Easy Access: Russian Cities

Public Transport Accessibility Analysis Based on Spontaneous Data

Intro

Public transport plays an increasingly important role in the way people move around the cities. Development and promoting of public transport can become a major solution for improving traffic situation, the perception of safety among users and overall people's satisfaction with urban life.

However, many developing countries face strong transport challenges. The increase in personal income makes private vehicles more affordable. A city may get into a vicious cycle as poor public transport results in more private vehicles and therefore affects the quality of transportation further.

Identifying key pain points of urban mobility and fast problem-solving can boost public transport's reputation and improve the quality of life. Spontaneous data allows us to measure the time of transport correspondence and thus increase the availability and the competitiveness of public transport. Habidatum evaluates public transit's accessibility through 3 key statistics - total travel time, number of transfers and time of first-/ last-mile travelled on foot.

International Context

Using spontaneous data for transport analytics is justified not only by the need to examine the transport system that permanently gets more and more complicated, but also by the amount of data generated on a regular basis through the traffic cameras, various systems of sensors, and monitoring programs.

Ample opportunities for application of spontaneous data lie in the analysis of road accidents. A group of scientists from the University of California discovered a correlation between road accidents, traffic flow, weather and lighting conditions[1]. They used information about 1200 traffic accidents registered in the police records including the scene, the lanes on which the accident took place, the severity of the damage caused, and the number of vehicles involved. Information on the traffic flow, lighting and weather conditions has been obtained from sensors installed on the road.

Another group discovered correlation between Twitter data and traffic incident records[2]. Twitter data can also give context and emotional meaning to roadway incident reports, according to this study.

Spontaneous data also helps measure the traffic flow density. In London electronic sensors known as "loops" are buried in the road and used to analyze congestion. The specified

[1] Thomas F. Golob, Wilfred W. Recker. 2001. "Relationships Among Urban Freeway Accidents, Traffic Flow, Weather and Lighting Conditions" http://www.path.berkeley.edu/sites/default/files/publications/PWP-2001-19.pdf

[2] Eric Mai, Rob Hranac. 2013. "Twitter Interactions as a Data Source for Transportation Incidents" http://www.cs.uml.edu/~hachreka/files/related/13-1636.pdf

speed limit varies depending on the traffic density and many other parameters that set a general model[3]. Introduced in 1995, that system not only normalized the speed of the flow in the congested area, but also reduced the number of road accidents.

London authorities are also using data obtained from the “Oyster" travel cards, which are used by citizens when paying for public transport[4]. The city receives large amounts of information about how, when, and in which manner its public transport system is availed.

Spontaneous data can be used not only for analyzing the road transport, but also for air travels or pedestrian traffic flows. For example, in Brazil, GPS data is utilized in a system that provides a more efficient use of air space, by spreading aircraft paths with greater precision and, consequently, with less temporal and spatial intervals[5].

Various types of spontaneous data can serve as the basis for the construction of the whole transport management system. Thus, in Chattanooga (Tennessee, USA), a large company-carrier US Xpress is monitoring its fleet with the use of the entire system of sensors, which shows the level of gasoline usage, the condition of the brakes and the engine; on top of that it indicates the location of each truck. All of this data is combined with comments of drivers, which makes observing and optimizing the entire branched system in real time possible[6].

A similar approach is used in Melbourne, Australia. The largest tram system in the world, Yarra Trams, has significantly improved the quality of its services after launching the monitoring system operated by using 91,000 sensors, embodied on the vehicles and rails. The company can quickly and efficiently redirect the routes, identify and resolve problems before they occur, and react swiftly to various challenges, be it a flash flood, a major event in the city, or an increased load during the rush hour[7].

The government of São Paulo is also carrying out various test runs using the analysis of spontaneous data in order to improve the management of the local bus fleet that comprises 15,000 vehicles. The developed system relies on GPS data got from the equipment and transport cards for obtaining per-minute information about the location of buses and the number of passengers getting on a bus at each stop[8].

In the places with poor roads and disordered traffic using the data can solve complex problems without requiring a lot of time or money. For example, in Bangalore, India, a

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[3] National Audit Office. 2004. “Tackling congestion by making better use of England's motorways and trunk roads” https://www.nao.org.uk/wp-content/uploads/2004/11/040515.pdf

[4] Bernard Marr. 2015. “How Big Data And The Internet Of Things Improve Public Transport In London” http://www.forbes.com/sites/bernardmarr/2015/05/27/how-big-data-and-the-internet-of-things-improve-public-transport-in-london/#2c91e2073ab3

[5] Carl-Stefan Neumann. 2015. “Big data versus big congestion: Using information to improve transport” http://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/big-data-versus-big-congestion-using-information-to-improve-transport

[6] Mark van Rijmenam. 2014. “Trucking Company US Xpress Drives Efficiency With Big Data” https://datafloq.com/read/trucking-company-xpress-drives-efficiency-big-data/513

[7] ITSInternational. 2013. “Melbourne uses big data to transform tram services” http://www.itsinternational.com/categories/classification-data-collection/news/melbourne-uses-big-data-to-transform-tram-services/

[8] Angelica Mari. 2015. “São Paulo city government trials Big Data to improve public transport” http://www.zdnet.com/article/sao-paulo-city-government-trials-big-data-to-improve-public-transport/

system called Nericell has been launched[9]. When being attached to the mobile device, this system uses its accelerometer, radio, GPS, and microphone sensors in order to detect potholes and bumps in the road and fix up abrupt braking or places with a high level of warning signal sounds.

The cases given above serve as a sample of the wide experience of cities and countries all over the world. The usage of spontaneous data in transport analytics has a diverse range of applications, and by all means a great potential for further development.

Measuring Public Transport Accessibility in Russian cities

This research is an origin-destination analysis based on various open data sources. It can be divided into the following work stages.

First, the most popular local centers have been allocated. They were defined by using social networks Instagram and Vkontakte, as well as open source map projects OpenStreetMap and Wikimapia. The next step was to identify origin points through a sample of all the buildings in the cities. Finally, public transport routes were calculated between these origins and destinations in four Russian cities: Nizhny Novgorod, Kazan, Ufa and Yaroslavl.

The average travel time in Nizhny Novgorod exceeds 47 minutes, which is too long for such a high-density city. There are several clusters of inaccessibility where it takes at least 25 minutes to walk to a bus stop*. The biggest is located along the Volga riverfront. Due to the city's industrial past, the riverside has long been treated as a place for factories, not people, and right now desperately needs urban interventions.

