

GEOINFORMATION FACTOR APPLICATION FOR ECONOMY COMPONENT OF THE MEGACITY TRANSPORT INDUSTRY AND TRANSPORT IMPACT ASSESSMENT ON MEGALOPOLIS ATMOSPHERE

Anna Sinitsyna, Irina Karachevtseva, Elena Cherepanova

Ph.D. Anna Sinitsyna, Moscow State University for Geodesy and Cartography.
Address for contact: Russia, Moscow, 105064, Gorohovskiy pereulok, 4. Tel.: +7(495) 262-19-53.
E-mail: anna_sinitsyna@bk.ru.

Ph.D. Irina Karachevtseva, AEROCOSMOS Scientific Center for Aerospace Monitoring
Address for contact: Russia, Moscow, 105064, Gorohovskiy pereulok, 4. Tel.: +7(495) 632-17-19.
E-mail: aerokosmos@mail.ru.

Researcher E. Cherepanova, AEROCOSMOS Scientific Center for Aerospace Monitoring
Address for contact: Russia, Moscow, 105064, Gorohovskiy pereulok, 4. Tel.: +7(495) 632-17-19.
E-mail: aerokosmos@mail.ru.

Abstract

The complex approach for the account of the megacity industry transport component (MITC) and its influence estimation on a megacity environment condition is considered in the present work (on Moscow example). The economic-mathematical modeling for the MITC optimization and calculations of the motor transport emissions on city highways are carried out on the road and transport complex (RTC) characteristics basis with GIS software using. The long-term research results presented here based on investigations in Moscow State University for Geodesy and Cartography (MIIGAiK). Researches for transport emissions estimation are supported by the Russian Federation Education and Science Ministry and conducted by AEROCOSMOS Scientific Center for Aerospace Monitoring. Some consultations were carried out for special questions with representatives of the Internal Affairs Ministry, General Plan Moscow City Institute and Mosgorgeotrest (special enterprise for Moscow actual maps). The basic results of these researches have been officially approved by the Moscow City Government.

Keywords

MITC - Megacity industry transport component

RTC - Road and Transport Complex

GIS – Geoinformation system

SRS - Street-Road System

1 Introduction

The group of young scientists, postgraduates, and students leading by Professor Kira Shingareva studies the problems of the Megacity Road and Transport Complex (RTC) (case study Moscow) on the «Economic and Business» chair of The Moscow State University for Geodesy and Cartography since 2000 year. During this period some researches of Moscow Parking Space were conducted [1], [2], [3], [4]. The Main Economic and Organization Parameters of Parking Placing Basic Map in Moscow were developed [5]. The Structure of Megacity Parking Space GIS (case study Moscow) was created [6], [7]. The Economic Efficiency within some Moscow State Projects of RTC was evaluated [8], [9], [10].

The group took part in the realization of experiment «South-East Radius». It was conducted according to realization of the Moscow Government Decree issued on August, 29-th 2000 year № 698 «On the Conception for Organized and Legal Regulation of the Temporary Placing Accommodation System for Motor Transport Means at Moscow Territory» leading by experts of The Scientific Research and Project Institute of Moscow General Plan and The Centre for Tele-automatic Traffic Regulation of Russian Federation Internal Affairs Ministry [11], [13].

Some models and methods of Transport Component Influence on Economic Efficiency to Megacity Industry (case study Moscow) were developed [8], [10], [12], [13]. As the next step of the problems study for Megacity RTC (case

study Moscow) it is GIS application for the economy component of the megacity transport industry and assess transport impact of the atmosphere megalopolis.

Researches for motor transport emissions estimation are supported by the Russian Federation Education and Science Ministry and conducted by AEROCOSMOS Scientific Center for Aerospace Monitoring by the theme «MEGAPOLIS - integrated technology assessment of air pollution of major cities in the regional and global scales, based on the aerospace and ground-based monitoring to reduce the negative consequences of anthropogenic impacts». «MEGAPOLIS» is a European project partners on FP7-ENV-2007.1.1.2.1: Emissions, urban, regional and Global Atmospheric POLLution and climate effects, and Integrated tools for assessment and mitigation (MEGAPOLI). MEGAPOLI is funded by the European Commission through Framework Programme 7, sub-divisions «Environment», (including climate change).

