of Moscow and St. Petersburg, and after 2014 also Sevastopol are considered as federal cities (cities-states) having the status of subjects of federation. These cities-states consist of boroughs, which are self-governed municipalities; 2) the biggest regional cities have the status of urban neighborhoods. Three cities, namely Chelyabinsk, Samara and Makhachkala are divided into smaller municipalities (communes); 3) small cities and urban-type settlements have the municipal status of urban settlements. The difference between urban settlements and urban neighborhoods is mostly based on the size of city territory and its place in the urban hierarchy: urban settlements are smaller in size, concern places of local significance and often still remain quite rural in terms of functions and lifestyle, whereas urban neighborhoods are larger, include cities of regional significance and have more political power.

11   Therefore, in Russia there are 3 levels of political and, thus, statistical organization: federal districts (federal), subjects of federation (regional) and municipalities (local level).

Urban agglomerations or Morphological Urban Areas

12   This approach embraces "*continuously-built urban centers forming either part of one administrative unit or a group of several*" (Pumain et al, 1992, p. 5), and considers a territory of coherent and geographically continuous entities. By using the morphological approach, we identify a city core, i.e. a territory of the densest interactions of individuals, firms and institutions. A growth of these urban agglomerations often corresponds to an urban expansion accompanied by a spread of

built-up zones, new roads and public transport. The empirical methodology for this approach was proposed by Pumain *et al.* (1992) who delineated cities as *Morphological Urban Areas* (MUA) in the European Economic Community, followed by Moriconi-Ebrard (1994), who systematized this approach on the world scale.

13   For Russian cities, this methodology was more recently applied by Cottineau (2014, a), who used the following steps to delineate MUAs in the Russian contexts:

1. Identification of urban spots using satellite images or aerial photographs. The distance threshold between two buildings to consider them as continuous is 500 meters;

2. Superimposition of the administrative mesh on these morphological entities. The contiguous local units (municipalities) were integrated, where most of the area was an intersection with the urban spot based on the satellite images.

14   This results in a delineation of urban agglomerations based on the municipality level (Cottineau, 2014, b). This delineation allows to work on the population evolution of areas, but unfortunately, no data is available for other kinds of themes such as workers and industries by activity.

15   Another study on the morphological urban areas was initiated in 2015 by the *Global Human Settlement Initiative*[2] on the world scale, that is based on built-up areas and identifies urban centers (cities), dense and semi-dense urban clusters (towns and suburbs) and rural areas.

Urban regions or Functional Urban Areas

16   An urban regions definition "comprises a nucleus town and its sphere of influence or employment catchment area, which are frequently defined in terms of commuting" (Pumain et al, 1992, p. 5). An urban region includes all dormitory towns situated around an agglomeration and these towns are usually defined by the estimation of numbers of people, who regularly go to the core city for work or study reasons, creating regular commuting flows. In other words, this definition illustrates functional borders of a city and can be called Functional Urban Areas (FUA).

17   One of the first methods harmonizing urban regions in the USSR was proposed by the American scholars (Lewis et al., 1976), who researched internal urban population shifts in Russia/USSR from the beginning of the 20th century. To delineate Russian cities, they introduce the definition of "*metropolitan area*" or "*urban region*", which means "*an area with an urban population of one million or more people based on the summation of the population residing in a major central city and other urban centers of 15,000 and over within a 50-mile radius (straight-line distance) of that central city*" (Rowland, 1998, p. 272). They explain further that "*the criterion of 15,000 and over has been adopted, because this is the smallest population size for which data on individual urban centers are available in all Russian and Soviet censuses from 1897 to 1989 [...] the 50-mile zone has been further subdivided into three "concentric" internal zones in order to assess internal geographical patterns and shifts in such patterns. These include the main central city itself; the "inner suburbs," or urban centers of 15,000 and over beyond the central city out to a radius of 25 miles from the center of the central city; and the "outer suburbs," or those 15,000-plus centers in the 25- to 50-mile zone*". The goal of this method is to estimate urban population shifts within time concerning "flexible" administrative city borders, however, for other types of analysis, such as economic analysis, other criteria need to be applied.

18   Exploring different Soviet/Russian methods used to delineate so called "urban agglomerations" ("*городская агломерация*") that are actually closer to the urban region concept, we identified two main approaches: 1) the ones focusing on transport-time accessibility of the nucleus (delimitation by transport accessibility isochrones that usually set as one and a half or two hours' time threshold to access a core) (Examples: Naimark & Zaslavskiy, 1988; Polyan et al., 1988); 2) others which focus on the labor/study commuting flows based on the local mobile operators' data (Bogorov et al., 2013; Makhrova & Bochkarev, 2017; Makhrova & Babkin, 2019). Both of these methods of urban delineation correspond to a traditional understanding of functional urban areas or urban regions in the Western urban geography, therefore, in this paper we will work with these more consistent terms.

19   Methods based on the time isochrones of a core accessibility are the most common in Russia for a functional delineation, which can be either case-specific (Burian, 1973; Skutin, 1975; Makhrova et al., 2013; Schmidt et al., 2016; Reznikov, 2017;) devoted to a particular city, or universal methods delineating functional urban areas on the national scale (Polyan, 1988; Polyan & Selivanova, 2007; Antonov & Makhrova, 2019).

20   In the Soviet geography two principal methods of urban regions' delineation were developed. The first one is the method of the Institute of the Academy of Science of the USSR (described and applied in Lappo, 1975; Lappo, 1978; Polyan, 1980; Polyan, 1982), which was one of the first attempts to define all Russian (Soviet) urban regions and started in the early 1970's, based on the census data of 1959. The basis for determining urban boundaries was an internal spatial closure of a weekly life cycle of the population (Lappo, Maergoiz, 1974). Existence and development of urban regions is founded on intra-urban relations in various fields such as production, social networks, environment, etc., which are concentrated in the central city and its main sub-centers. The method consisted of the following criteria:

1. Core population threshold: more than 250,000 people;

2. Time threshold to the core: boundaries of an urban region defined according to a two-hour (gross) isochrony transport accessibility to the city center, combined with a 0.5-hour travel time band from the big and medium cities in the periphery of urban area. Travel time from sub-centers on the periphery is considered because sometimes several functions of a core city were given to its satellites on the periphery, which led to an extension of functional linkages on the periphery;

3. Development threshold: coefficient of development is more than 1.
The formula of the coefficient of development:

$K_{dev.} = P (M*m+N*n)$

P – population of the urban area;
M and **N** are the number of official cities and urban-type settlements;
m and **n** are their shares in the total population of the urban area.

21   The authors highlighted that cities with a population of more than 250,000 people had much higher agglomerating potential, however, the existence of developed urban regions with population in a core less than 250,000 inhabitants is possible. Using this method, 84 urban regions were identified in the USSR for the year 1979.

22   An alternative method was proposed by Listengurt (1975) from the Central Scientific-Research and Design Institute for Urban Planning (*ЦНИИП ГРАДОСТРОИТЕЛЬСТВА*). This approach focused not so much on the fixation of already existing urban regions, but on the identification of groups of interrelated settlements that can potentially become, in

the future, the basis for the formation of planned and regulated systems of settlements. Listengurt (1975) formulated the following criteria:

1. Core population threshold: 100,000 people;

2. Time threshold to the core: 2 hours;

3. A share of the population of the outer zone of an urban region to its total population is not less than 10% (agglomerative index);

4. The number of urban settlements in an urban region, in addition to its core, is at least three;

5. The minimum value of the agglomerative coefficient is 0.1 (the latter is the ratio of the density of urban settlements per 1000 km² to the average shortest distance between the two nearest urban settlements within an urban agglomeration. According to the calculations of Listengurt, the values of this coefficient vary from 0.1 (a rare uniform network) to 4.3 (a dense and condensed network of urban settlements).

23　According to this method, 193 urban regions were identified in the USSR (Polyan, 1988). These two previous approaches, that are very close methodologically, were the two principal ones in the USSR until 1988, when the group of researchers namely Polyan, Naimark and Zaslavskiy proposed the "standardized method of urban agglomeration delimitation" ("*УНИФИЦИРОВАННАЯ МЕТОДИКА*") introducing different criteria to define functional urban regions (Polyan, 1988). We summarize this method in the Table 1.

Table 1. Stages of the standardized method of urban region delimitation according to Polyan (1988)

Stages of delimitation	Criteria	Urban region		
		Largest	Big	
			Polycentric	Monocentric
1	Core city	Large city (250,000 people and more)	Two big cities (more than 100,000 people) with a distance between each other not more than 50 km.	Big city (more than 100,000 people)
2	Urban region boundaries	1,5 hours from a core city along with 0,5 hours from big and middle towns on the periphery	1 hour from a core city along with 0,5 hours from middle towns on the periphery	1 hour from a core city along with 0,5 hours from middle towns on the periphery
3	Satellite zone	Not less than 4 urban settlements	Not less than 6 urban settlements	Not less than 4 urban settlements
4	Development coefficient	1,0 and more	1,0 and more	2,0 and more

24　This method is quite elaborated though it does not consider real interactions between a core city and its satellites, such as, commuting flows (which are not collected). Within the last national delimitation of Russian urban regions, based on this standardized

method (Polyan & Selivanova, 2007), 52 urban regions have been identified, 43 of which (or 83%) are situated in the European part of Russia. Eight urban regions are located in the regions of Siberia and only one in the Far East: Vladivostok. However, Siberia and Far East include most of the potential urban regions, such as Khabarovsk, Chita, Komsomolsk, Ulan-Ude etc. This means that in these parts of Russia, developed urban regions, with established large functional linkages, are still in the phase of formation, and they still need to accumulate existing economic and human resources to complete this urbanization process. According to this approach, from 1989 to 2002, only one urban region around Grozny disappeared (which is the consequence of the civil wars in this region in the 1990s), and only one around Tyumen appeared (Polyan & Selivanova, 2007).

25   Another research on the national delineation of FUAs focuses only on the 36 largest urban areas with a population of more than 500,000 inhabitants in the core city from 2010 to 2018 (Antonov & Makhrova, 2019). This research introduced an interesting graduation of three levels of delineations: 1) "*minimal*", including a core and all the neighboring municipalities; 2) "*basic*", including municipalities around a core in which most of the population lives within a 2-hour isochrone of transport accessibility from the agglomeration core; 3) "*extended*" variant of the delimitation is also distinguished on the basis of the transport accessibility of a core, however, it includes those municipalities that only partially enter the 2-hour isochron. Using the coefficient of development proposed by the Institute of the Academy of Science of the USSR (presented earlier in this paper), the authors conclude that most of the FUAs in Russia have a low development coefficient, except Moscow and St. Petersburg, and evolve due to their core-cities, which serve as drivers of development for the FUAs.

