

REPORT OF SHORT-TERM SCIENTIFIC MISSION IN ENVIRONMENTAL AND NATURAL RESOURCES DEPARTMENT, INSTITUTO POLITECNICO DE BRAGANCA

STSM title: SETTING PROTOCOL FOR THE INVENTORY OF URBAN GREEN INFRASTRUCTURE

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1. Introduction

Quite recently environmental services are considered as one of the most important aspects of sustainable urban development. Widespread urbanization produces many irreversible effects on environment and ecosystem services it provides.

Which ecosystem services are important for the city? Among the main ecosystem services we consider the dust detention of tree canopy, regulation of temperature and humidity in the atmospheric surface layer, noise and wind reduction, absorption of carbon dioxide and other harmful contaminants through the process of photosynthesis, maintenance of the water cycle through transpiration and energy flows, formation of a favorable landscape and visual environment for the people, separation of VOCs from the air and induced ionization, which are especially important for the health of citizens and for recreational needs. Recently, urban environmental injustice has received considerable attention in urban studies. Unequal access to green spaces represents environmental disparities when some urban residents are deprived of the benefits that green spaces provide.

2. Aims and objectives of the STSM

The aim of this STSM was to apply diverse GIS approaches for mapping the Green Infrastructure (GI) in the Moscow area in order to generate a database of urban green spaces and also to perform a GI analysis with spatial indicators. Among the objectives there was the intention of selecting contrasting neighborhoods in which to identify, classify and map green areas, which would allow for the application of multiple indicators, thus prompting the evaluation of individual neighborhoods under diverse urban locations.

The Host Institution for this STSM was CIMO-Mountain Research Centre located in Bragança (Portugal) and the receiving investigator was Professor Artur Goncalves.

3. Research area and the methodology

3.1. Research area

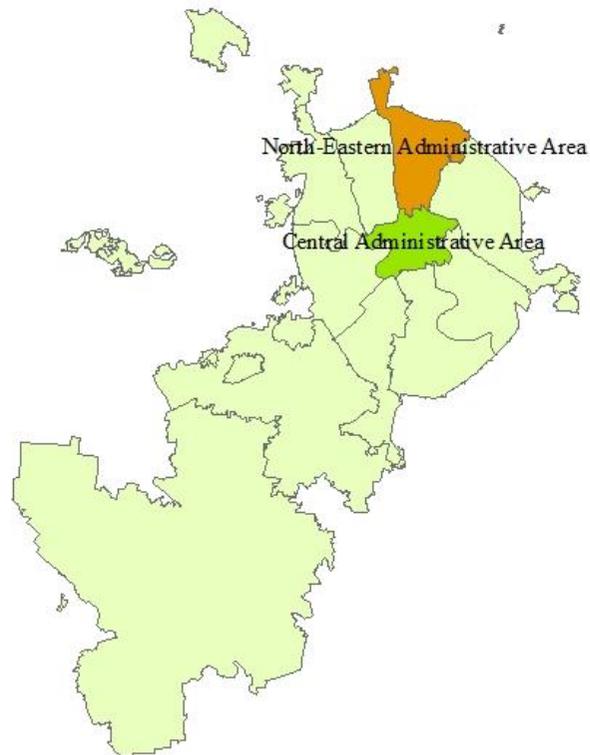


Figure 1
Map of Moscow administrative division

3.1.1. Moscow city

Moscow is an overcrowded megapolis that continues to attract more people searching for work and better life. The life style of Moscow citizens is very active and dynamic; the city every day gets stuck in rush hour traffic and green spaces play a major role in helping people to clear their minds during few hours free of work.

The concentration of people and their activities in cities has also intensified territorial transformation processes in urban areas and it has led to changes in normal economical and social realities, creating new ones. Planners and developers have to reduce some of the negative effects of urbanization due to inclusion or maintenance of urban green spaces. These elements, defined as open spaces with vegetation, no buildings and limited amount of impermeable surfaces, can be used in the mitigation of the negative effects of urbanization. As the key plots 2 out of 146 districts were chosen due to their location and characteristics: Yakimanka and Babushkinskiy. These two districts have almost the same acreage but totally different characteristics and location.