2 Substantive provisions

2.1 Demography

Now the most of large cities have turned to the centres of the sharpest environmental problems, especially sharply it concerns megacities. Calculations of experts in the demography field demography, including show United Nations experts calculations show, that by 2050 more than 70 % of mankind become city and will live in the largest cities-megacities and its agglomerations with the population, exceeding ten millions inhabitants. The share of city dwellers has exceeded quantity of the Earth inhabitants living outside of cities in 2008 year for the first time in mankind history [14]. Urbanization growth is accompanied by a concentration of the population, the industry and transport on the small areas that leads to increase in anthropogenous loading at all components of the city environment, including atmosphere. The similar tendency is observed and in Russia where as an example of considerable city growth agglomerations the Moscow megacity expansion (from 1999 year to 2009 year) (Fig. 1). The Moscow megacity is the largest Europe megacity, for example, the Russian capital population is made 10,56 million by person on the January, 01st, 2010 [15].

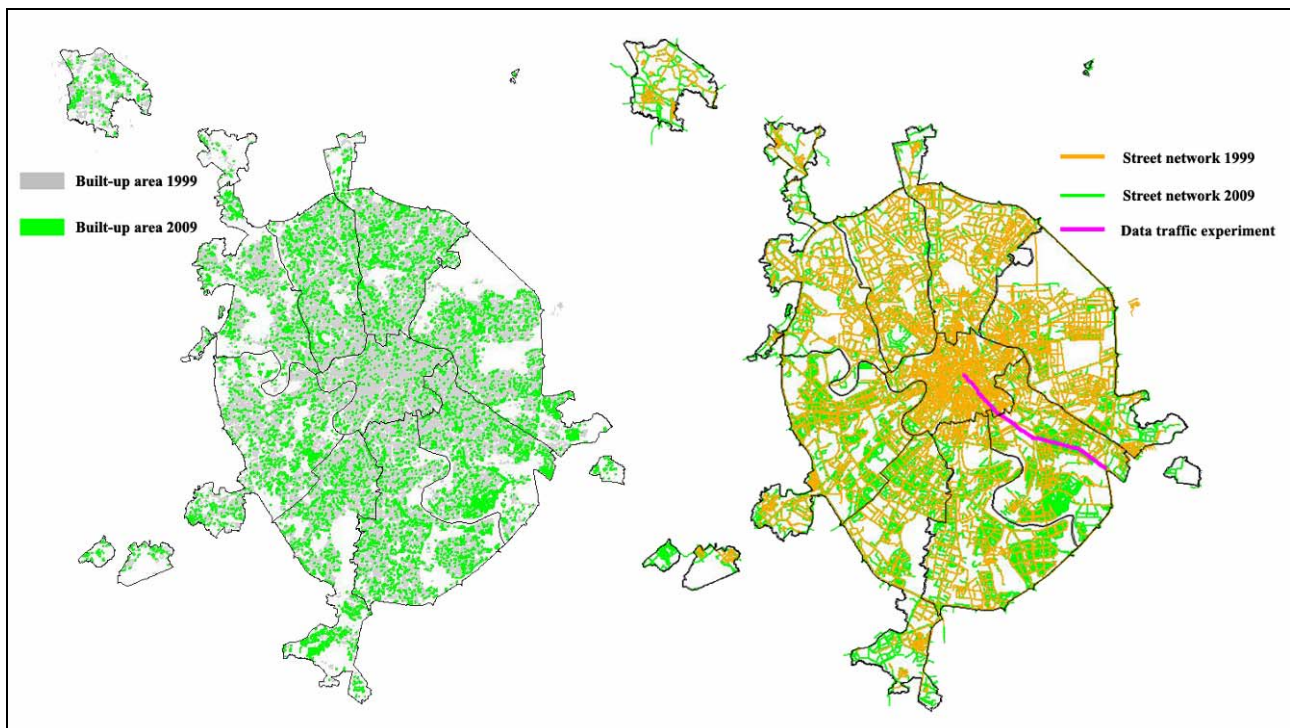


Figure 1. The increase built-up area (left) and street network (right) in Moscow megalopolis during 1999-2009