26   Considering that only one new region has been formed in the last 13 years (Tyumen), some researchers agree that the formation process of urban regions in Russia is almost complete. Today the development of the established urban regions goes towards the intensification of ties within the already existing urban regions, towards the contraction of the population in them and, as a consequence, to the increase in the development coefficient of these urban regions (Lappo et al., 2007; Polyan & Selivanova, 2007). This tendency of the intensification of intra-urban processes in the established FUAs, instead of an emergence of new ones was illustrated by the recent research of Antonov & Makhrova (2019).

27   To analyze emergence and development of existing FUAs, a case-study strategy, based on the big data analysis have been used. For instance, Moscow's FUAs boundaries were defined based on data from mobile operators on users' localization, which show stable commuting flows (Makhrova & Bochkarev, 2017; Makhrova & Babkin, 2018; Makhrova & Babkin, 2019). The authors show various districts-attractors of inhabitants and changing population distribution around Moscow depending on daily, weekly and seasonal fluctuations of population. They identified that a winter working day is the time of the highest population concentration (contraction) in the city of Moscow and especially in its areas-attractors (districts with developed labor market, study and commercial functions). By contrast, in a typical summer day off the population is spread in the Moscow oblast municipalities (outside the city of Moscow), where people have their summer residences ("*ДАЧА*"), which decrease the population of the city of Moscow down to 30% compared to a typical winter work day (Makhrova & Babkin, 2018). Having identified commuting flows' patterns in Moscow, they conclude that daily

commuters "shrink" the city, concentrating the population in the central districts-attractors, whereas weekly and seasonal commuters "extend" it, spreading the population further around the core and, therefore, creating a dynamic FUA around Moscow.

28   Having discussed the principal methods used for urban regions delineation in the Russian context, we can establish the following groups of criteria, which were considered by different authors:

1. The criteria for the core city (first of all, number of inhabitants);

2. Boundary criteria: spatial, temporal or another radius;

3. The criteria of the satellite zone (the number and population of urban settlements in it, their relationship with the core, functional complementarity);

4. The criteria of real interaction (intensity of various flows and connections, primarily, commuters); criteria characterizing urban region' integrity (population density, complexity, development, agglomerativeness, etc.). It is clear that the criteria of this group are those of control, since their values can be obtained only after a territory is delimitated as an urban region.

29   In February 2019, *The Strategy of Spatial Development of Russia until 2025*[3] was approved by the Russian government, which is currently the main document defining a forecasting vision of the development of urban regions in Russia. This document, devoted to the spatial economic development of different Russian territories ("subjects of the federation"), highlights urban centers as the main drivers of regional economic development, defining centers of economic growth and describing perspectives of regional economic specializations. Urban regions are understood as a set of compactly located settlements and territories, connected by the joint use of infrastructural facilities and united by intensive economic, labor, and social ties. In other words, an urban region is basically a core municipality (a legal city) with surrounding zones gravitating towards its core, which include both rural areas and small and medium-sized cities, so the development of urban regions allows better consideration of the diversity of settlements' types. Particularly, there are two types of urban regions mentioned in this Strategy: large (from 500,000 to 1,000,000 people) and the largest (over 1,000,000 people). In total 41 urban regions were identified, despite the fact that the method of delimitation was not precisely described in the Strategy and the authors did not provide any references to any external methods (Kuznetsova, 2019). According to Zubarevich (2019), in the beginning of the development of this Strategy, around 20 urban regions were delineated, leading to 41 urban regions in the final version approved by the Russian Government. She argues that this increase from 20 to 41 is a consequence of the typical Russian lobbying system of regional authorities hoping to obtain additional funding from the federal government. Considering that all these official urban regions receive strong additional governmental financial support for further development, this interpretation seems to be quite realistic.

Polynuclear urban regions, or conurbations

30   The last urban concept refers to polynuclear urban regions or conurbations that are defined as "*continuously-built but comprise a number of centers polarizing human dealings*" (Pumain et al., 1992, p. 5). Often, these urban forms are "*the product of a number of urban agglomerations or regions which, though initially separate, have become merged as a result of*

their geographical spread" (Pumain et al., 1992, p. 5). In the Russian context, research on conurbations is almost always very scarce, which can be explained by the dominancy of monocentric regions that are studied as functional urban areas. Lappo (2012) identifies only 4 conurbations in Russia, including several cities of comparable size (cores): 1) Samara-Togliatti-Syzran; 2) Caucasian Mineral Waters; 3) Rostov; 4) Kuzbass. Usually, these conurbations are studied either as a single case-study (Lyubovnyy, 2011), or along with other urban regions within a national delineation (for instance, the Strategy of Spatial Development of Russia until 2025, 2019).

The need for a new urban delineation

31   Exposing the main conceptual approaches to cities' delineation, we highlighted that the mainstream of studies since Soviet times is focused on the urban regions approach (Functional Urban Areas - FUA), which is different from the morphological urban agglomeration approach (MUA) spread amongst European studies. However, all the proposed methods of urban regions are quite limited, first of all because they are focused only on the largest cities applying a certain population threshold (over 100,000, 250,000 or 500,00 people). Another serious limitation of these approaches is their normative method, delineating urban regions with the same criteria, despite very different core city sizes. For example, when delineating urban agglomerations of a city with 100,000 inhabitants and with 12 million inhabitants (like Moscow), these methods use the same thresholds of commuting time, however, these cities have incomparable influence on their surroundings. The approach of Rowland (Lewis et al., 1976; Rowland, 1998) is convenient for the retrospective population dynamics analysis, however, it also has the same limitation of the normative criterion of a distance from a core: regardless of the core city size, the distance of 50 miles should be unchanged.

32   The MUA approach identifying physical borders of all settlements based on the built-up area incompletely encompasses the whole cities' influence area and is focused mostly on so called urban expansion. However, this MUA method can help to observe dense distribution of population around a core city that is an important factor to identify the higher influence zone of this core city (for example, the world atlas of the Global Human Settlement Initiative [2015] can be used). For different reasons, the first concept of a city within its administrative boundaries cannot be used for comparative studies: arbitrary denomination mostly based on political connivance has importance but cannot constitute a criterion to compare cities' properties.

33   In this paper, we propose an urban delimitation that would include areas that likely host multinational companies whose location is most dependent on the access to high level services, in particular to airports with a good level of connectedness. We argue that this definition would better show the rank of a city in global urban hierarchy and, therefore, would be more appropriate to compare Russian cities to other cities of the world. Thus, we apply the new concept of Large Urban Regions in the Russian context that Rozenblat (2020a) developed for most of the cities of the world (Database "Large Urban Regions of the world", Rozenblat, 2020b). This implementation would be, on one hand, *universal* as we apply it to all Russian cities using the same concepts and the same set of criteria (such as development of transport networks, population density, presence of an airport etc.), but on another hand, *case-based* as we consider every city separately and we do not necessarily use systematic thresholds (for example, we do not

argue that all core-cities must have at least 4 town-satellites, but adjust it in every case). Based on this mixed approach, *our principal objective of this new urban delineation is to make Russian cities comparable on the world scale in order to be able to study their integration in globalization.*

34   We argue that in order to study cities' insertion into global processes we should adopt a broader urban definition, which besides a core city itself, also includes the whole accessible surrounding territory. All the urban and rural spaces around core cities benefit from the access to their services and developed infrastructure, such as freeways, high speed trains or an airport, and consequently, all the firms located around cores take advantage of the regional process facilitated by dynamics of a core city (Rozenblat, 2020a). Therefore, in this paper we elaborate the concept of Large Urban Regions applicable to Russian cities that include a city core and an urban region around it, that together become a comparable urban definition on the world scale. Being applied to the Russian urban context, the approach of Large Urban Regions (LUR) contributes to the research on the globalization process of cities of transitional economies (i.e. countries that have transitioned from central-based economic systems to market-based economic systems) with a further aim to compare it with the same processes in the cities of developed countries.

Redefinition of Russian cities through Large Urban Regions

35   The concept of Large Urban Regions (LUR) proposed by Rozenblat (2020a) is a new urban definition, which can be used for *comparative socio-economic analysis of cities* particularly in the context of cities' economic globalization and their integration into a "world city network". She defines Large Urban Region (LUR) as an aggregation of administrative local units around a core city, which are economically influenced by this core, meaning that they have important local interactions constructing a unique regional urban system. The area around a core is different for every city, depending on the economic power of the core city, the general density of the city location, the density of transport networks, the continuity of population density, the historical constitution of the cities and the administrative and political regional borders (*oblasts*: subjects of federation). Also, a critical feature to define a core of LUR is the presence of an important airport, as a main gate to the whole region, through which all the aggregated local units can be accessed easily by visitors, but also that local economic actors can use for their global activity.

General method to delineate Russian LURs

36   Being a universal conceptual framework of cities' delimitation, LUR method remains context (country)-specific in the process of its construction. Below we describe steps for delineating Russian LUR:

Units of aggregation

37   Ideally, in order to construct LUR we should aggregate the smallest municipal units, which are, in Russia, urban neighborhoods (*gorodskoy okrug*), urban settlements

(*gorodskie poselenia*), rural settlements (*selskie poselenia*), and boroughs of the federal cities[4]. However, firstly, due to the lack of economic data for urban and rural settlements (only population data is available) such as the number of employees, unemployment rate, data on industrial sectors, and secondly, due to the lack of political and economic power of these types of municipal formations, we decided to take municipal districts, which include urban and rural settlements. Instead of boroughs of the federal cities, we took the entire cities' territories.

Identification of the core cities

38   The core city of a LUR can be identified with night satellite images provided, for example, by Google[5]. We also used, as a starting point, the DARIUS database on morphological urban areas (Cottineau, 2014, b), which includes urban settlements with a population of more than 10,000 people that we completed by considering the zones defined by the Global Human Settlement Layer (GHSL, 2015).

Selection of aggregation units around the city cores

39   In order to select districts for potential borders of a LUR, we should first look at the distribution of towns and other urban settlements around a core city according to the satellite images and according to DARIUS. As a starting point for a distance measurement from a core, we offer to use the principal airport, which is particularly helpful in the case of polycentric urban areas, where an airport can be between cores (case of Samara-Togliatti, similar to other cases in the world such as Bonn-Cologne in Germany). Then, we should check their connectivity with a core (road's networks and railroads), as well as to consider a distance criterion. A distance threshold varies in every case, it mainly depends on the size of a core city (the bigger a core city is, the bigger its influence zone is), on accessibility to urban settlements around a core, their sizes and economic importance, and on the relative density of the region. Along with other satellites, we aggregate mono-industry cities (*monogoroda*), scientific cities (*naukograd*) and closed cities (*ZATO*) located around a core, as important regional centers of industry and innovation.