3.1.2. Yakimanka district

The Yakimanka district (Figure 2) is situated in the historical part of Moscow city, in the southwestern part of Central Administrative Area (Figure 1). A major part of the historical buildings in this area were destroyed by the Fire of 1812 (except for a few blocks). In the XIX century after the Dam was constructed over the river Yauza the process of industrialization started, as these formerly flooded lands were very attractive cause of their low price. In Soviet Union the development of the district was quite contradictory. Soviet authorities closed and 22 churches, reconstructed the main street (Bolshaya Yakimanka). All these transformations changed the original characteristics of the district. Later there was opened a large public park – Gorkiy Park. Major transformation of Yakimanka took place in Leonid Brezhnev's time. The western side of Bolshaya Yakimanka was rebuilt in the Brutalist style with high-rise housing typical for the last decades of the XX century. Nowadays the Yakimanka district has a population of 27 169 residents and an area of nearly 500 ha (Table 1), it is known as one of the most popular places for day and night time activities and entertainment. The Yakimanka district is also one of the most expensive districts of Moscow city. It takes the 4th place for the Real Estate prices among other districts.

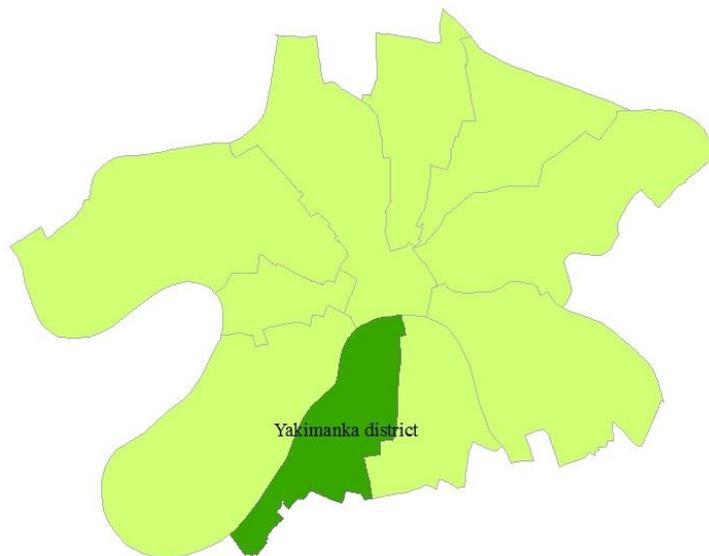


Figure 2
Administrative boundaries of the
Central Administrative Area of Moscow



Figure 3
Administrative boundaries of the North-
Eastern Administrative Area of Moscow

3.1.3. Babushkinskiy district

The Babushkinskiy district (Figure 3) is quite recent when compared to Yakimanka. Originally there was a town Babushkin that was incorporated into Moscow in 1960 and then intensely urbanized. At the present time the Babushkinskiy district is a part of North-Eastern Administrative Area (Figure 1) of

Moscow city. In the past it was in the central part of a former Babushkinskiy district. The size of the district is nearly 500 ha and the amount of population is equal to 87 594 inhabitants (Table 1). The Babushkinskiy district is attractive from an ecological point of view, as there is an important amount of green spaces, including few large park areas and an extensive street and residential greenery. The prices for the Real Estate are quite low in comparison to the districts situated in the central part of the city.

Table 1
General quantitative information for the chosen districts

District	Total area of green spaces	District area	Adm.area	District Population	Adm.area population
YAKIMANKA	1642955,605	4803168,791	66178223,88	27 169	760 690
BABUSHKINSKIY	1581023,941	4934147,384	101653987,3	87 594	1 402 928

3.1.4. The methodology

The main purpose of this STSM was to create a database that will include different attributes of the selected green spaces and to apply different Urban Indicators such as Total Percentage of Urban Green Spaces, Per Capita Area of Green Spaces, Green Space Percentage for Different Green Spaces Categories, Green Spaces Per Capita for Different Green Spaces Categories and Distance to green spaces on the key plots.

3.1.5. Requirements for the protocol

For Protocol creation it is necessary to define the unit of analyses for the case study and to analyze it's interrelations with the research area. The basic unit of the following analyses is urban green infrastructure with a particular typology, characteristics and functions that are inherent for the area of study.

Russian classification of urban green spaces differs from the European experience due to a different city planning scale. In this context it is quite hard to relate Russian realities with European studies without combining different approaches to the interpretation and evaluation of urban green spaces.