2.2 Ecology

The Russian Federation ecological doctrine as the primary goals of scientific maintenance in the environment protection sphere defines communication studying between people diseases and the environment quality changes, and also ecological monitoring modern methods working out and development. The ecological condition of the air environment causes the greatest concern as it is a constant person inhabitancy. It is not always possible to receive the air environment

quality authentic estimation, despite serious control measures behind an atmospheric air condition. It is defined by a considerable quantity of the polluting substances connected with motor transport uncontrollable issue first of all.

2.3 Emissions on transport

Tendencies of emissions on transport continuously grow. There is about 23 % of the hotbed gases connected with power global emissions on a transport share [16]. Thus the share of issue CO₂ from motor transport makes 74 % of general issue CO₂ from which 45 % are necessary on automobile transport, 35% are necessary on a truck transport (Fig. 2). State regulation (standards on fuel, taxes, city planning) and the effective technologies realisation on transport (fuel with the low carbon maintenance using, transport types replacement, struggle against jams) plays the major role in decrease in emissions of polluting substances. However, hotbed gases on transport emissions grow faster, than in other industrial sectors, therefore transport is the major part of an atmosphere emissions decrease strategy.

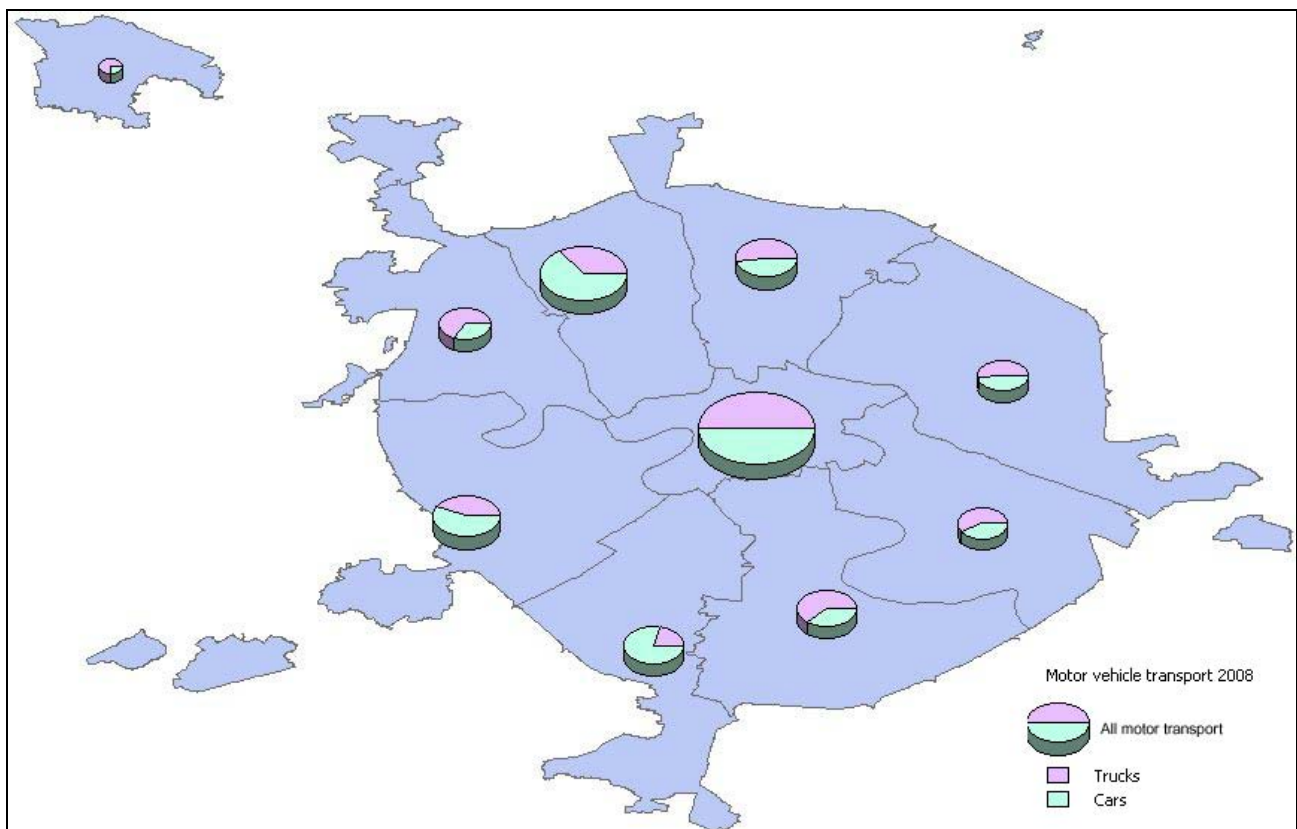


Figure 2. Available Car Administrative District of Moscow are normalized by the number of all motor transport, source [20]

3 The decision of a problem of the control of environment on the GIS-technology basis

The environment control problem decision is probably in a large city agglomerations in the shortest terms on the various technologies integration basis: GIS, space monitoring, land measurements [17]. It is necessary some technological problems performance for an effective utilisation of geoinformation technologies with a view of the the various data connected with highways set complex analysis [18]:

- a digital cartographical GIS basis preparation for its integration with a database on highways;
- highways data gathering and its processing according to GIS requirements;
- the statistical information according to GIS requirements gathering and processing;
- GIS database structure providing solved problems performance working out;