Respecting regional borders

40   Due to the specificity of the Russian context, we decided to respect political borders of the subjects of federation, because every federal subject differs substantially in terms of all economic indicators, governmental financial support and regional policies. Therefore, we assume that urban settlement in every subject of federation gravitates towards its capital city, and not to a city belonging to another subject of federation (here we also take into consideration a strong hierarchy of urban settlements in Russia, set by Catherine the Great and working well still today). However, there are some exceptions, where we had to integrate some districts of neighboring oblasts that are described further in the section 4 of this paper. Selecting districts for LUR, we also avoided including highly agricultural areas that might be within a set distance from a core, which are lacking urban activities (sometimes there are not even any towns there, only villages) and completely rural in their essence.

41   Following all these conceptual criteria, we aggregated districts around each core-city following the proposed method. Thus, we constructed cities according to the statistical

concept that is called *large urban region* (Rozenblat, 2020a), which become comparable on the world scale and allow us to evaluate their mutual relations and their insertion into global processes.

## Two case studies of Large Urban Regions' delineation in Russia

42   To illustrate the delineation of Large Urban Regions (LUR) we selected two examples: a) St. Petersburg, as a monocentric urban structure and the second city in Russia, in terms of population, economic and political power; and b) Samara oblast characterized by its polycentric organization. By selecting these two types of cities, we want to illustrate the application of the LUR delineation on the two very different local urban organizations. This section presents the delineation procedure in great detail for these two case studies, in order to make the method clear and illustrate its reproducibility. The evaluation of the effectiveness of this method for international comparisons will be examined in the following section.

Example of St. Petersburg: monocentric LUR

43   St. Petersburg is the second largest city in Russia, with a population of 5.3 million inhabitants, in its administrative borders (Rosstat, 2018). The city is a separate subject of federation (city-state), surrounded by the Leningrad oblast (1,8 million inhabitants (Rosstat, 2018)), which has international borders with the European Union: Finland on the North (around 150 km from the center of St. Petersburg) and Estonia on the West (around 130 km from the center of the city). St. Petersburg is an important economic and industrial center of the country: according to the Gross Regional Product (GRP) it takes the third place in Russia, after Moscow and the Tyumen oblast, an oil-rich city bordering Kazakhstan (Rosstat, 2018).

44   In terms of urban geography, St. Petersburg is clearly a monocentric city, which is a core city for the whole surrounding region, as revealed by the satellite image at night (Fig.2). To identify the borders of a large urban region around St. Petersburg, it is important to first understand the distribution of population and settlements around the core city.

Figure 2. Population distribution around St. Petersburg
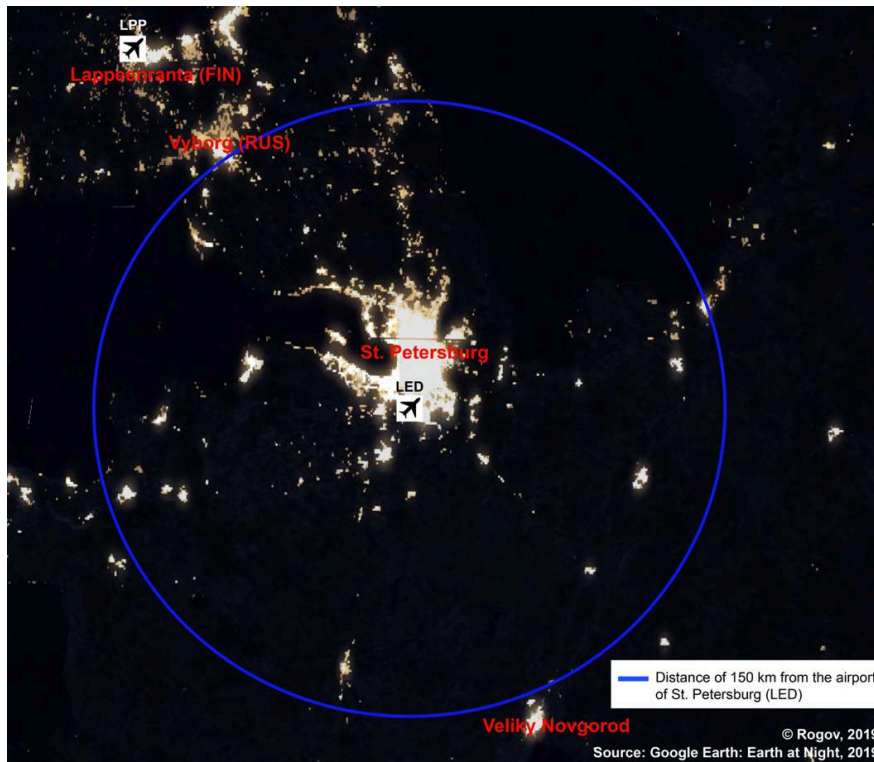
45   The distribution of the population around St Petersburg's core goes most intensively to the North towards the border with Finland and to the West, towards the border with Estonia. Probably, because these two directions go along the Finnish gulf, and people prefer to live close to water. Secondly, the North is particularly famous due to its diverse and numerous water recourses: variety of lakes and rivers. Also, both of these directions lead to countries of the European Union: Finland and Estonia, which are very popular amongst local people for so called one day "shopping" tourism. Therefore, these two axes have great advantages of their economic-geographic situation, especially, the North because of Finland. The population distribution in the East and South is apparently mostly along roads and is more discontinuous.

46   As a core point, we take the international airport of St. Petersburg Pulkovo (LED), considering it to be the main gate to the whole surrounding region. Pulkovo is the fourth largest airport in Russia after 3 principal airports in Moscow (SVO, DME and VKO) with more than 18 million passengers of traffic in 2018, 7 million of which from international traffic[6]. At the same time, just next to the border between Finland and Russia (20 km from it), there is the international airport of Lappeenranta (LPP) that could also be a potential gate to Vyborg and other settlements in the Northern part of the region, because it is much closer than the airport in St. Petersburg (50 km instead of 150 km). However, we do not consider it as a principal gate because of two main reasons: 1) between Russia and Finland there is a visa regime, which makes access to the airport in Lappeenranta more complicated; 2) the airport in Lappeenranta is quite small and provides only a few flights to the European Union and worldwide.

47   The road network around St. Petersburg (Fig.3) reveals the accessible morphological urban areas (MUA) identified by C. Cottineau in her database DARIUS (Cottineau, 2014, b). Every MUA is an urban settlement that has either the legal status of a city (this way

population does not matter), or an urban-type settlement that has a population over 10,000 inhabitants[7]. With the transportation and the density of MUAs defined by Cottineau (2014 a, b), we observe that in the direction of Finland and Estonia the road network is much denser and the number of MUAs is greater than in the South-East direction, which corresponds to the population distribution shown in the figure 2.
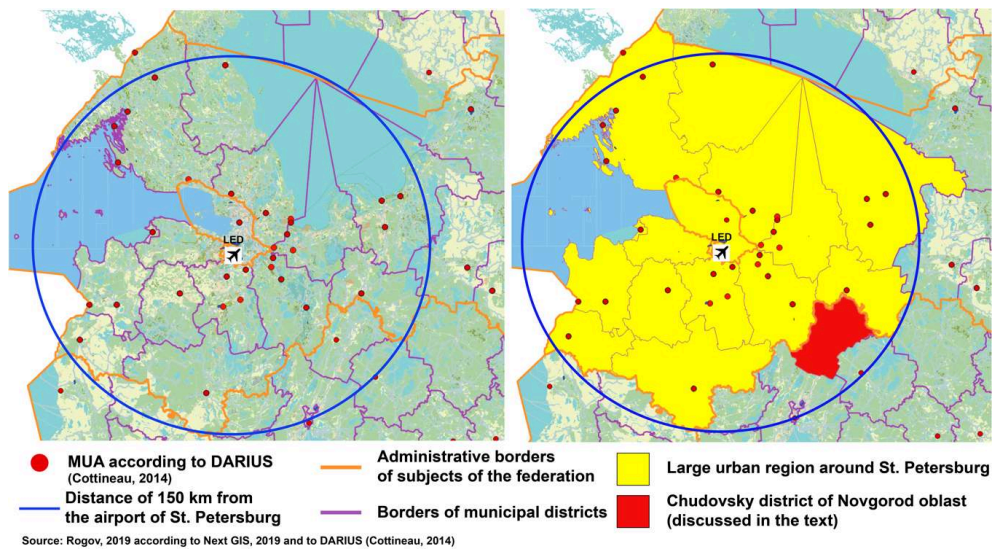
Figure 3. Road networks and MUA around St. Petersburg

48   Since we assume that most of the economic activities take place in cities, we find it important to analyze the distribution of MUAs around a core city. LUR being an urban definition for studies on the economic integration of cities into global processes must include smaller regional economic sub-centers. Therefore, in order to delineate the LUR of St. Petersburg, we propose to include all the MUAs within 150 km from the airport LED as being better linked by a transport network and respectively having a higher economic dependency from St. Petersburg.

49   To construct LUR as a large statistical unit, we should aggregate in a continuous way the smallest statistical units, such as municipalities. However, as already mentioned, since Rosstat provides only population data for municipalities, and not any economic indicators, such as employment and production data, we will aggregate entire municipal districts ("*rayon*" in Russian, which are sets of municipalities). It is reasonable to do so also because municipalities in Russia do not have a lot of political and economic power to influence local economic processes, concerning firms' activities, investment attraction etc. Usually these types of questions are addressed by districts' (*rayons*) administrations.

Figure 4. Discussing the delineation of the Large Urban Region (LUR) around St. Petersburg

MUA according to DARIUS (Cottineau, 2014)
Distance of 150 km from the airport of St. Petersburg
Administrative borders of subjects of the federation
Borders of municipal districts
Large urban region around St. Petersburg
Chudovsky district of Novgorod oblast (discussed in the text)

Source: Rogov, 2019 according to Next GIS, 2019 and to DARIUS (Cottineau, 2014)

50   In the figure 4 we represent the region around St. Petersburg, with the borders of municipal districts and the borders of the Leningrad oblast. On the right side of the picture we highlighted, in yellow, the selected districts we propose to aggregate as LUR around St. Petersburg. We follow several main criteria:

1. an equal maximum distance radius from the principal airport (Pulkovo, LED): we selected a zone of 150 km;

2. inclusion of districts with MUA: in this case they all encompass at least one MUA;

3. we respect the borders of the subjects of the federation, because institutionally and regarding economic organization, they differ substantially, which is of crucial importance for business.

51   The inclusion in the same subjects of the federation is the reason why we did not include some districts of Novgorod oblast in this LUR and particularly, the Chudovsky district (in red in Figure 4), which otherwise absolutely has to be integrated into this LUR: first, because it is completely within a distance threshold of 150 km; and second, crossed by highways towards Moscow which means it is well connected and accessible. However, since Chudovsky district is in the Novgorod oblast, it is closer and more accessible to Novgorod city, we assume that it gravitates towards Novgorod city and is part of the Novgorod LUR, as well as the other districts of the Novgorod oblast. Resnikov (2017) as well did not include it in the St Petersburg FUA.