When comparing all statistics, several problem areas have been identified. In particular, they are the housing development of TIZ Hope in Priokskiy area, Grabilovka village in Sovetsky area, and several housing developments situated along the Grebnoy canal and Podnovie sloboda.

**Refer to Appendix for the additional maps illustrating the distribution of total travel time, number of stops, and travel time on foot for each city.*

[9] Prashanth Mohan et al. 2008. “Nericell: Rich Monitoring of Road and Traffic Conditions using Mobile Smartphones”
https://www.microsoft.com/en-us/research/wp-content/uploads/2016/02/Nericell-Sensys2008.pdf

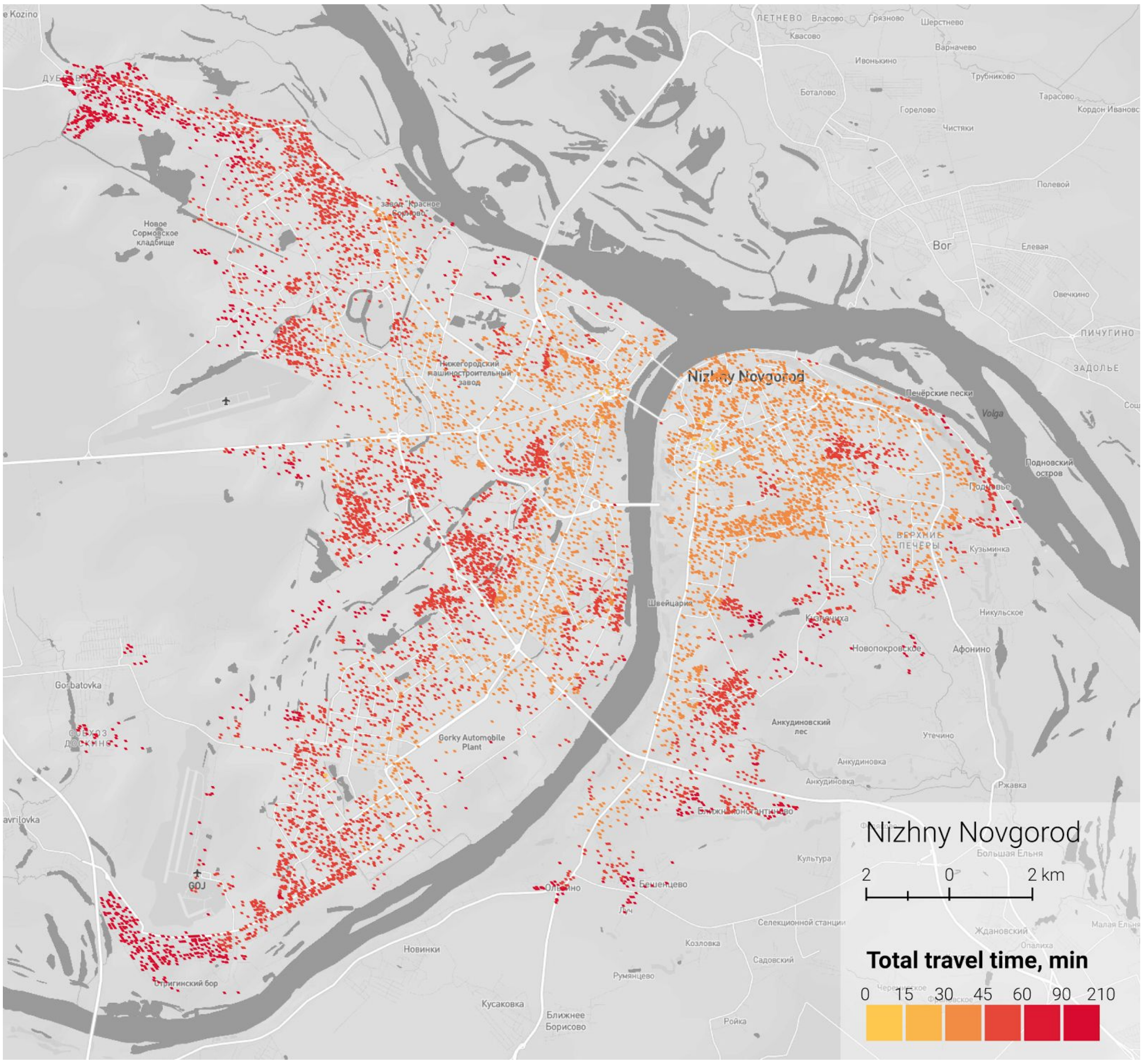


Figure 1a. Spatial distribution of indicators of correspondence to local centers of Nizhny Novgorod on the basis of total travel time

Kazan has a concentric ring model with an unbalanced transport network. Just like Nizhny Novgorod, the city is facing challenges of poor connectivity between various parts of the city due to lack of communication between the two banks of the river. The workplaces are highly concentrated in the city centre while residential areas are situated in the peripheral areas. Therefore, the main load comes from the outskirts towards the city center.

There are no direct bus routes to the north-eastern areas, thus locals are forced to change at least 3 times. The central points of interest in the vicinity of Kremlin and Koziya Sloboda can be characterized by poor walkability, which may be the reason for a decreasing level of tourist attraction.

Eastern neighbourhoods have a low number of bus stops, making first- and last-mile connections extremely long in duration. The city does not pay due attention to the huge private residential sector in the peripheral areas. It results in the formation of so-called “private desert islands” that are separated from any urban activity and enclosed by high fences. At the same time, due to the increasing motorization of the population, that further negligence of the public transport problems will not only increase the load on the road network, but also promote the expansion of the load from the center towards the periphery of the city.