- GIS settlement block for megacity motor transport atmosphere polluting substances emissions estimation working out;
- the megacity industry transport component economic-mathematical modelling carrying out end user interface working out.

3.1 «The Moscow megacity transport component account and its impact on the atmosphere» GIS Subsystem

"The Moscow megacity transport component account and its impact on the atmosphere» GIS Subsystem development was started within the MEGACITY project frame for large cities atmosphere pollution estimation integrated technologies creation . Geoinformation methods and means as the integrated technologies element using is caused by that the city atmospheric air condition complex estimation is impossible without the motor transport emissions influence account and analysis. There are about 75-80 % on the average of all megacities environment polluting substances emissions weight on transport share.

3.1.1 Emission assess

The moving motor transport emissions calculations can be spent according to the technique confirmed in the Russian Federation [19]. The city motor transportation streams (its structure and intensity) distribution features and its changes in time (within days, week and year) researches are spent for city motor transport emissions definition and its subsequent using as atmosphere pollution calculations initial data according this technique. The transport streams structure and intensity depend on territorial characteristics and a city street-road system (SRS) structure, motor pool quantity, industrial enterprises arrangement features, motor transport services, gasoline stations, parkings and car repair shops. Time distinctions are substantially caused by an industrial enterprises and establishments operating mode, and also city environment climatic features. The basic highways (and its sites) with the raised movement intensity and crossroads with high transport loading list is made on the city SRS GIS analysis basis and also the attributive information on transport loading. It is necessary to spend also the account of passing vehicles in both directions with division on type and fuel used character cars groups for the motor transportation streams characteristics definition on the street-road system chosen sites.

According technique emissions calculations can be carried out for the following harmful substances arriving in atmosphere with fulfilled cars gases: carbon oxide(CO); nitrogen oxides NO_x (in recalculation on nitrogen dioxide), hydrocarbons (CH), soot, sulfurs dioxide (SO₂), lead connections, formaldehyde, bensopiren (Fig. 3).