52   Four districts in the Eastern part of the Leningrad oblast were not integrated into LUR for the following reasons: 1) they are too far from the core (more than 150 km, which would be equal to more than two hours' drive by car); 2) these regions are very poorly populated: there are only 5 MUAs with an average population of 26,000 inhabitants per MUA, out of 1.8 million citizens of the whole Leningrad oblast (Rosstat, 2018).

53   Thus, we selected 14 districts in the Leningrad oblast and the city of Saint-Petersburg as forming a unique Large Urban Region that we will call Saint-Petersburg LUR. Based on the analysis of population distribution and road networks we identified the territories around St. Petersburg that gravitate towards it, and, therefore, are better connected and more easily accessible than others. Also, we respected the political context and we did not aggregate districts of other subjects of federation. Compared to

the delimitation of urban agglomeration around St. Petersburg, done by Reznikov (2017), which is completely functional, the Saint-Petersburg LUR is much bigger. Moreover, the Reznikov (2017) delineation is not composed of entire municipalities or districts and, thus, statistics are difficult to collect). In figure 5 we illustrated four different delineations of St. Petersburg: political definition, MUA, FUA and LUR.

Figure 5. Comparison of different delineation concepts applied to St. Petersburg
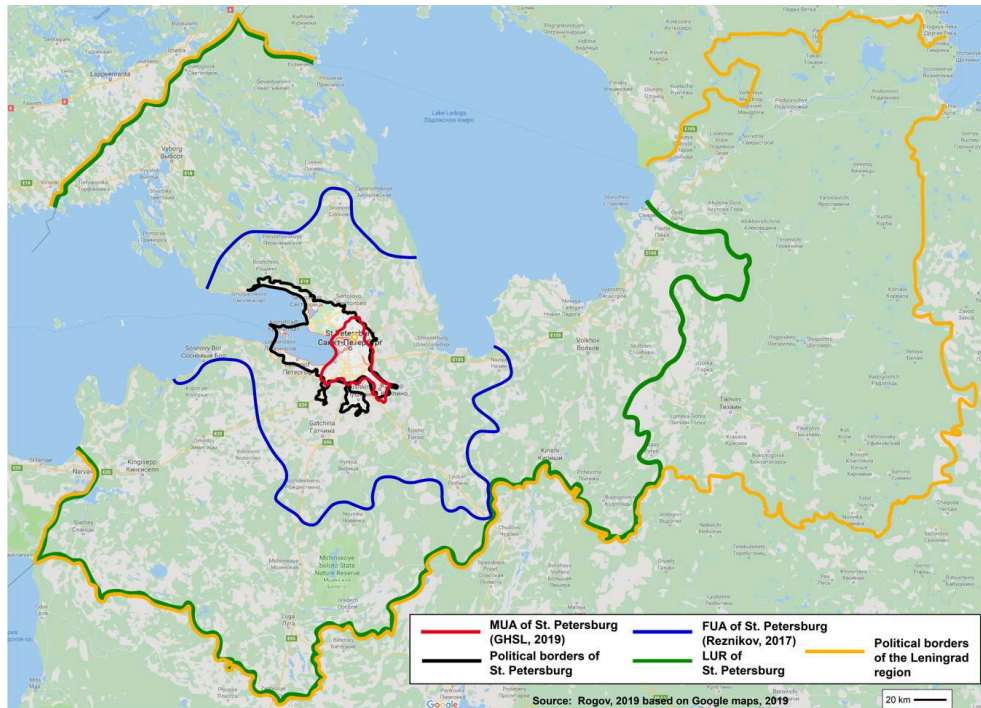
54   Among these different concepts, the MUA, according to GHSL (2019) is the smallest one, within the political borders of St Petersburg. The FUA defined by Reznikov (2017) is larger, and the LUR is even larger. To construct the LUR, all the other "smaller" delimitations can be nested inside. Along with the territory, the population also changes according to different urban definitions (Tab.2).

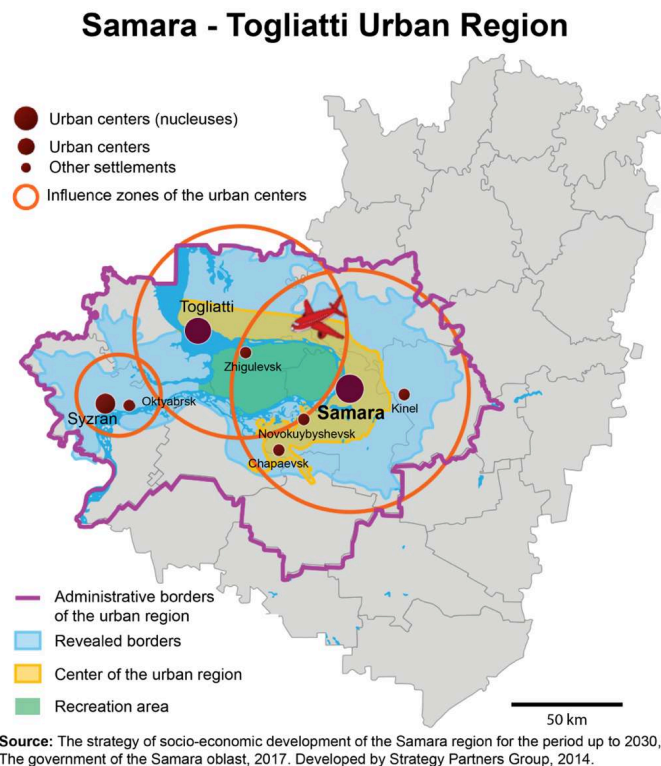**Table 2. Comparison of population of St. Petersburg according to different city concepts**

Concept of city delineation	Population	Source and year
Political borders of St. Petersburg city	5,351,935	Rosstat, 2018
Morphological Urban Area (MUA)	4,300,867	The Global Human Settlement Layer (GHSL), 2015
Functional Urban Area	6,266,104	Reznikov (2017); Calculation by the authors, 2019 based on Rosstat, 2018
Large Urban Region (LUR)	6,987,987	Rosstat, 2018

55   Therefore, LUR is the largest urban concept that includes the whole region around the core city of St Petersburg. To construct the LUR, we aggregate administrative units, ideally on the smallest level (municipality), but in the Russian context, because of the data availability, we took the level of a municipal district, which is an aggregation of smaller municipalities (and comparable to the US counties that constitute Statistical Metropolitan Areas [SMAs]). Then, we can consider this LUR as comparable to the Greater London region or with the New York Combined metropolitan statistical area - CMSA (Rozenblat, 2020a).

Example of Samara oblast: polycentric LUR

56   In order to consolidate the methodology, we consider a second example, Samara, which will lead to a construction of a polycentric LUR. Samara is one of the largest industrial centers of Russia. Together with Togliatti city, it forms a joint economic region, which is specialized, particularly, in mechanical engineering, car manufacturing, metalworking, oil extraction and chemical industry (for example Mokina, 2012; Simonova et al, 2015). The biggest cities of Samara oblast are situated along the Volga river, and two of the biggest ones (Samara and Togliatti) around a peninsula formed by the Samara bend of the Volga river. Due to the proximity of these two cities, their comparable big sizes and their high industrial development for a long time (the largest automobile manufacturer in the USSR and in Eastern Europe "AvtoVAZ" was founded in Togliatti in 1966), this urban region is well studied in the economic geography perspective. Traditionally, it was considered as a two-core conurbation (Lappo et al, 2007), despite the methods of delimitation that varied from one study to another (Smirnov, Yakovlev, 2014; Titov et al, 1996; Lyubovnyy, 2011). In addition, the local government launched an official strategy of development of Samara oblast in 2017 that defined the so called "Samara-Togliatti urban region" which, besides two cores – Samara and Togliatti – also includes several surrounding administrative districts (Fig. 6).

Figure 6. Samara – Togliatti Urban Region for strategic development.

Source: The strategy of socio-economic development of the Samara region for the period up to 2030,
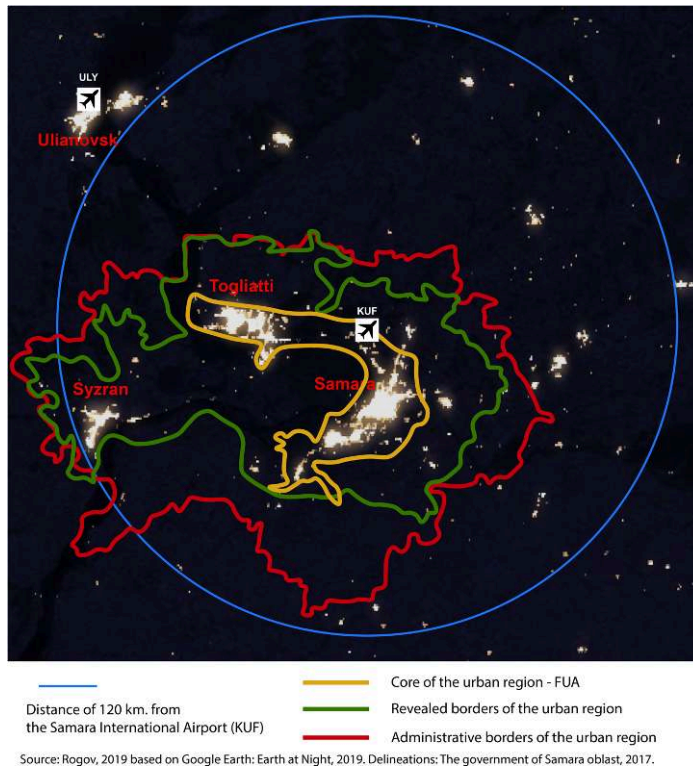The government of the Samara oblast, 2017. Developed by Strategy Partners Group, 2014.

57   The Strategy of socio-economic development of the Samara oblast for the period up to 2030[8] suggests that the Samara – Togliatti urban region is made of the largest cities (two cores and one potential core) and surrounding towns gravitating towards them. In fact, the delineation of the Samara – Togliatti strategic urban region, defined by the oblast government, includes two core cities and the main smaller cities that are situated in the influence zone of the cores (these zones are defined by the local government in the Strategy and are proportional by the size of corresponding core cities). In terms of the urban concepts, we can say that the center of the urban region (in yellow in Figure 6) defined by the Strategy corresponds to the FUA definition, whereas so called "revealed borders", which include the influence zones, might correspond to the LUR definition. What is particularly interesting, is the fact that the Strategy Partners Group defines administrative borders of this conurbation, consisting of smaller statistical units such as districts, and therefore, it becomes itself a single statistical unit similar to constructed LURs. This urban region is amongst the 41 urban regions included in the federal Strategy of Spatial Development of Russia until 2025, and therefore, its defined political borders are officially recognized by the Russian government as a type of delineation, however, without pre-defined specific institutional power. Syzran, situated in the Western part, was not defined as a nucleus, however, the authors of the strategy admit, that, in the future, it will become one and the region will transform into a three-cores conurbation. To verify the relevance of this delineation, we redefine below this conurbation according to the criteria of LUR, as defined in the beginning of the section 3 and already discussed in the example of St. Petersburg.