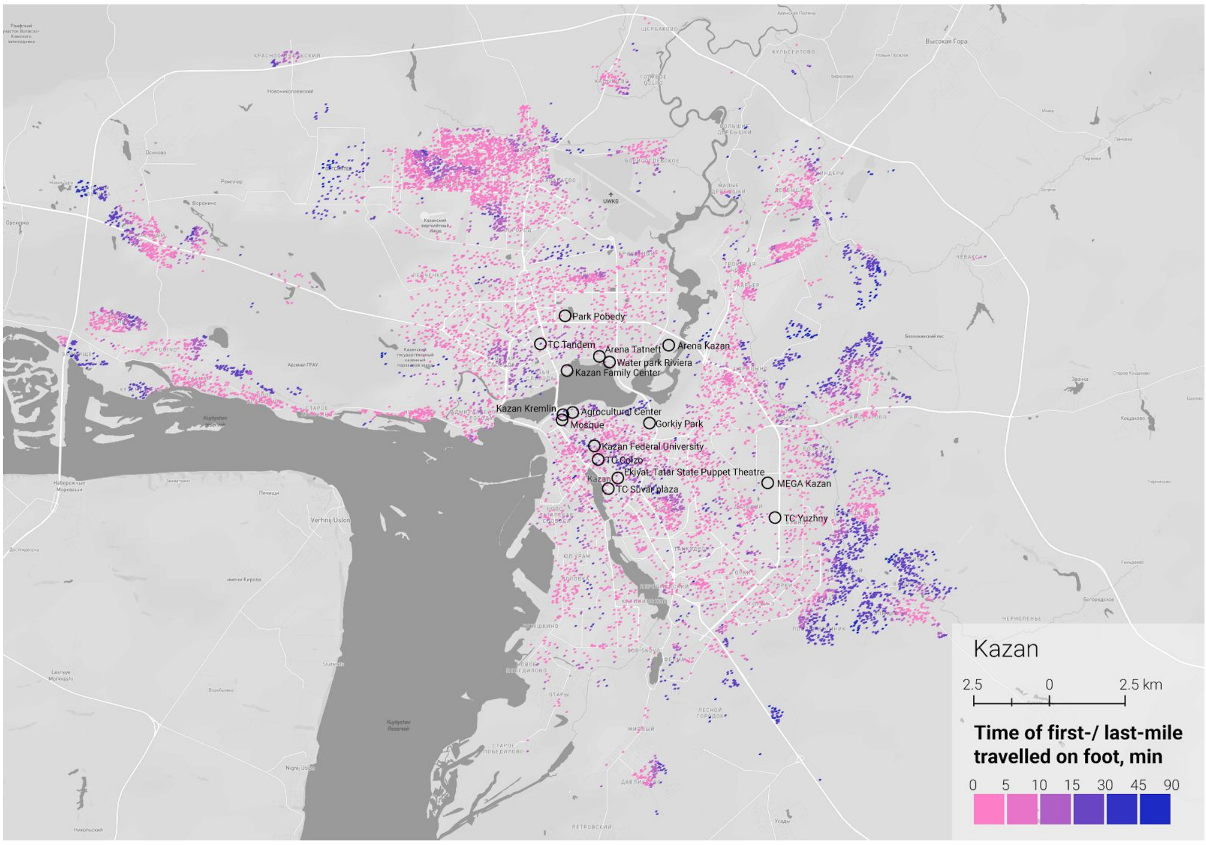


Figure 2c. Spatial distribution of indicators of correspondence to local centers of Kazan on the basis of travel time on foot

According to the study carried out by the General Architecture Bureau of Ufa, 98% of Ufa territory is within 30-minute travel by car. However, less than 40% of the city area has the same public transport accessibility[10].

The neighborhood of Shaksha is distinguished by the most restricted level of accessibility: it is necessary to spend more than 80 minutes (up to 140 minutes in some cases) to get to the activity centers.

The main industrial areas including "Bashneft-Ufaneftekhim" and "Bashneft Novoil" plants are located in the northern part of the city. Not only does it take people more than an hour to travel there, but they also have to transfer to other buses up to 4 times. Same problems are observed in the neighborhood of Dema.

[10] Ural Expert, 2014. "Achilles and the tortoise: the modernazation of the transportation system of the city of Ufa" http://www.acexpert.ru/articles/ahilles-i-cherepaha-modernizaciya-transportnoy-sis.html

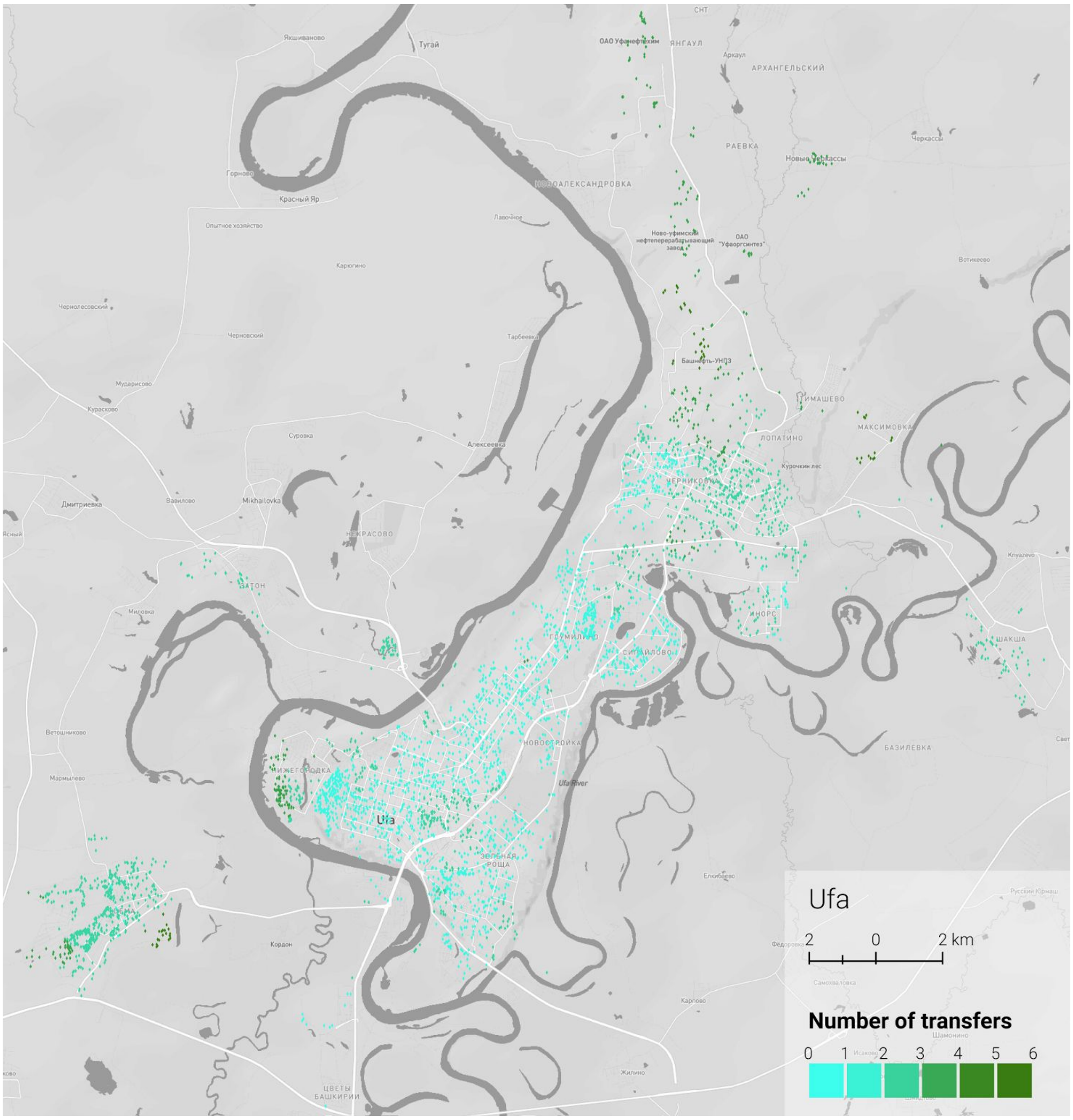


Figure 3b. Spatial distribution of indicators of correspondence to local centers of Ufa on the basis of number of transfers