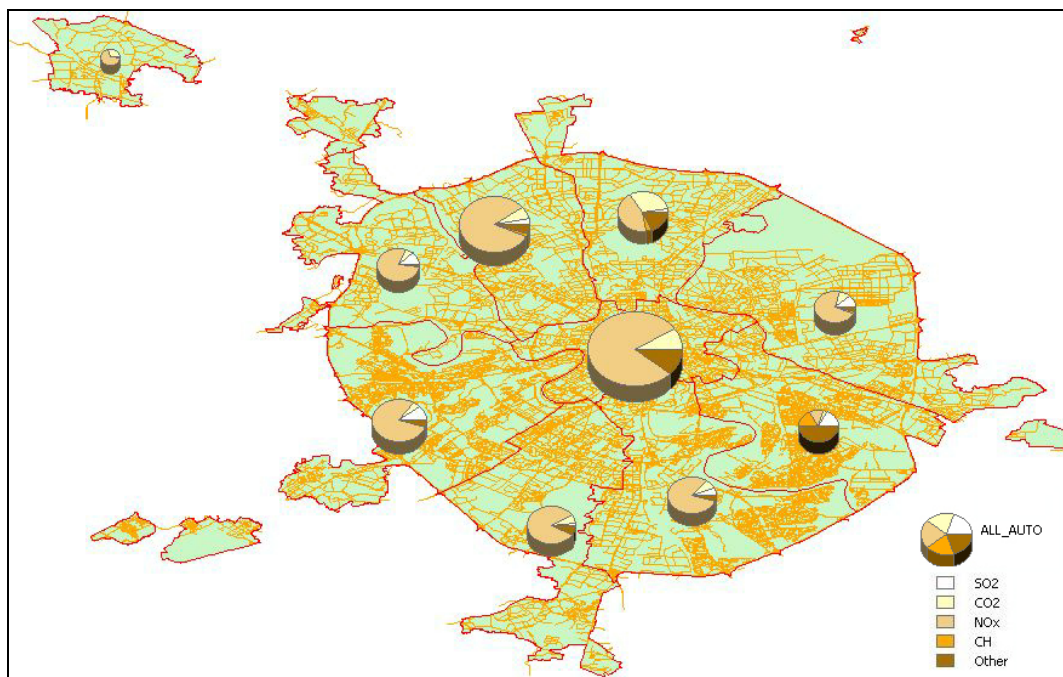


Figure 3. Emissions Administrative District of Moscow are normalized by the number of cars, source [28]

GIS subsystem developed includes the electronic Moscow map realised by ArcGIS 9.2 (ArcView ESRI™) means with the additional special thematic layers created for the transport component account purpose. As much as possible full, authentic, comparable and modern information on the Moscow megacity dynamics to social and ecological conditions, including statistical data [20] and transport component researches [21, 22, 23, 24] are used during GIS creation. The

received results will be compared further with data which it is planned to receive during the atmosphere pollution experimental researches which are carried out within the MEGACITY project limits.

3.1.2 GIS subsystem structure

The GIS subsystem developed special layers reflecting the Moscow transport component various factors condition and territorial position (economic, town-planning, social, ecological) are subdivided into following components:

- «Administrative division and town-planning structure» (includes layers Administrative districts and areas, Quarters, Buildings);
- «The city territory functional zoning» (components are allocated: many-storeyed building, industrial zones, gardens and parks, water objects, etc.);
- «The Road and transport network and economy» (includes layers Streets, the Parkings, the Distance Zones from the Center, the Industrial enterprises);
- «City Ecology» (includes administrative districts atmosphere, water and soil condition characteristics and also data according to an atmosphere condition which will be received by results of experimental researches and data processing of the remote sounding, carried out under the project "MEGACITY").