58   To understand the distribution of population around this urban region we look at the night satellite image of Samara oblast, where we drew the official existing delineations (Fig.7).

**Figure 7. Population distribution around Samara and different delineations**

Source: Rogov, 2019 based on Google Earth: Earth at Night, 2019. Delineations: The government of Samara oblast, 2017.

59   The main airport (and the only one) of the whole Samara oblast is the International Airport Kurumoch (KUF), situated between Samara and Togliatti. Being the main international gate to the whole region, this airport has very heavy passenger traffic: in 2018 the total passenger traffic reached 3 million, with 782 thousand being international passengers[9]. Therefore, due to its central position, it allows us to consider it as a central point for the potential LUR. Thus, to include Syzran we should use a distance threshold from this airport at least around 120 km which we can see on the picture. The use of this threshold allows us to also include smaller industrial cities in the North and East in case they are well connected to the cores by roads. To verify this, we look at the map of a road network around these two cores, where we also situated MUAs identified in the database DARIUS (Cottineau, 2014, b) (Fig.8).

Figure 8. Road networks and MUAs around Samara.
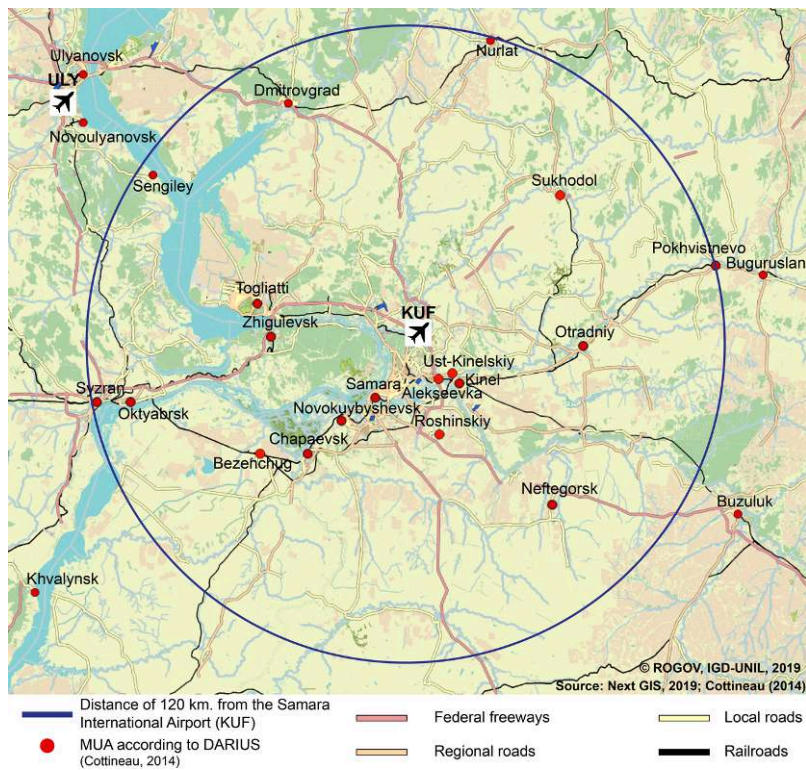
60   We see that the road network is quite well developed in both the North and East, which links little industrial satellite towns to the cores. Also, in these directions there is a railroad that serves as another link to the cores. Since in the North-West direction there is another large city, which is the center of Ulyanovsk oblast, that has its own public airport ULY, we assume that it creates its own LUR around itself and therefore, we would include smaller cities in the North-West in that LUR, and not in the Samara LUR. Another reason for this is the political borders of two different oblasts that we want to respect (see the figure 9).

Figure 9. Resulting LUR of Samara compared with other delineations.
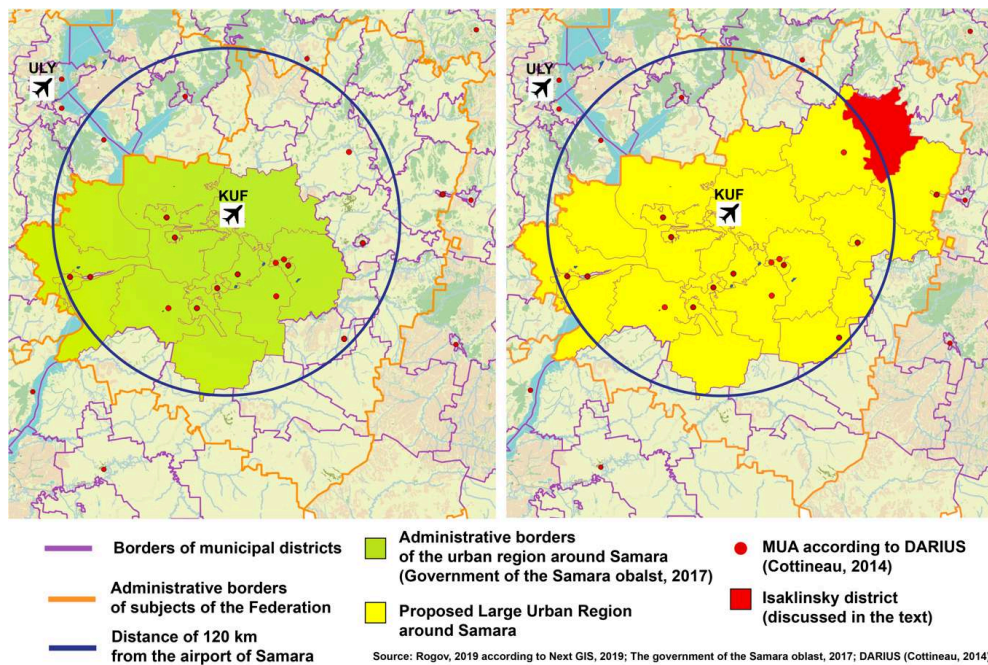
61   Thus, we propose to extend the official definition of Samara LUR and include more districts that first, are well connected to the cores, and second, have MUAs. Based on the accessibility criterion and distance from the airport, we finally decided to extend existing delineation to six districts in the East-North direction. The main criteria for this selection were: 1) proximity to the KUF airport; 2) presence of highways in districts (some of them are crossed by interregional roads); 3) presence of MUAs in districts; 4) continuity of districts. Also, before the inclusion of any districts in a LUR, we should pay attention to the industrial importance of a district, particularly if some of the main criteria are not met. In the case of Samara, we hesitated about the Isaklinsky district: it does not have any MUAs, it is not crossed by any major roads, however, for continuity reasons and because it is just on the border of the 120 km threshold from the core we could include it. To take a decision, we explored the economy of this district and its importance for the oblast. It turned out that this district is completely agricultural and it does not have any petrol extraction companies or high-tech production, which means that, in its essence, the district remains rural. Therefore, we decided not to include it in the Samara LUR. The neighboring Pokhvistnevsky district, which is the same distance to the Samara airport, encompasses a MUA; Pokhvistnevo (over 28 thousand inhabitants[10]), which is much more urbanized and directly linked with a regional road to Samara. Thus, we included the Pokhvistnevsky district in the Samara LUR.

62   In the figure 10 below we compare different existing delineations. By extending the urban region of Samara and including more economic nodes (official cities) than the government of the Samara oblast suggested in 2017, we can better represent the economic power of the region on the world scale. The urban region delineation proposed by the government is quite good for identifying a zone, where most of the economic activities of Samara oblast take place. The fact that this delineation is included in the Federal Program of Spatial Development and the selected districts receive additional financial support, clearly leads to an acceleration of interactions

between local economic agents and, therefore, for bolstering local economy, which is the main objective of this delineation. Another goal of this official delineation is to support, so called, mono-cities-satellites by diversifying their economies and also to strengthen Syzran and make it the third core of this urban region, which might explain why this delineation goes clearly towards Syzran and not so much towards the North-East of the oblast. However, for a comparison of cities on the world scale, we find it important to include as many towns around a core as possible. Therefore, we decided to extend the existing delineation of Samara urban region and to include towns that are within a certain distance threshold and well connected to the cores. We did not include the periphery of the Samara oblast in the Samara LUR because these districts exceed the distance threshold, are not very well connected or have a highly rural economy (mainly agriculture). In figure 10 we map different existing urban concepts of Samara.

Figure 10. Comparison of different delineation concepts applied to Samara
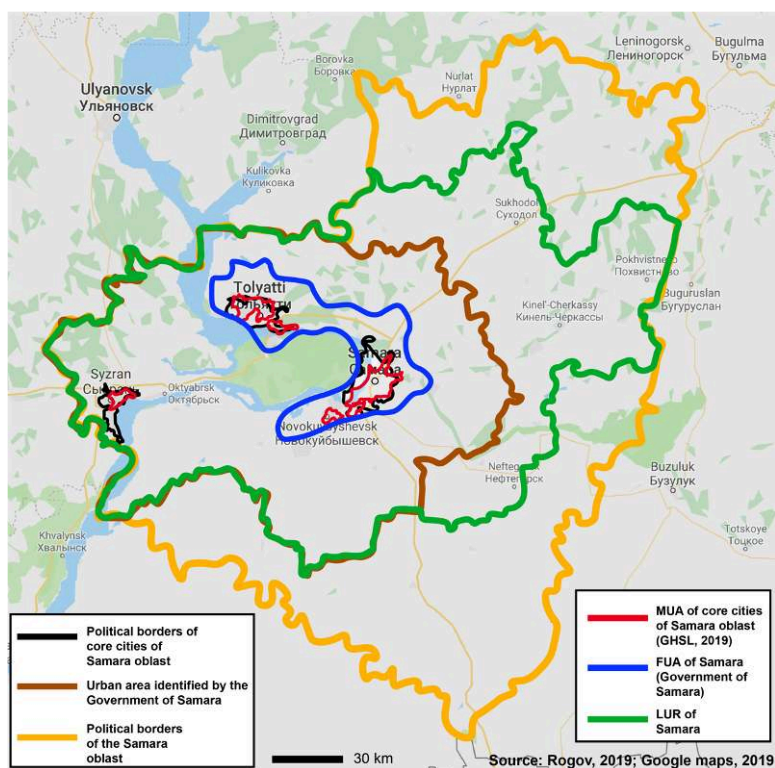
63   All the existing delineations of Samara are nested one in another. We can divide them into two different types:

1. *Political delineations*, which are state-financed and/or managed by local authorities, such as administrative borders of the cities, the urban area defined by the government of the Samara oblast and the oblast.

2. *Scientific delineations (MUA, FUA, LUR)*, which are proposed by scientific institutions in order to address specific research questions. There is no political body that governs a city in its conceptual borders and respectively a city in these borders is not state-financed but one assumes that they constitute some consistent spatial systems that must be considered for planning or for comparison with other cities.