In Yaroslavl all three statistics correlate with each other. There is high traffic load on the historic center. It originates partly because of overruns caused by the imperfections in the road network. It also has to do with welfare and recreational travels undertaken by the population of the peripheral areas.

The south-western suburbs and the districts along the left bank of the Volga are the least accessible in the city.

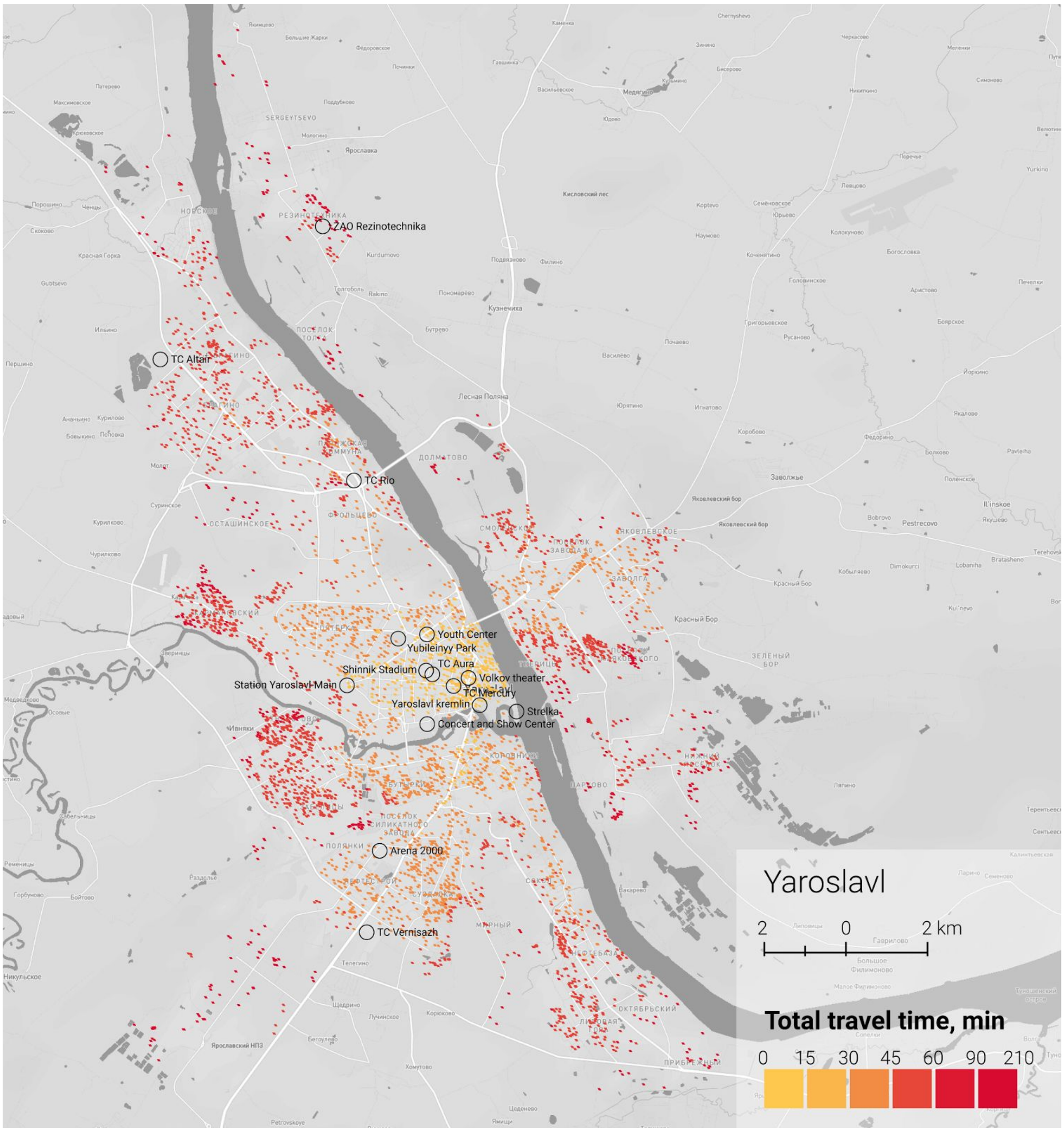


Figure 4a. Spatial distribution of indicators of correspondence to local centers of Yaroslavl on the basis of total travel time

Summary

Walking to transit, the number of transfers and the total travel time are believed to be some of the key factors in attracting people to public transport. Understanding these pain points, their reasons and possible solutions is key to efficient transport network optimisation.

Using spontaneous data is a fast and effective way of evaluating public transport accessibility. The results of our analysis help identify the network's main trouble spots, target the biggest problems and strengthen the competitiveness of public transport.
Habidatum can measure accessibility with great accuracy. We work with different scales - from the entire city to a single neighborhood. By using the Habidatum platform we can explore dynamic changes in traffic situations for certain periods - from days to minutes - and

identify over-crowded areas and periods of time.