In the case study the following classification of public green spaces was applied:

Type	Distance, m	Area, m2	Comments
Neighborhood Parks	300-800	1000-10000	Neighborhood parks are the basic unit of the park system and serve as the traditional urban recreational and social focus of the neighborhood. Neighborhood parks should serve as extensions of the neighborhood around them, allowing for recreation and social activities that cannot be accommodated in residential yards.
District Parks	1600-2000	10000-50000	District Parks are destination parks that service groups of communities, specific districts, and can be used for City wide functions. They are designed as major destinations for residents and visitors, and may have a tourism focus. The size and location of each park may vary, as determined by the park's particular focus and facilities.
City Parks	Within the city borders	>50000	City Parks are large areas of open space, which are publicly accessible and provide a range of facilities and features offering recreational, ecological, landscape, cultural or GI benefits. Attract visitors from all over the City and can be reached by public transport.
Street Greenery			Street greenery provides multiple benefits to urban environments, meeting diverse and overlapping goals. Street greenery's instrumental functions include carbon sequestration and oxygen production, airborne pollutant absorption, urban heat island effect mitigation, noise and storm-water reduction. Few studies have been conducted on street greenery in residential areas, although it may provide a series of benefits to urban residents, such as energy saving, provision of shade, and aesthetic values.

*Distance – the maximal distance residents or visitors of the district are supposed to walk to get to particular type of urban greenery

** This classification was generated using different international studies and methodologies (Russian Federation, EU countries, Canada, USA)

***References: (Bain et al., 2012; Roy et al., 2012), (Appleyard, 1980), (Nowak et al., 2007), (Lawrence, 1995; Jim and Chen, 2008), (Laforteza et al., 2009), (Chen et al., 2006; Miller, 1997); (Onishi et al., 2010), (ANGST. Natural England, 2010), (Jia Jianzhong, (2001) cit in. Manlun (2003)), (Rueda, 2012), (Van Herzele & Wiedemann, 2003)

3.1.6. Mapping green areas

As a first step, the existing green spaces were mapped using ArcGIS software. Such green infrastructure elements were then classified by their functional purposes; such was the case of every public green space and street trees (canopy cover). A few single trees couldn't be properly identified by imagery interpretation, due to occasional image interpretation difficulties.

The limited timeframe determined that the latest activities of this STSM are to be developed after its conclusions, namely the ones that will demand for an on-site validation and evaluation, which will be an essential step leading to consolidated results.

3.1.7. Indicators of green areas' availability

Based on the studies of different cities, different researchers provide some guidelines to evaluate the nature of green spaces. One of the main factors in determining the nature of green spaces is their percentage in the city (1, 2). The functionality of urban green spaces is influenced by the location and distribution (accessibility) in the whole city (3, 4, 5).

Indicator	Description	Methodology	References
1. Total Percentage of Green Spaces (%)	Used in many studies in relation to some generic green spaces services. There is a common assumption that the amount of green spaces has a positive effect on urban sustainability and public health	$\frac{\text{Urban Green spaces}}{\text{Urban area}}$	De Vries et al., 2003; Maas et al., 2006; Ward Thompson et al., 2012
2. Green Spaces Percentage for Different Green Spaces Categories (%)	This indicator consists on the calculation of the percentage of the area covered with different categories of green spaces within the urban or peri-urban limits.	$\frac{\text{Urban Green Spaces Typologies}}{\text{Urban area}}$	eg. Dunnett et al., 2002; Bell et al., 2007; Leeuwen et al., 2002; GMES Urban Atlas used by Kabisch & Haase (2014) Scottish Methodology - GSS (2010)

<p>3. Per Capita area of public green spaces, m2/hab.</p>	<p>These are common amongst key indicators for sustainable development.</p> <p>Often these indicators are the main elements provided for green spaces quality analysis.</p>	<p><u>Usable (or Public) Green Spaces</u> Urban Population</p>	<p>Rueda (2012) Fuller & Gaston (2009)</p>
<p>4. Green Spaces Per Capita for Different Green Spaces Categories, m2</p>			
<p>5. Distance to green spaces</p>	<p>Several studies have demonstrated that there is a tight relation between the distance to green spaces and the use of such spaces.</p> <p>Distance (or proximity) is a key element for evaluating accessibility within the urban context.</p>	<p>Euclidian or Linear Buffer distance</p>	<p>Giles-Corti et al., 2005; Grahn & Stigsdotter, 2003; Maat & de Vries, 2003; Madrazo, 2004; McCormack et al., 2006; Neuvonen et al., 2007; Nielsen & Hansen, 2007; Schipperijn, 2010; Schipperijn et al., 2010</p>

4. Results

In total, the obtained database contains 377 green infrastructure items situated in the Yakimanka district and 620 items – in the Babushkinskiy district. All the GI objects were classified and divided into four classes: Neighborhood Parks, District Parks, City Parks and Street Greenery.