64   For comparison of these different urban concepts we provide below a table with population data (Tab.3).

Table 3. Comparison of population of Samara according to different city concepts

Concept of city delineation	Population	Source and year
Political borders Samara city Urban area (Gov.) Samara oblast	1,163,440 2,825,975 3,193,514	Rosstat, 2018 Rosstat, 2018 Rosstat, 2018
Morphological Urban Area (MUA)	900,591	The Global Human Settlement Layer (GHSL), 2015
Functional Urban Area (Gov.)	2,176,854	Calculation by the authors, 2019 based on Rosstat, 2018
Large Urban Region (LUR)	2,999,689	Rosstat, 2018

65   The Morphological Urban Area (MUA) defined by the Global Human Settlement Layer (GHSL, 2015) is more restricted than the political border of Samara. The Urban area defined by the Samara Oblast, including all the districts until Tolyatti and Syzran, double the population. Thus, the LUR, more widely delineated, adds more than 170,000 inhabitants. With the LUR, we can consider Samara-Tolyatti-Syzran as an urban region comparable to St Petersburg, for studying its capability to insert in the globalization. It is also comparable to other Large Urban Regions of the world. The criteria and thresholds are not necessarily strictly identical, but the conceptual approach is similar and adapted to the Russian regional contexts.

Harmonized urban definition in Russia: towards economic globalization research

66   In total we defined 120 Large Urban Regions in Russia: the principal criteria to define a core city of a LUR was the presence of an airport and then, we used an airport code as a universal code of the LUR, similar to other LURs of the world (and for cities having different airports, we choose the code of the main airport) (Rozenblat, 2020a; Rogov, 2020). One LUR contains several morphological urban areas, which explains the big difference between the resulting 120 LURs in Russia, and the 1,330 MUAs identified by C. Cottineau (2014, b). The morphological aspect of a city is one of the important criteria to construct LUR and therefore, in this study we used the database of C. Cottineau (2014, b) as a main source of MUAs for Russia. Thus, the 120 LURs encompass more than 90% of the Cottineau's MUAs.

67   To construct each LUR we manually aggregated different types of municipal formations[11] in Russia, selecting them "by hand" and discussing for every case. All of these municipal formations have an official code OKTMO[12], which has the following format: OKTMO is a AA BBB CCC DDD code, where AA is a code of a subject of the Federation; BBB is a code for a municipal district (*munitsipalniy rayon*) or urban neighbourhood (*gorodskoy okrug*); CCC is a code for rural settlements (*selskoe poselenie*)

or urban settlements (*gorodskoe poselenie*), which are continuous municipalities, and DDD is a code for a single settlement inside a municipality. In LUR construction we did not use DDD level because of the non-continuity of settlements. Using the same set of criteria that were discussed earlier in this article, and based on the code of municipal units that we used for the LUR construction, we made the following assumptions:

1. Municipality

68   As local units or municipalities we consider municipal formations of the level C in the OKTMO code, namely rural settlements (*selskoe poselenie*), urban settlements (*gorodskoe poselenie*) or inter-settlement territories (*mezhselennie territorii*) as a part of municipal districts. However, since urban neighbourhood (*gorodskoy okrug*) is not divided into smaller local units (besides a few exceptions), we consider it both as a municipality and functional urban area. For federal cities we consider their intra-city territories (*boroughs*) as municipalities.

2. Functional Urban Areas

69   As Functional Urban Areas (FUA) or districts, we consider municipal formations of the level B in the OKTMO code, namely municipal district (*munitsipalniy rayon*) or urban neighbourhood (*gorodskoy okrug*) as bigger continuous municipal units. For the three federal cities (Moscow, St Petersbourg, Sevastopol), we consider the entire city territory as a functional urban area (FUA).

3. Large Urban Regions

70   To construct Large Urban Regions as single statistical units we aggregated different FUAs. As mentioned before, in general we respected the political borders of the subjects of federation, besides several special cases: 1) the two federal cities that form the same LUR together with the surrounding region (St. Petersburg is joined with the Leningrad oblast; Sevastopol with the republic of Crimea). 2) Moscow as the biggest Russian metropolis has an economic influence far beyond its political borders, and thus, the LUR of Moscow includes entire Moscow oblast and some bordering municipal districts of the neighboring oblasts, such as Tula oblast, Tver oblast, Ryazan oblast and Vladimir oblast including their administrative centers. Other surrounding oblasts such as Smolensk, Yaroslavl and Kaluga are much more accessible due to the presence of airports and, therefore, they form separate LURs. 3) Adygea republic was included in Krasnodar LUR because it is an enclave situated within Krasnodar kray and depended on the infrastructure of the city of Krasnodar, such as an airport and transport network. 4) Some municipal districts of Karachay Cherkess Republic, including the administrative center, was integrated into the LUR of Mineralnye Vody due to the reasons of shared use of the infrastructure and transport dependence from the airport of Mineralnye Vody (MRV). 5) The last exception concerns the city of Murom: being the large important city of Vladimir oblast, which is partly included in the Moscow LUR (bordering districts and the city of Vladimir), Murom is much closer to the airport of Nizhny Novgorod (132 km), than to the airports of Moscow (around 250 km), and, thus, in order to go to Murom, people would rather pass by Nizhny Novgorod, which has a large international airport (GOJ).

71   In the database (Rogov, 2020) we included the population data (Rosstat, 2018) for every municipal unit and, in total, for every LUR. The official codes OKTMO that we kept for every municipal formation, are convenient to collect other types of socio-economic data. We also attached zip codes to every municipality in order to avoid possible

spelling mistakes in firms' addresses when translating from Cyrillic to Latin letters and thus, to locate firms without ambiguity. Below we provide the population data for the Russian cities with more than one million inhabitants (data from Rosstat for 2019) within political borders (core municipality) and within the delimited Large Urban Regions (Tab.4):

Table 4. Population comparison of the Russian cities with the population above one million of inhabitants in the core according to two delineations in 2019

Rank	Core municipality*	Population 2019	Rank	Code LUR	Large Urban Regions – LUR**	Population 2019
1	Moscow	12'678'079	1	SVO	Moscow	23'980'359
2	St Petersbourg	5'383'890	2	LED	St Petersbourg	7'056'141
3	Novosibirsk	1'618'039	3	SVX	Ekaterinburg	4'159'246
4	Ekaterinburg	1'515'832	4	ROV	Rostov on Don	4'021'172
5	Nizhny Novgorod	1'261'823	5	KRR	Krasnodar	3'426'968
6	Kazan	1'251'969	6	GOJ	Nizhny Novgorod	3'306'950
7	Chelyabinsk	1'200'719	7	KUF	Samara	3'015'676
8	Omsk	1'164'815	8	OVB	Novosibirsk	2'665'755
9	Samara	1'156'644	9	UFA	Ufa	2'665'238
10	Ufa	1'135'480	10	CEK	Chelyabinsk	2'287'400
11	Rostov on Don	1'133'307	11	KJA	Krasnoyarsk	2'219'550
12	Krasnoyarsk	1'096'086	12	KZN	Kazan	2'187'710
13	Voronezh	1'054'111	13	VOG	Volgograd	2'099'259
14	Perm	1'053'938	14	PEE	Perm	1'947'069
15	Volgograd	1'013'468	15	OMS	Omsk	1'890'735
16	Krasnodar	1'007'963	16	VOZ	Voronezh	1'651'135

* Political central city borders (urban neighborhoods *(gorodskoy okrug))*. For St. Petersburg and Moscow the borders of the subject of the federation are used; data source: Rosstat, 2019

** Large Urban Regions; data source: Rogov, 2020 (delineation); Rosstat, 2019 (population data)

Rank of the LUR higher than rank of the core municipality

Rank of the LUR lower than rank of the core municipality

Rank of the LUR is the same as the rank of the core municipality

© Rogov, Rozenblat, 2020

Figure 11. Population of Russian cities with more than one million inhabitants in the core according to two delineations in 2019

Data source: Rosstat, 2019
© Rogov, Rozenblat, 2020
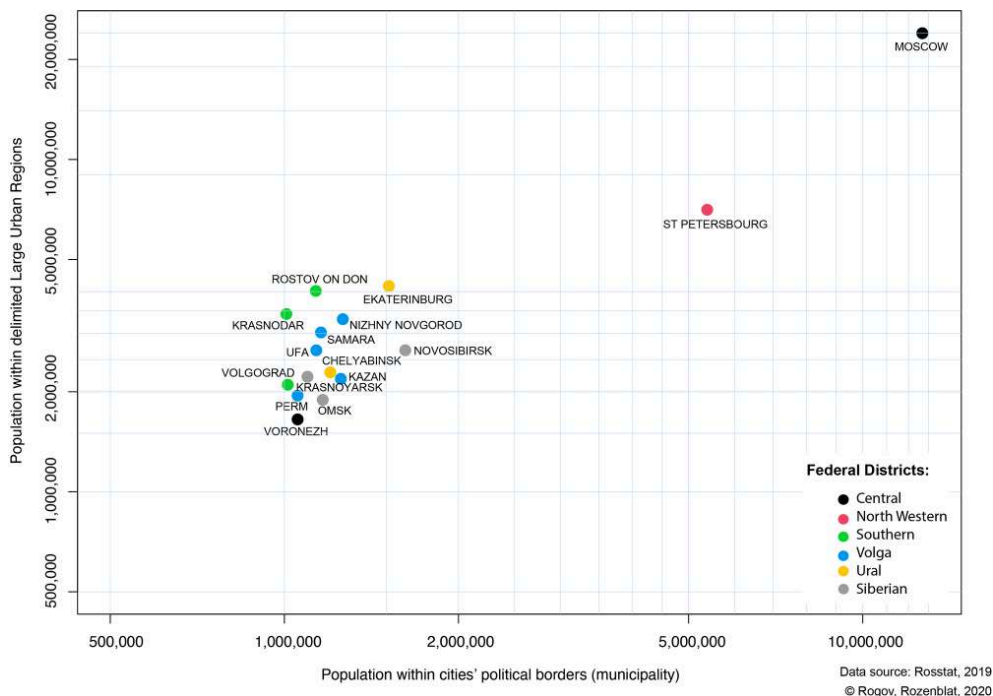
72   Moscow and St. Petersburg, being the only global cities in Russia[13], do not change their position in the Russian urban hierarchy depending on the type of urban delineation used, and for centuries have dominated the Russian system of cities. As we can see on the figure 11, these two federal cities are truly separate, whereas all the other cities are of comparable size and thus, changed their relative positions to each other. Ekaterinburg being surrounded by many large and middle-size industrial cities such as Nizhniy Tagil (356, 000 inhabitants), Kamensk-Uralskiy (170,000 inhabitants), Pervouralsk (146,000 inhabitants) and others that were included in the large urban region of Ekaterinburg, grew more than 2 times becoming much closer to St. Petersburg in terms of population size. Rostov-on-Don increased almost 4 times due to the inclusion of such large cities as Taganrog (249,000 inhabitants), Shakhty (233,000 inhabitants), Novocherkassk (168,000 inhabitants), Volgodonsk (171,000 inhabitants) and others in the surrounding area. The Southern regions of Russia such as Rostov oblast and Krasnodar kray are some of the most densely populated areas in the country due to its nice climate and accessibility to the warm Azov and Black seas. However, the LUR of Krasnodar gained population also due to the inclusion of the Adygea republic, which is situated within Krasnodar kray being its enclave.