The transport accessibility analysis is part of Habidatum's transportation analytics. For more information visit habidatum.com

APPENDIX

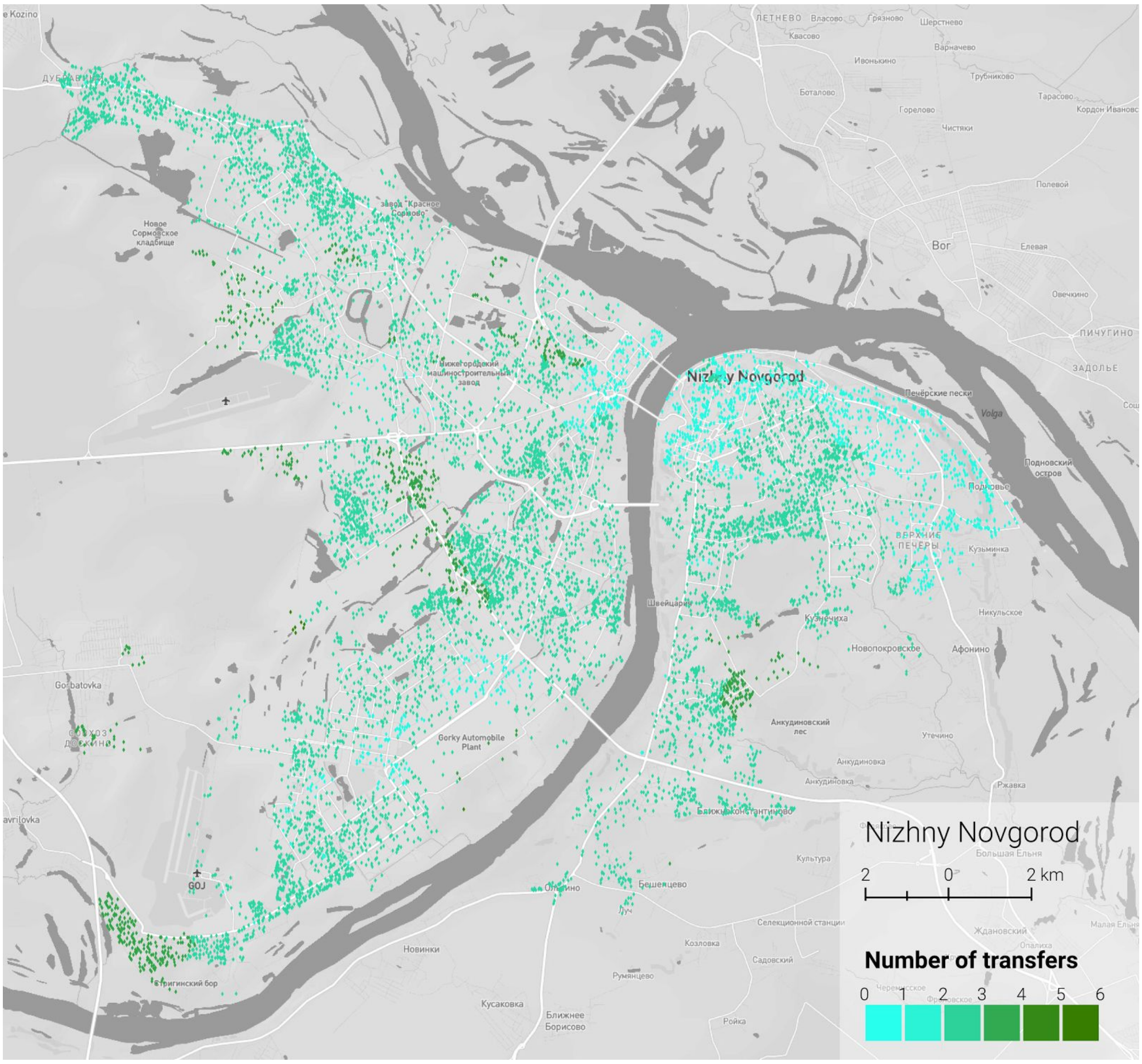


Figure 1b. Spatial distribution of indicators of correspondence to local centers of Nizhny Novgorod on the basis of number of transfers