4.1. Protocol

Context:

- Literary review on green infrastructure ecosystem services and how to address them with indicators;
 - Selection of the case studies from contrasting Administrative Divisions (146 Municipalities) within the Moscow city context taking into account different attributes:
 1. Location in the city: city centre vs periphery or suburban;
 2. Functional attributes: Predominantly Residential vs Mixed use;
 3. Time of initial construction: Old vs modern;
 4. Income related: high vs low income.
 - Definition of the study areas (Municipalities and surrounding areas of up to 500 meters from some attributes)
 - Definition of attributes table for the different layers to be used on the project (see below). Such as:
 1. Typology of Green Spaces (Public and Private) – For its diverse potential to provide not only environmental benefits but also to generate social and economic benefits.
 2. Vegetation - Diverse vegetation with different potential to provide ecosystem services in multiple scales.
 3. Urban context – Provide relevant data for the interpretation of the interactions between green spaces and the complementary urban context.
 4. Landscape/biophysical context – These variables may allow for the interpretation of the existent land use development and the level of biophysical integration of existent green spaces.
 - Data collection from existent sources (e.g. open street map).
 - Gap analysis with the definition of the need for additional information.
 - Drawing/extraction of polygons by from aerial or satellite images, using visual recognition or remote sensing, combined with on-site recognition
 - Determination of a set of attributes tables of both quantitative and qualitative data that will be used for the application of green infrastructure indicators and for its interpretation.
 - Indicators determination with the generating of maps and tables for each municipality.
 - Evaluation of results taking into account the urban and biophysical context of each municipality.
- Analysis takes into account the international references and data from other cities (e.g. Urban Audit).