The data classification developed system (for example, see Table 1) allows to characterise the basic Road and Transport complex (RTC) aspects and to spend the information complex analysis with GIS using as for megacity transport industry component optimisation and the city highways motor transport emissions calculations.

Table 1. The Structure of the data in the GIS layer "Streets"

ID Street	Destina-tion	Develop-ment	Speed	Week-days	Seazon	Month	Day	Transit	Conge-stion	Frequency Congestion	Duration Congestion

3.1.3 GIS subsystem testing

The results received during experiment «The South-East Radius» megacity transport industry component optimisation economic-mathematical modeling [21, 22, 25, 26] are used for a pilot GIS subsystem pilot testing reflecting real ecological conditions on highways. The South-East Radius motorways (from the Moscow centre to the Moscow motorway ring) (Fig are chosen. 1, right) were choiced as a test site. There are motor transportation stream moving structure and intensity official data received in Motor Licensing and Inspection Department [21] for this radius. The morning and evening o'clock "peak" data and also intermediate time intervals in the working days and the days off during various seasons (Table 2) are used for the South-East Radius transport loading change dynamics GIS-analysis carrying out.

Table 2. Example of Experimental data on the Moscow megalopolis South-East Radius

ID obj	Name	Zone Center	ID Street	To Center	To Region	Hour	Day	Week days	Month	Seazon
2	Marksistskaya Street	Middle zone	300	0	0	10	morning	Saturday	January	Winter
3	Volgogradskii prospectus_2	Periphiral zone	103	2	2	13	day_1	Friday	January	Winter

3.1.4 Some following results

An experimental site highway (the Moscow megacity South-East Radius) data gathering is executed by the present moment. The megacity atmosphere pollution statistical information from 2000 year to 2008 year and also the Moscow motor transport statistics for 2008 year input and processing according to GIS requirements are spent. The GIS subsystem two component database structure (the Moscow megacity transport component account (Fig. 3) and the Moscow megacity atmosphere pollution account) is developed by the collected experimental and statistical information analysis results.

The various graphic and statistical dependences construction is carried out for GIS results evident representation. The data selection criteria and the information sorting order are defined by the researcher in the spatial and analytical modelling course. So, the geoinformation analysis with reception of the Road and transport complex and the Moscow

megacity environment condition characterising various aspects special cards is made by preliminary researches results (Fig. 3, 5, 6).

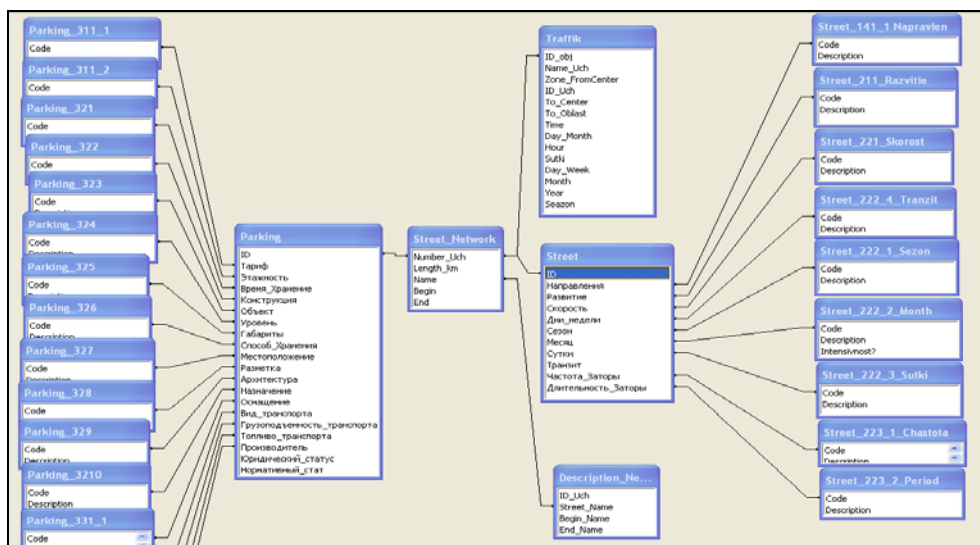


Figure 4. Street network database structure

The subsystem is created on the modern geoinformation technologies basis that allows to operate with the data diverse information huge files in which it is supposed to be included, besides cartographical and statistical data, space images and the megacity atmosphere remote sounding results (Fig. 5), the atmosphere and microclimatic modelling land supervision results. It will allow to investigate influence both social and economic, and ecological factors on megacity population health on the quantitative methods basis.