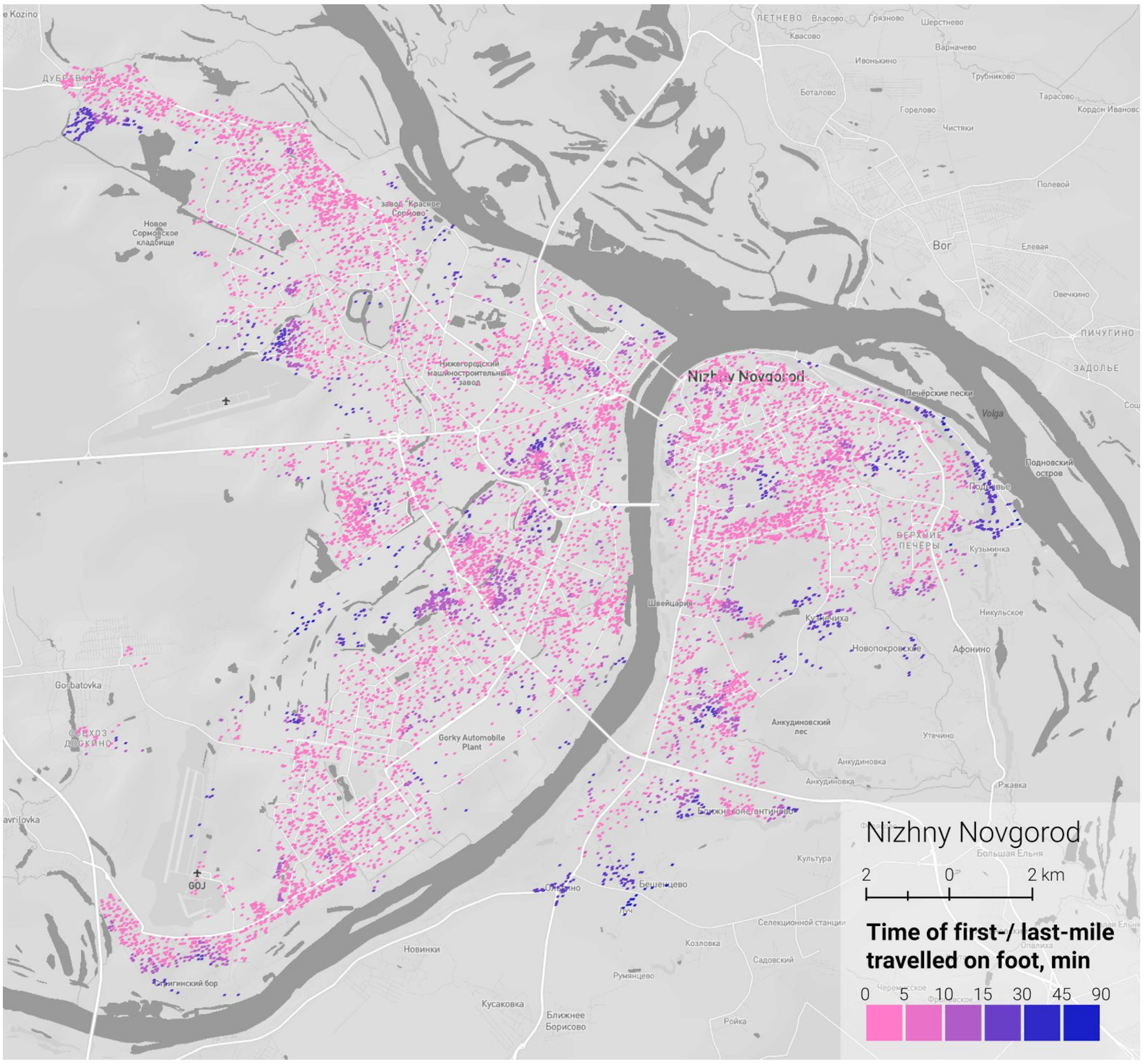
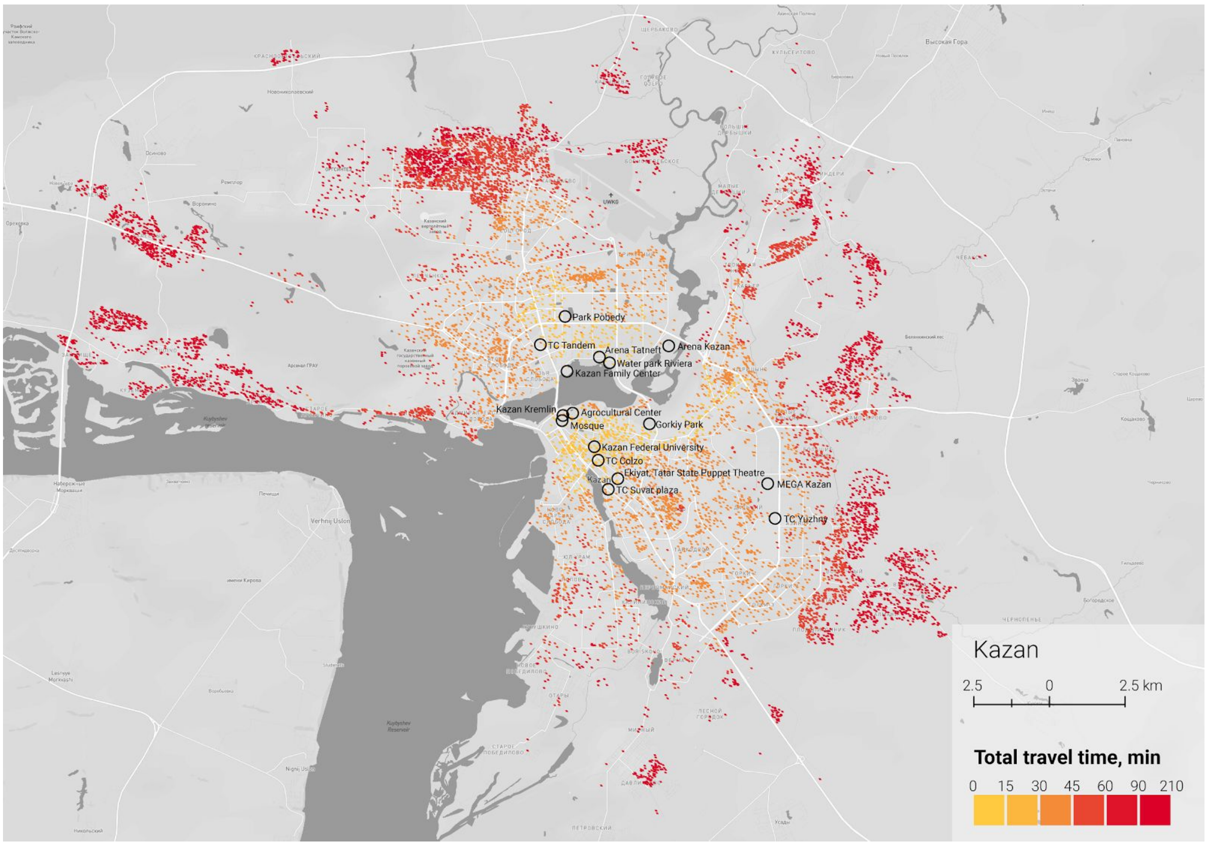


Figure 1c. Spatial distribution of indicators of correspondence to local centers of Nizhny Novgorod on the basis of travel time on foot



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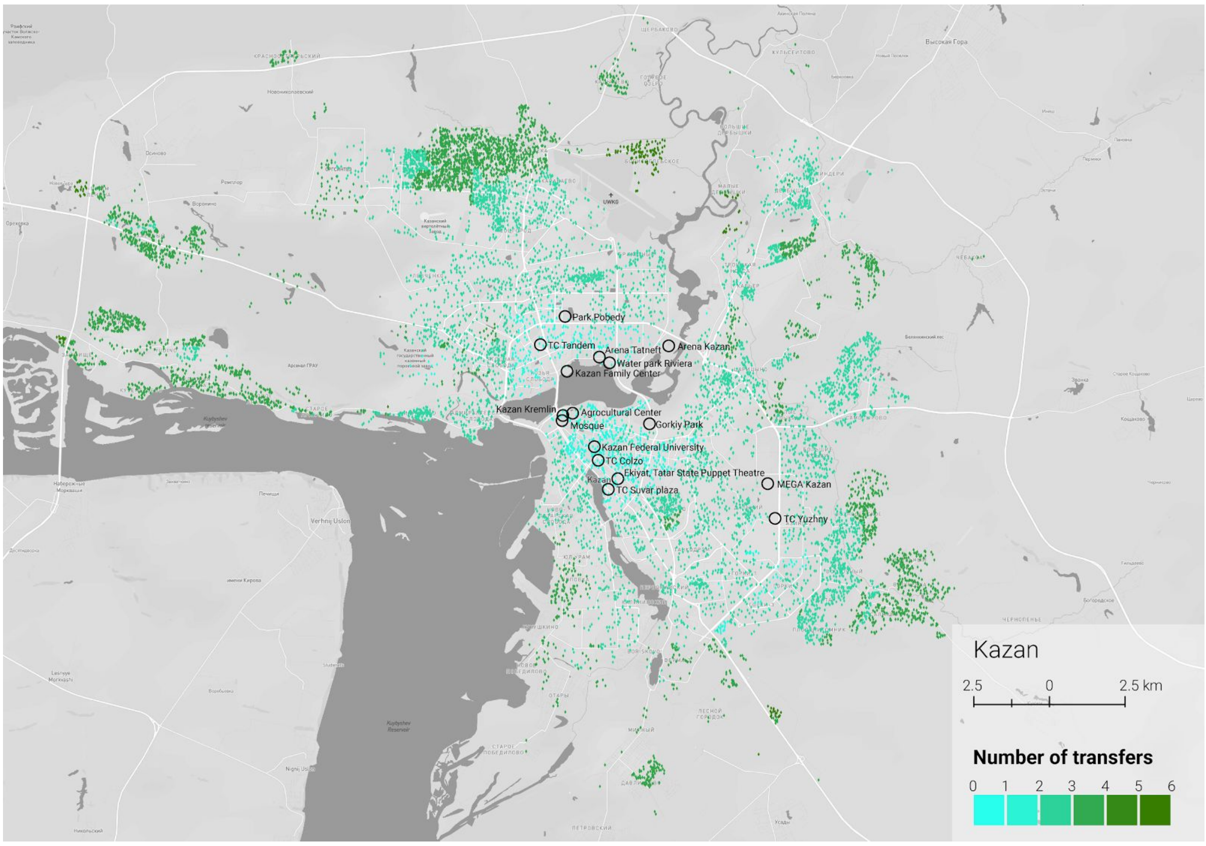