4.2. Analysis of the green areas in the Yakimanka District (Central part of Moscow city)

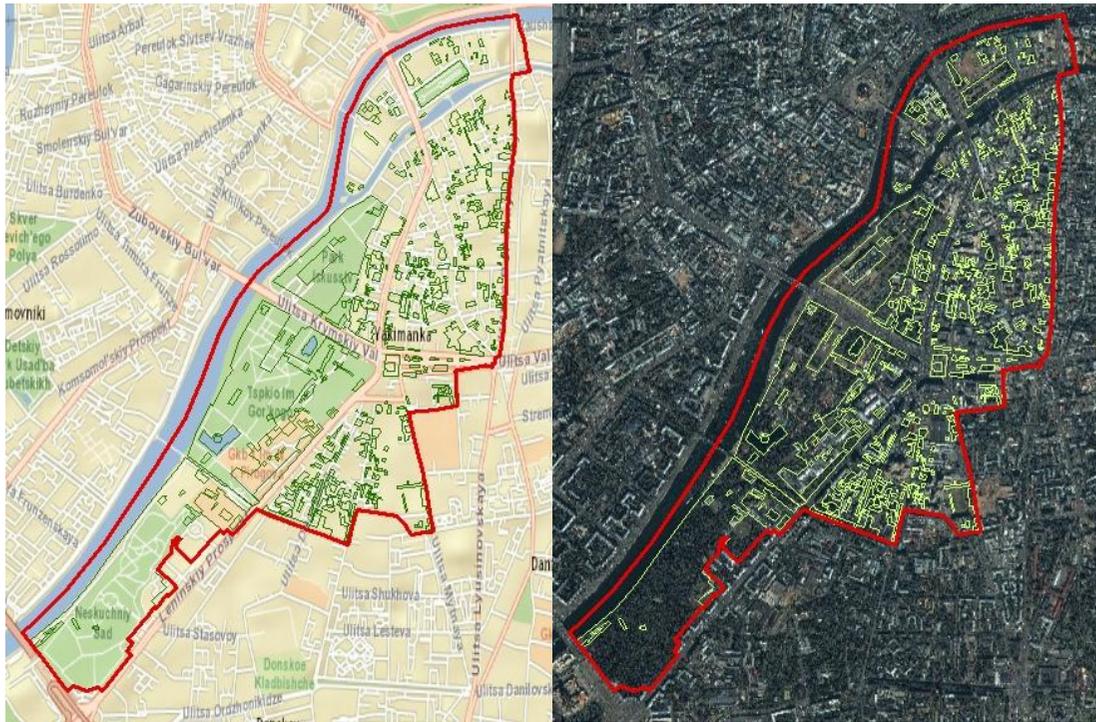


Figure 4
Figure 5
Green Spaces of the Yakimanka District

The GI in the Yakimanka district consists of 3 city public parks, 2 district public parks, 12 neighborhood public parks and 360 plots of street greenery (Figures 4, 5). The major part of green spaces of the district is presented by public city parks (Diagram 1), which have a well developed infrastructure and respond the social needs of the population of Moscow city. At the same time the quantity of street greenery is quite low, and in the conditions of the overcrowded city center always stacked in traffic and human traffic jams it is a big problem for population of the district.

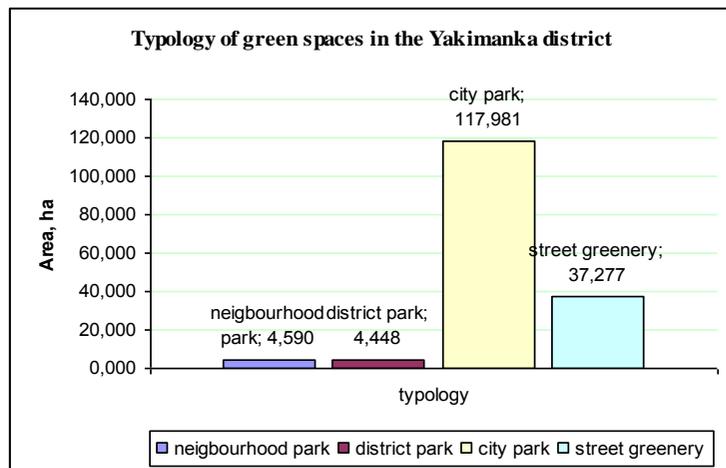


Diagram 1

4.3. Analysis of the green areas in Babushkinskiy district (the suburban part of Moscow city)

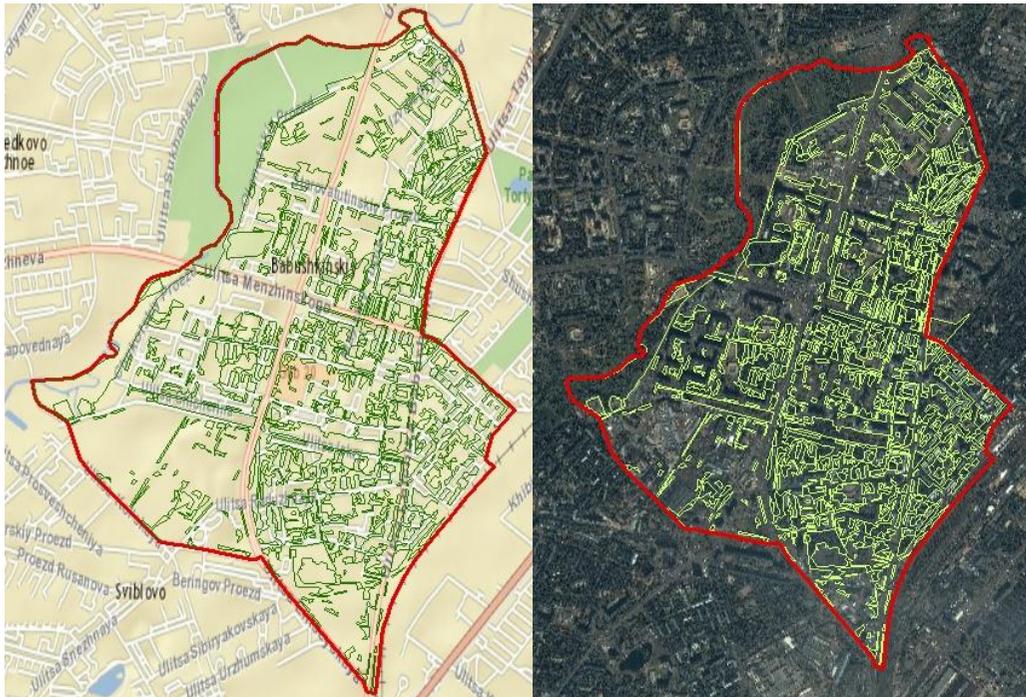


Figure 6 **Figure 7**
Green Spaces of the Babushkinskiy District

The GI of the Babushkinskiy district consists of 3 district public parks, 2 city public parks and 614 plots of street greenery (Figures 6, 7). In this district the highest amount of green spaces is presented by street greenery (Diagram 2) and at the same time there is a limited amount of neighborhood public parks in the district. The quantity of population is quite high, and the insufficient amount of the neighborhood public green spaces is compensated with the large amount of street greenery and well developed network of district parks. The two city parks situated in the district have a natural view, less developed infrastructure (comparing to city parks in the center) and don't respond all the social need of the population of the district.