73   Another well populated region is along the Volga river: one third of all the cities in the table are situated along this long waterway. In the LUR of Nizhniy Novgorod we included large cities as Dzerzhinsk (240,000 inhabitants), Arzamas (104,000 inhabitants), Bor (120,000 inhabitants), Vyksa (82,000 inhabitants) and others being tightly linked to Nizhniy Novgorod as their core city. However, gaining more than 1,5 million of inhabitants, it moved down in the ranking to the 6th place, standing right behind the Southern cities.

74   Based on the ORBIS Bureau Van Dijk data for 2019 we calculated the number of multinational firms for the same Russian cities both for the political municipal centre of these cities and within the limits of their large urban regions (Tab.5).

Table 5. Number of multinational firms in the Russian cities with the population above one million of inhabitants in the core according to two delineations in 2019

Rank	Core municipality*	Number of multinational firms' establishments in 2019 ** (%***)	Rank	Code LUR	Large Urban Regions - LUR	Number of multinational firms' establishments in 2019 **
1	Moscow	8296 (73,7%)	1	SVO	Moscow	11254
2	St Petersbourg	2364 (88,4%)	2	LED	St Petersbourg	2673
3	Kazan	727 (65%)	3	KZN	Kazan	1120
4	Ekaterinburg	580 (60,6%)	4	SVX	Ekaterinburg	956
5	Novosibirsk	561 (85,3%)	5	GOJ	Nizhny Novgorod	946
6	Nizhny Novgorod	483 (51%)	6	ROV	Rostov on Don	847
7	Rostov on Don	408 (48%)	7	KUF	Samara	689
8	Samara	400 (58%)	8	OVB	Novosibirsk	657
9	Krasnodar	337 (56,2%)	9	KRR	Krasnodar	599
10	Voronezh	311 (72,3%)	10	UFA	Ufa	465
11	Ufa	294 (63,2%)	11	CEK	Chelyabinsk	462
12	Perm	288 (75,7%)	12	KJA	Krasnoyarsk	432
13	Krasnoyarsk	285 (66%)	13	VOZ	Voronezh	430
14	Chelyabinsk	283 (61,2%)	14	PEE	Perm	380
15	Volgograd	257 (69,2%)	15	VOG	Volgograd	371
16	Omsk	228 (73,5%)	16	OMS	Omsk	310

* Political central city borders (urban neighborhoods *(gorodskoy okrug))*. For St. Petersburg and Moscow the borders of the subject of federation are used. Data source: UNIL 2020, ORBIS BvD, 2019.

** Data source: UNIL 2020, ORBIS BvD, 2019.

*** Percentage of the total amount of firms within the core municipality regarding the total of the LUR (right side of the table).
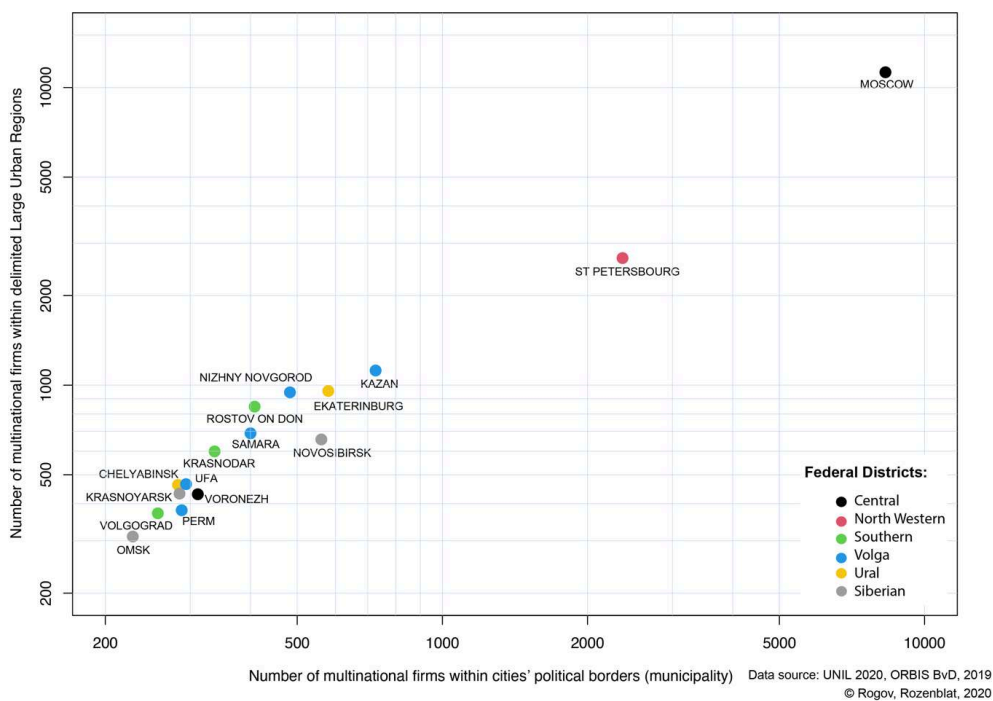
Rank of the LUR higher than rank of the core municipality

Rank of the LUR lower than rank of the core municipality

Rank of the LUR is the same as the rank of the core municipality

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Figure 12. Multinational firms of Russian cities with more than one million inhabitants in the core according to two delineations in 2019.

75　As table 5 shows, for such cities as Nizhniy Novgorod, Rostov on Don, Krasnodar and Samara it is crucial to consider the large urban area around a core: half of the firms are situated outside of the political borders of the respected cities. Being delineated as LURs, these cities gain many multinational companies located in their surrounding areas, and thus, enhance their rank in the national urban hierarchy. Novosibirsk and Voronezh, by contrast, lost their relative position in both rankings on population and firms, that illustrate a high concentration of activities and human capital in the core cities.

76　Kazan, being a capital city of the national republic of Tatarstan, takes the third place in both ways of delineation. This city is the leading industrial and financial center of the whole Volga region, and the local government gives a special attention to attract investments in Tatarstan: in 2015, 2016 and 2017 the republic took the first place in the national investment rating, and in 2019 it took the second place after Moscow[14]. Most of the investments attracted in Tatarstan are concentrated in Kazan, leading to the fact that Kazan in 2019 was ranked as the city with the highest quality of life in Russia[15], overperforming St. Petersburg and Moscow.

77　Probably, the particular attraction of Ekaterinburg, Nizhny Novgorod and Chelyabinsk regions for multinational firms can be explained by the fact that in these regions, there are a lot of mono-industry cities (*monogoroda*) with large companies specialized in metallurgy, non-ferrous metal processing and machine engineering, that were all included in the respective LURs: 17 mono-industry cities in the Ekaterinburg region (Sverdlovsk oblast), 16 specialized cities in the Chelyabinsk oblast, 12 mono-industry cities in the Nizhny Novgorod region[16]. Moreover, around these cities there are large scientific centres for experimental physics and nuclear research that were integrated in their LURs: for example, Lesnoy and Novouralsk in the Ekaterinburg region; Ozersk, Snezhinsk and Trekhgorniy in the Chelyabinsk oblast; Sarov in N. Novgorod oblast.

78　Looking at the figure 12, it is hard to say that cities of a specific federal district tend to gain more firms than others, however, in every district there are leading cities and those that follow up. For example, in the Volga district the leading cities are Kazan, Nizhny Novgorod and Samara; in the Southern district it is Rostov on Don and Krasnodar; in the Ural district it is Ekaterinburg, and in Siberia it is Novosibirsk. It would be reasonable to say that these leading cities from different federal districts can compete with each other, and the same for the group of cities that follow, such as Chelyabinsk, Ufa, Voronezh, Perm, Volgograd and Omsk.

79　By taking these largest Russian cities, we illustrate that economic globalization concerns not only core municipalities, but also large areas around them, which do not have the same facilities and, therefore, are dependent on their cores. These large regions profit from services and develop infrastructures of a core city, and particularly from an airport that being a gate to international global exchanges, makes these regions accessible, which is a key condition for global integration. An important objective of this new delineation is to encompass the area likely to be home for the multinational companies, which are by basic presumption the most dependent on the access to an airport. By incorporating these territories into one statistical unit called Large Urban Region, we provide a comparable harmonized city definition, on the world scale, which is appropriate for using both national (Rosstat) and international statistical data in multi-level research (Rogov & Rozenblat, 2018). This delineation can be used in further research on a global cities' connectedness seen, for example, through

multinational firms' ownership networks (Rozenblat et al., 2017), interfirm collaboration (Pan et al., 2018), innovation patents network (Bergquist et al., 2017) or others applied to the Russian context.

Conclusion

80   Every urban delineation is purpose specific and answers a particular research question. In this paper we proposed the delineation of Large Urban Regions (LUR) for Russia to answer the question of how to demonstrate integration of Russian cities into economic globalization through the presence of multinational firms. Russia, as a post-socialist country, started its integration into global processes only after 1991, and it is still far from being complete. Proposing this new urban definition, we are motivated to better illustrate the process of insertion of the national urban system, being still in a transition period, into global transnational processes.

81   The principal objective of this new delimitation of LUR is to encompass different areas around a core city, which might host multinational firms. By basic presumption, these types of firms are the most dependent on locations near an airport, that's why the presence and accessibility of an airport in an urban area plays a central role in LUR construction. At the same time, it was also important to respect the political borders of the subjects of the federation that represent a strong level of governance.

82   With the deep elaboration of two examples, St. Petersburg and Samara, we showed that for a polycentric urban structure such as the city of Samara, the new delineation completely changes the city's position in the national urban hierarchy enhancing the city rank. This phenomenon is quite frequent for Russian cities with many large industrial satellites, scientific cities or ZATO built quite far from the cores during the socialist era. By contrast, for monocentric cities such as St. Petersburg, the type of urban delineation does not significantly vary its rank. It was further illustrated with the largest Russian cities, some of which had more firms outside a core city municipality. Thus, the delineation of Large Urban Regions better evaluates Russian cities in the world urban economic networks and hence, it is more adapted to study cities on the global scale.

83   Moreover, since every LUR is an aggregation of official statistical units, such as different municipalities with official OKTMO territorial codes, it is convenient to collect national socio-economic data, however, it constitutes a limitation of LURs for Russia: it is quite regular that all over the country some municipalities merge with each other, or in contrast, separate (which is rarer)[17]. Another limitation, which is not a country specific, is a consequence of the dynamic nature of cities: LURs should be adjusted first, to the development of infrastructure around a core city, and second, to the presence of multinational firms, which might come to the new surrounding municipalities that are not yet integrated into the proposed LURs delineation. In fact, urban territories evolve, expand or shrink. Thus, such delineations necessitate a frequent check and update of the proposed composition of LURs.