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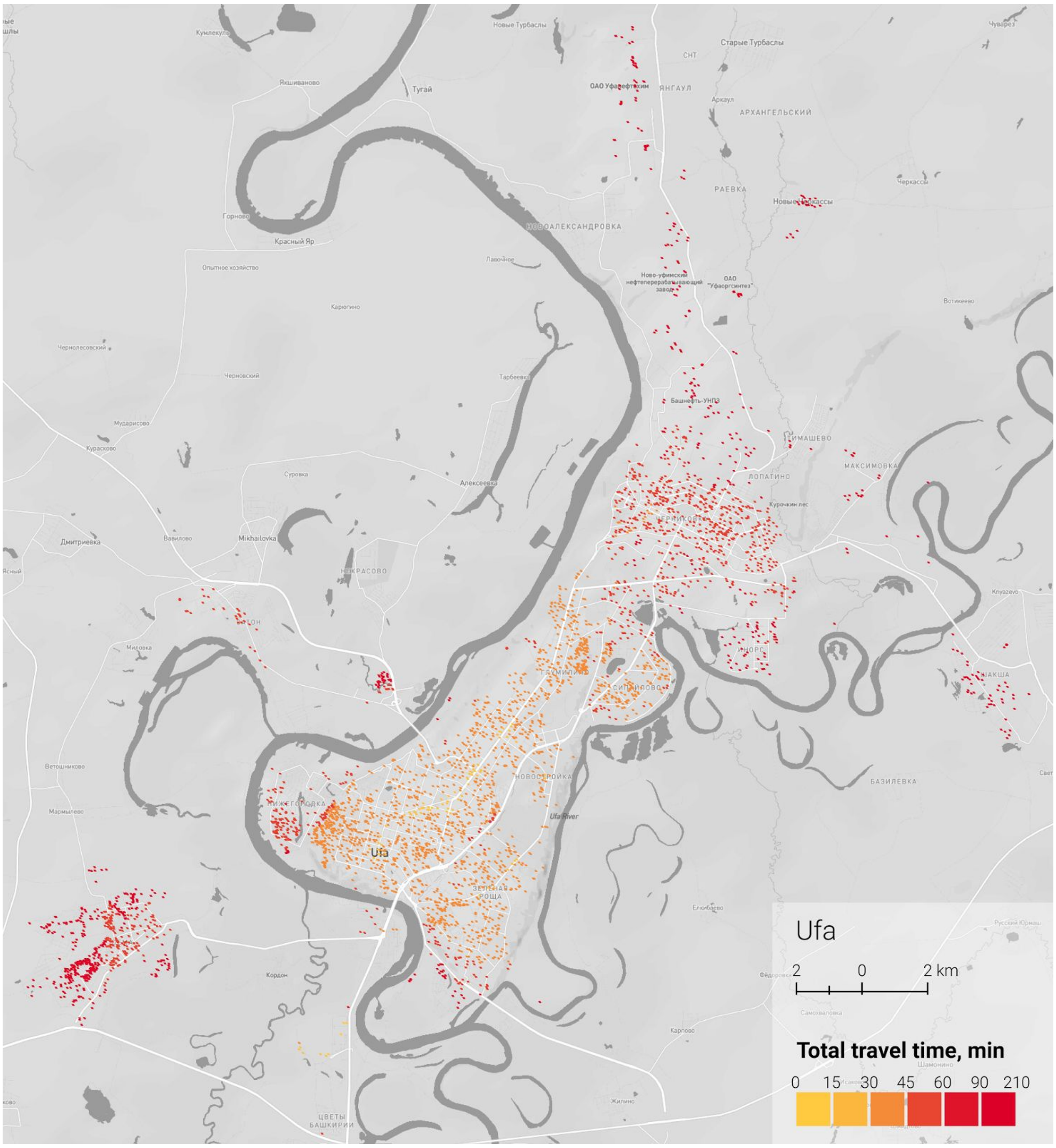