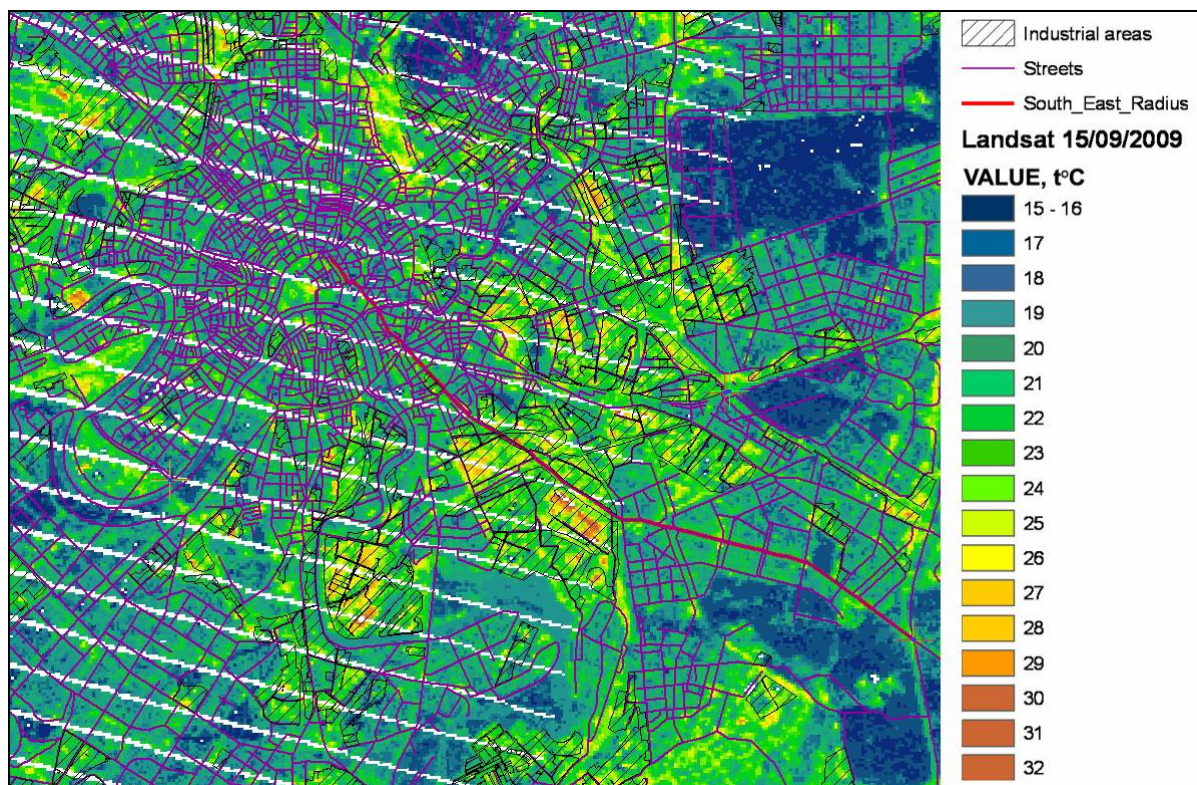


Figure 5. Correlation between street network, industrial zones and hot points of Moscow test area, thermal band analysis LANDSAT ETM+, 15.09.2009

The geoinformation systems allow to carry out various kinds of modeling with application of the logic, economic-mathematical, ekologo-hygienic analysis except diverse data integration and results visualisation on a large-scale cartographical basis. It will be a further development subject of the megacity transport industry component account and a megacity environment condition estimation offered by authors geoinformation factor complex application.