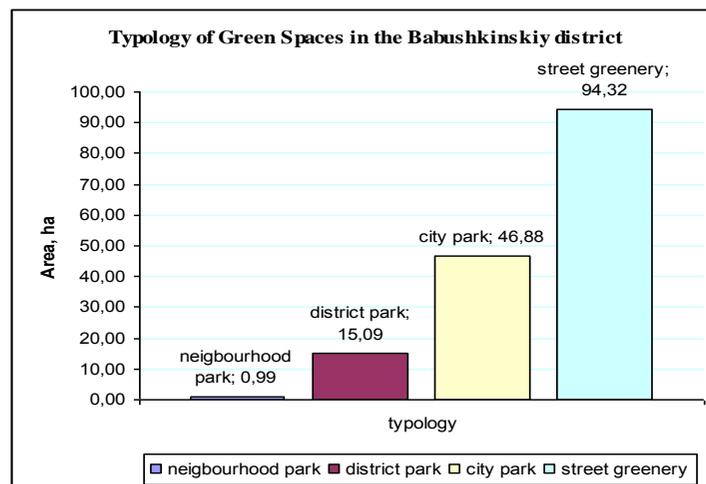


Diagram 2

4.4. Comparative analysis of the multiple indicators of green areas' availability in the central and suburban parts of Moscow city

Both districts provide a larger area of green spaces, including public green spaces and street greenery. The Babushkinskiy district has a greater amount of street greenery concentrated in residential areas comparing to Yakimanka. Districts in the periphery often have a mixed-use development, and in case of Babushkinskiy the residential areas occupy the major part of acreage of the district. But at the same time the business life of Moscow is focused in the central part of the city and it leads to a different zoning of the central districts. Less territory is occupied with residential buildings and the residents of Yakimanka are provided with a great amount of public places situated in an every quarter of district.

If we compare these two districts, we can see that the district situated in the periphery has less public green spaces with developed infrastructure, and this value is lower than an international minimal value in Urban Green Spaces (10m²). In the meanwhile the value of Public Green Spaces Per Capita for Yakimanka several times exceeds the minimal value per habitant (Diagram 3). Without any doubt it affects the living standards for the residents of both districts.