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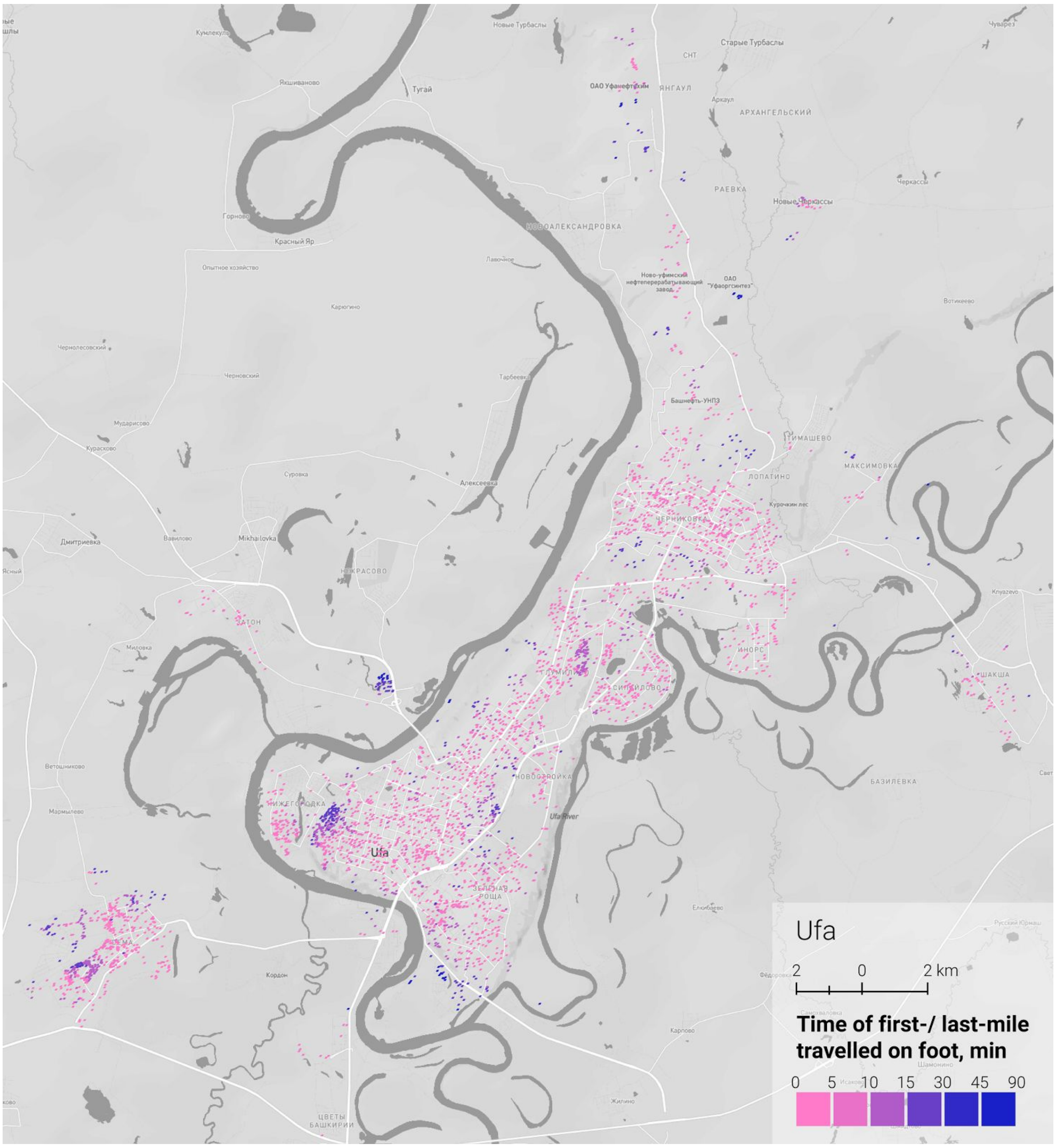
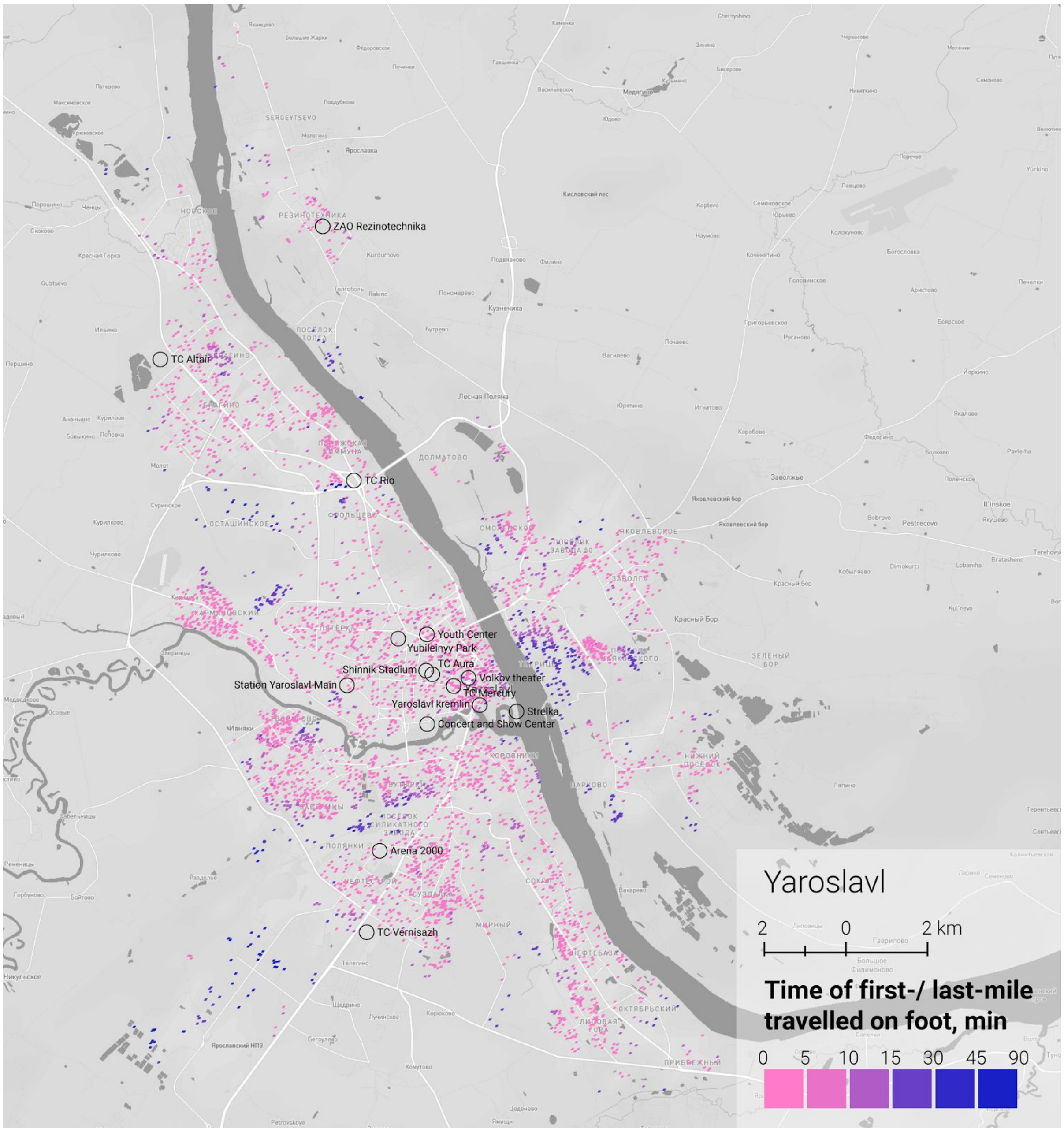


Figure 3c. Spatial distribution of indicators of correspondence to local centers of Ufa on the basis of travel time on foot

Figure 4b. Spatial distribution of indicators of correspondence to local centers of Yaroslavl on the basis of number of transfers



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