84   Despite these limitations, the building of LURs constitute a large step ahead to obtain robust results in the international positioning of Russian cities and to better understand their spatial and social transformations. It is possible to collect national statistical data provided by Rosstat for each municipality constituting LUR and thus, to study both the external integration of Russian cities by multinational firms, and their

internal distribution and socio-economic effects on different areas of each large urban region. Therefore, it was worth producing the effort of creating this consistent delineation, which enables to study the impacts of the global integration on local urban development, that paves the way for future research.

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APPENDIXES

Appendix 1

A harmonized database on Russian cities: Large Urban Regions (Russian LUR database)

DATABASE: RUSSIAN LARGE URBAN REGIONS 2020

Available online: https://doi.org/10.5281/zenodo.3354435

The main source of the Russian data is the Russian Federal State Statistics Service (*Rosstat*), which was used for the construction of this database. Particularly, names and types of Russian municipalities (municipal formations) as well as the population data for them were taken from open data of Rosstat[18]. Translation of all the names in English was done by the authors.

In Russian context we consider the largest municipalities such as municipal districts (in Russian: *munitsipalniy rayon*) and urban neighborhoods (in Russian: *gorodskoy okrug*) as functional urban area (FUA). In this database we didn't delineate morphological urban areas (MUAs). Therefore, we composed FUAs from the smallest municipalities, so called rural settlements (*selskoe poselenie)* and urban settlements (*gorodskoe poselenie*), which belong to municipal districts. In the case of urban neighborhoods, we took this type of political body in our database both as municipality and FUA, because it is not divided into smaller political entities.

Thus, in the database there are the following geographical units:

- **MUNI**, which means urban or rural settlements, or urban neighborhood;
- **MUA**, which remains empty;
- **FUA**, which considers larger municipalities such as municipal districts and urban neighborhoods ;
- **LUR**, which is an aggregation of several FUAs around a core city.

For all the MUNIs, FUAs and LURs we provide a population data for 2018 published by Rosstat.

As a possible limitation of this database potential future changes in the status of municipal formations and their political borders could be noticed. For example, recently there were some cases especially in Moscow oblast when municipal districts (*munitsipalniy rayon*) were transformed into an urban neighborhood (for instance, Pavlovo-Posadskiy district changed its municipal status and was transformed into an urban neighborhood Pavlovskiy Posad without changing its borders). One of the reasons for this change in the status of municipality is the calculation of urban population: if inside a municipal district (rayon) there can be both urban and rural settlements and consequently part of the population is considered as rural, then in the case of the status of urban neighborhood all the population will be considered as urban. Therefore, this database has to be regularly updated respecting all the changes in the status of municipal formation, which are published annually by Rosstat.

Reuse potential

Since Large Urban Regions are already delineated worldwide (Rozenblat, 2020b), this database can be used for urban comparative research on the world scale. On the one hand, following the provided delimitation of LUR, one can study the insertion of Russian cities in globalization and, in particular, a place of Russian cities (conceptualized as LURs) in the global network of cities. On the other hand, this database can be used to study social economic trajectories of Russian cities based on the national data such as employment, population, average salary rate etc. Since every LUR is composed from single statistical units, for which Russian Federal State Statistic Service collects different data, and each statistical unit has its own unique code OKTMO, which is an official territorial code in Russia, it allows to collect and use this

type of national data within LUR delimitation. For the collection of international data, we provide zip codes, which are attached to every municipality (Version 3 of the database).

Keywords

Large Urban Regions, Russia, cities, statistical urban definition, comparative urban research

Language

English, names of municipalities are also written in Russian

Theme

Topics of the database: Large Urban Regions, conurbation, spatiotemporal analysis, Russia, cities in the era of globalization, evolving database.

Spatial coverage

The Russian Federation: 10,472 municipalities; 1,380 Functional Urban Areas (FUA); 120 Large Urban Regions (LUR)

Temporal coverage

Time lapse: municipalities as for 2020

Publication date: July 2019

Latest update: May 2020

Format name and version: Excel file, Version 1, Version 2, Version 3, Version 4

File's format: .xlsx

Creation date: Version 1: July 2019; Version 2: February 2020; Version 3: March 2020; Version 4: May 2020.

Dataset creator

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Repository location

https://zenodo.org/

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Type of spatial representation

Controlled list limited to the following values:

text table (textTable): Text or tabular data

Spatial resolution (scale or minimum cartographic unit)

Urban settlement (*gorodskoe poselenie*), rural settlement (*selskoe poselenie*), inter-settlement territories (*mezhselennye territorii*), and urban neighborhoods (*gorodskoy okrug*), boroughs of the federal cities, which we consider as municipalities.

Geographic extension

All Russian territory

NOTES

1. Russian Federal State Statistical Service, URL: https://www.gks.ru/

2. Atlas available online, URL: https://ghsl.jrc.ec.europa.eu/visualisation.php#

3. Available online (in Russian): http://government.ru/docs/35733/

4. For the explanation of different municipal formations in Russian please see the section *2.1 Urban localities* of this article.

5. Available online: https://earth.google.com/

6. Official website of Pulkovo airport: https://pulkovoairport.ru/en/about/performance/

7. In Russia there are two legal statuses of urban settlements: 1) city (there is no universal definition; strategic location/position and historical meaning are more important than the number of inhabitants); 2) urban-type settlement (intermediate position between a city and a village (English equivalent could be a "town"); usually more than 2,500 inhabitants; at least 2/3 of the population work in fields others than agriculture).

8. Available online in Russian: https://economy.samregion.ru/programmy/strategy_programm/proekt_strateg/

9. Data from the official website of the managing company of KUF airport "Airports of Regions": http://en.ar-management.ru/pressroom/news/?n=193 (Last accesses: Jul. 6, 2020)

10. Rosstat, 2019

11. For a detailed overview of different types of municipal units in Russia (municipal formations) please see the *section 2.1 Urban localities* of this article.

12. Official Russian Classification of Territories of Municipal Formations OKTMO (as of January 1, 2014 OKTMO replaces OKATO - Russian Classification of Objects of Administrative Division).

13. According to the ranking of cities produced by Globalization and World Cities Research Network.

URL: https://www.lboro.ac.uk/gawc/world2018t.html

14. The annual national investment rating of Russian regions created by the Agency for Strategic Initiatives. The rating for 2019 is available online (in Russian): https://asi.ru/government_officials/rating/

15. According to the study of the Financial University under the Government of the Russian Federation. Available online (in Russian): http://www.fa.ru/News/2019-11-27-research.aspx

16. The list of mono-industry cities is approved in the Order of the Government of the Russian Federation N 1398-p from July 29, 2014. URL: http://government.ru/docs/14051/ (In Russian).

17. For example, administrative reform in Moscow oblast of 2014-2019 that transformed municipal districts into urban neighborhoods (Moscow Oblast Law No. 11/2013-OZ "On Administrative and Territorial Structure of the Moscow Oblast".).

18. Avalable online : https://eng.gks.ru/

ABSTRACTS

The paper presents a new type of urban delimitation for Russian cities called Large Urban Region which facilitates showing the level of integration of cities into globalization through the presence of multinational firms, and enables urban comparative research on the global scale. An important objective of the new delimitation is to encompass the area likely to be home to multinational companies, which are by basic presumption the most dependent on location near a national or international airport. Previous studies on urban delineations in Russia have focused, almost exclusively, on morphological aspects or on functional urban areas, which have substantial limitations and are not always adequate for global urban comparisons. In this article we propose to apply a more suitable combination of criteria to delineate cities as large urban regions. We illustrate the relevance of these criteria for the polycentric urban structure such as Samara, and for the monocentric city such as St. Petersburg. Then, we apply this delimitation for all Russian cities which results in 120 Russian LURs. We demonstrate the usefulness of this new LUR delineation for the largest Russian cities showing how much it changes their sizes in terms of population and number of companies, and argue that these sizes are more realistic to state their rank in globalization than previous methods.

L'article présente un nouveau type de délimitation urbaine pour les villes russes appelé Grande Région Urbaine permettant, d'une part, de démontrer l'intégration des villes dans la mondialisation par la présence de firmes multinationales et, d'autre part, de faire des recherches comparatives urbaines à l'échelle mondiale. Un objectif important de la nouvelle délimitation est d'englober la zone susceptible d'abriter des entreprises multinationales, qui sont, par présomption de base, les plus dépendantes de leur localisation à proximité d'un aéroport national ou international. Les études précédentes sur les délimitations urbaines en Russie se sont concentrées, presque exclusivement, sur les aspects morphologiques ou sur les zones urbaines fonctionnelles, qui présentent des limites importantes et ne sont pas toujours adaptées aux comparaisons urbaines à l'échelle mondiale. Dans cet article, nous proposons d'appliquer une combinaison de critères plus appropriée pour délimiter les villes en tant que grandes régions urbaines. Nous illustrons la pertinence de ces critères pour la structure urbaine polycentrique

comme Samara, et pour la ville monocentrique comme Saint-Pétersbourg. Ensuite, nous appliquons cette délimitation pour toutes les villes russes, ce qui donne 120 LUR russes. Nous démontrons l'utilité de cette nouvelle délimitation des LUR pour les plus grandes villes russes en montrant à quel point elle modifie leur taille en termes de population et de nombre d'entreprises, et nous soutenons que ces tailles sont plus réalistes pour indiquer leur rang dans la mondialisation que les méthodes précédentes.

El artículo presenta un nuevo tipo de delimitación urbana para las ciudades rusas llamada Gran Región Urbana, permitiendo visibilizar la integración de las ciudades en la globalización dada la presencia de empresas multinacionales y realizar investigación urbana comparativa a escala mundial. Un importante objetivo de la delimitación propuesta es abarcar el área que probablemente albergará a empresas multinacionales, que, por presunción, son dependientes de su localización próxima a un aeropuerto nacional o internacional. En Rusia, estudios previos referentes a límites urbanos se han centrado casi exclusivamente en aspectos morfológicos o en áreas urbanas funcionales, los cuales presentan sustanciales limitaciones al no ser siempre adecuados para las comparaciones urbanas a escala global. En este artículo, proponemos la aplicación de una combinación de criterios más apropiada para delimitar ciudades como grandes regiones urbanas. Ilustramos la relevancia de estos criterios para la estructura urbana policéntrica de Samara y monocéntrica en el caso de la ciudad de San Petersburgo. Posteriormente, delimitamos con tal método todas las ciudades generando 120 LUR rusos. Demostramos la utilidad de esta nueva delimitación de LUR para las ciudades rusas de mayor talla al mostrar a que punto varía su tamaño en términos de población y número de empresas. Argumentamos que estas dimensiones son más realistas para indicar su rango en la globalización que los otros métodos tradicionales.

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