

## The Application of Geoinformation Systems for the Purposes of Economical-Statistical Analysis

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### Abstract

The research article discusses possibilities of modern GIS for solving problems of socio-economic analysis of regional and urban systems, and prospects of GIS support for implementation of basic functions of regional management. The experience of geoinformation technologies adoption in operation of the regional statistical agency is analyzed. Characteristics of structural-functional features of the GIS, oriented on solution of statistical analysis problems of regional systems of the Volga Federal district and the Republic of Tatarstan are given. Possibilities of its GIS-maps system and spatial databases, as well as in the authors' program package for operative preparation of the economic maps series for state estimation of main functional subsystems of the region, which enable to monitor economic activities in the regional municipalities are discussed.

**Keywords:** Regional Statistics, Geoinformation System, Municipal Management, Decision Support, Thematic Socio-Economic Mapping.

### 1. Introduction

One of the main aspects of informational support of regional government is gathering, processing, generalization and analysis of spatial data. Spatial information is a significant part of the information base of regional statistics. For urban settlements and municipalities spatiality attribute acts not as a factor, but as the main feature of their entity determining the basic properties, such as structure, function, dynamics and etc. [6, 8] Scope and purposes of the functioning of regional statistics dictate the necessity of accounting of specific characteristics of spatial information, primarily geographical position, proximity, borders objects, distances between them, etc.

Geographic information systems (GIS) and technologies ensure high quality of integration of electronic cartographic images with spatial economic databases. From the fundamental science point of view, geographic information systems are the knowledge store of spatial objects and phenomena implemented with the help of technical means. In technological terms, geographic information system represents a complex of technological and organizational means, performing functions of collection, storage, processing, display and distribution of spatial data [1, 2].

Geoinformation technologies develop the existing applications of information technology. Opportunities of georeferencing of economic data and displaying the results of economic analysis in cartographical, graphic, tabular and textual forms along with the possibilities of solving the econometric tasks and tasks of spatial econometrics (using package extensions) make them an indispensable tool for solving wide range of tasks of operative and strategic management of the regional system, focused on territorial criteria for assessing the quality of management decisions [14].

### 2. GIS in Urban and Municipal Management. GIS Support for Statistical Analysis

Have been developing since the early 1970s, GIS is widely used in government operations. Their use in the conditions of growing demand for spatial information is economically effective [3, 13]. Especially great are their capabilities in the solution of problems of accounting of land resources, monitoring of transport and communication systems, forecasting of emergency situations, the analysis of demographic processes, accounting and real estate evaluation, evaluation of ecological and economic systems and other [12].

Along with common to all information systems functions, GIS perform a number of functions of special interest for tasks of regional and urban systems analysis:

- Construction of summary reports on the basis of the text, tables, map-schemes, cartodiagrams etc. on the results of the analysis and forecast of a state of a territorial socio-economic system.

- The solution of the basic problems of statistical analysis for selected cities and municipalities.
- Solution of the tasks for spatial analysis and spatial econometrics.
- Territorial systems modelling [9].
- Problem analysis of analytical cartography, for example, change the scale of a map images, cartometry, thematic mapping and other.

GIS capabilities to support the implementation of the functions of urban and regional systems management allows to allocate such promising areas of their application as:

- Collection and storage of information on the current and the previous states of a regional system in mapping, visual and textual forms. Creation of databases system characterizing the spatial aspect of development of the socioeconomic complex of a region.
- The solution of the operational analysis problems of the state of spatial system: grouping, finding zones and areas for selected indicators of economic and social development, etc.
- The monitoring tasks of a regional system.
- Systematization of expert judgments, conducting a complex assessment of a regional system.
- Analysis of variants of administrative decisions and choice of the optimal criteria of the effectiveness of regional management [10].
- Assessment of the possible consequences of management actions on the basis of region functioning models [5, 7, 11].