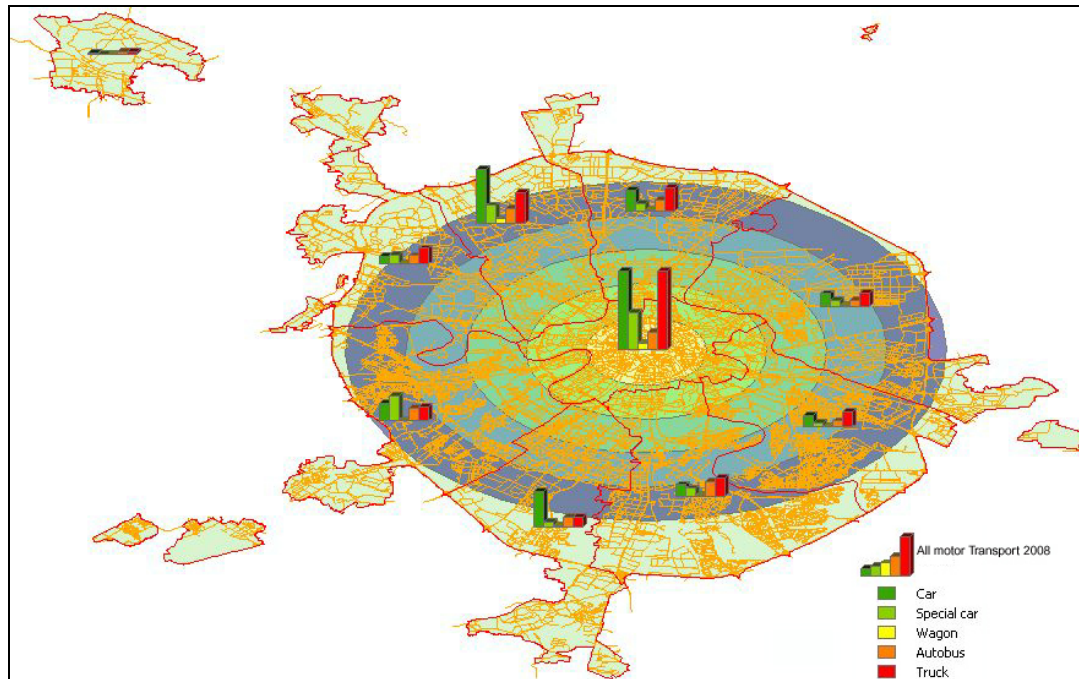





Figure 6. Moscow megalopolis Road Transport Complex Zoning

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	<p>Graduated from the Moscow State University for Geodesy and Cartography in 1999. Anna Sinitsyna Research the Megacity Transport Space Problem, Transport Systems Economic Efficiency Estimation Methods and GIS Application to this Field. Made Ph.D.: «The Transport Component Economic Estimation of Megacity Industry (On Moscow Example)». Has about 38 papers.</p>
	<p>Graduated from the Moscow State University for Geodesy and Cartography in 1982. Irina P. Karachevtseva was developing the Road Map Geodatabase, Geographical Names Database and GIS Application for Map production. At present is the head of GIS department of AEROCOSMOS Scientific Center for Aerospace Monitoring, currently working in the area of development environmental spatial database using remote sensing and GIS. Made Ph.D.: «Development of methods and technologies electronic road maps based on multi-scale database». Has about 30 papers.</p>
	<p>Graduated Lomonosov Moscow State University with Master's Degree in Geography in 2001. Elena Cherepanova is researcher of GIS department of AEROCOSMOS Scientific Center for Aerospace Monitoring, currently working in the area of application remote sensing data and GIS technologies to studies of urban ecology. Has about 10 papers.</p>