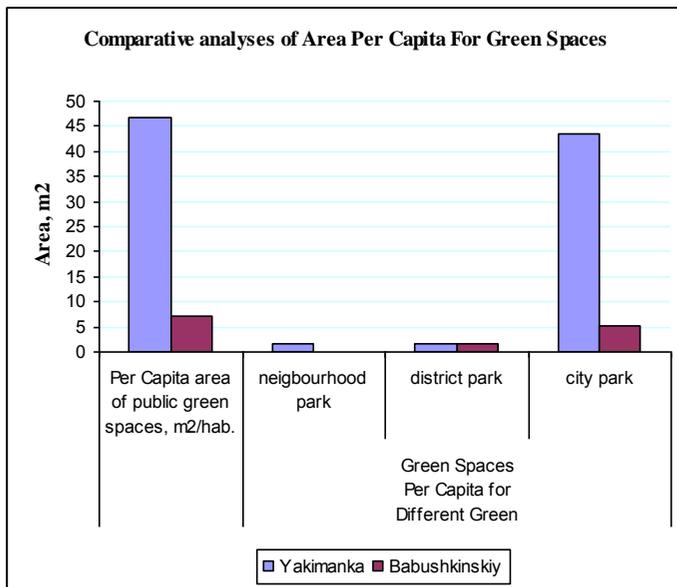


Diagram 3

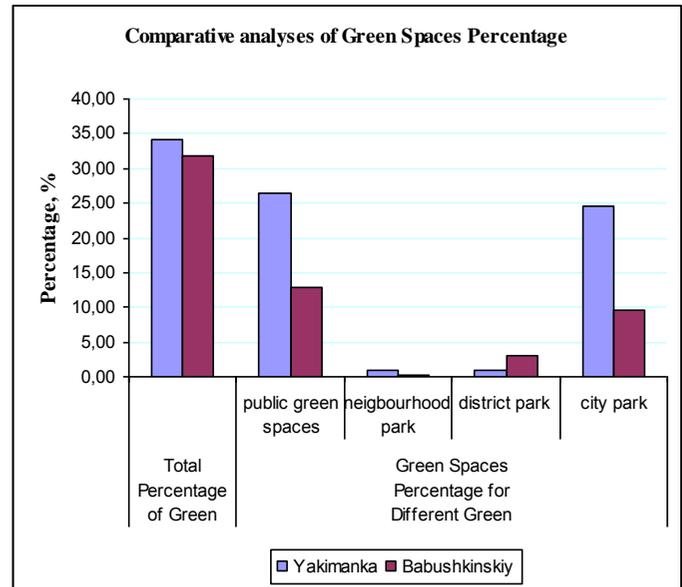


Diagram 4

Very important aspect in evaluation of green spaces is their accessibility in urban context, distance is related to multiple benefits including benefits to mental and physical health. The Babushkinskiy district has a well developed network of district public parks which cover all area of the district; therefore it compensates a small amount of neighborhood parks (Figure 8). It shortens the time residents of the district spend to reach public green places. Moreover, all the public places in both districts are accessible by public transport. The Yakimanka district has a great amount of neighborhood public green spaces,

situated near main highways, metro stations and bus stops (Figure 9). It gives a possibility to take a break in an overcrowded centre both to its residents and visitors.



Linear Buffer Distance to Different Categories of Public Green Spaces in Yakimanka

Figure 8

Linear Buffer Distance to Different Categories of Public Green Spaces in Babushkinskiy

Figure 9

(not taking city parks into account)

5. Discussion

The city centre provides its citizens and guests with a great amount of public green places, well equipped and therefore popular among the citizens of the whole city. The larger density of human and traffic flow leads to a worse health conditions of street greenery and prevents the normal functioning of its mechanisms and provision of all benefits and services (Diagram 5). It makes an ecological situation in central districts very complex comparing to the periphery.

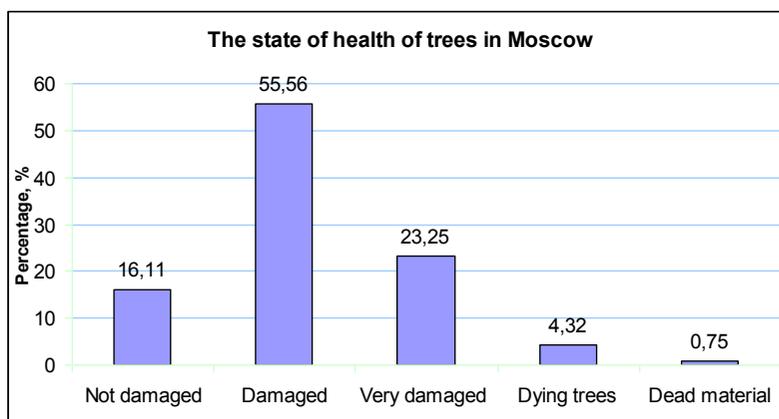


Diagram 5

During the last five years Moscow municipal governments changed their policy and now all the public green spaces of Moscow are being reconstructed, developed and improved. During these years city parks transformed into places where people have millions of facilities how to spend their leisure. The city parks in the central districts of Moscow have a wider range of facilities and services as far as the centre of the city is more often visited by tourists, international delegations, and due to a fact that the business life of Moscow is focused in the central part of the city.

The indicators applied are essential for better understanding and applying of spatial metrics for GI evaluation. All the indicators applied give us general information about the chosen districts, but they can serve as a base for depth studies of the environmental conditions and sustainability. In the future studies they'll let me to apply additional indicators regarding green spaces relation with the built-up environment in my Master Thesis, where I'll expand my analysis to additional neighborhoods.

6. Conclusion

The goals of this STSM research were successfully achieved: 1)The Protocol for an inventory and evaluation of Green Spaces was created; 2) The Database of green spaces of the chosen districts was generated and contains typology and different attributes; 3) Several spatial indicators were applied to the area of case study; 4) Obtained results were performed and discussed.