Awareness of the possibilities and prospects of GIS causes their increasing use of the city administration, bodies of municipal management etc. [2, 4] However, their use is primarily limited by the sphere of spatial database accumulation, by construction of thematic maps and simple analytical tasks implementation. Despite the fact that functions of the inventory, analysis and management of regional systems are declared as a goal GIS application, their opportunities are not sufficiently used in solving the main problems of statistical analysis and operational management.

### **3. Elaboration of the Specialized GIS for the Regional Statistical Agency**

The realization of all above circumstances posed a question of geoinformation technologies adoption in the work of departments of Territorial Organ of the Federal State of Statistics Service of the Republic of Tatarstan (Tatarstanstat). GIS technologies adoption started in the 2000s and was implemented in several directions, chief among which are associated with issues of monitoring and operational analysis of the economy and social sphere of municipalities [4, 15].

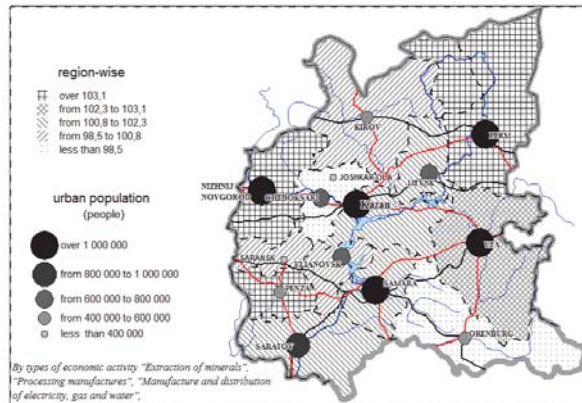
The basis of practical use of GIS-technologies is a geoinformation system, including cartographic basis, spatial database and GIS maps of different scale and detail. It is extensible, sufficiently flexible to change the database structure and the structure of the tasks, and focuses on the analysis of two territorial systems:

Regions of the Volga Federal district (VFD).

The Municipalities of the Republic of Tatarstan (RT).

Analysis of socio-economic development of regions of the Volga Federal district is accompanied by a set of spatial data and maps. It displays features of functioning of industrial and social spheres in the regions. For these purposes a special geoinformation map of regions of Russia, scale 1:7500000 was elaborated. It includes eight layers representing the major types of spatial (socio-economic and natural) objects: BORDER of the Federal district subjects; road network, it contains layers with main railways, major roads and other roads; river network, including layers with major rivers and lakes and small rivers and lakes; names of settlements including centers of Federal districts, centers of the Russia Federation subjects and other settlements, having not less than 5,000 population; markers of settlements; names of rivers, including major rivers and lakes and small rivers and lakes; subsidiary layer; map legend.

Each layer has its own special information structure. All the layers form a single system. Composed map has a rather significant information content and includes a large (several hundred) number of features. Built GIS maps form the basis of the solution of a wide spectrum of tasks connected with the analysis of the regional socio-economic system of the Federal district - economic analysis, analysis of demographic processes, transport problems solution etc. (See Fig.1). Operative updating of the VFD thematic maps allows monitoring a state of the regions, identifying features of the dynamics of the main socio-economic indicators.



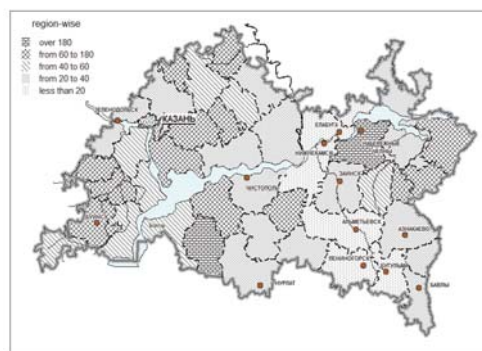
**Figure .1.** Industrial Production Index of the Volga Federal district regions in 2013 (as percentage of 2012)

GIS support for the analysis of the Republic of Tatarstan regional system state is based on a series of maps of the territory of the Republic, reflecting the state of the industry, agriculture and social sphere of cities and municipalities. Spatial database contribute to a deeper analysis of the socio-economic situation in the regions, which, in turn, allows monitoring dynamics of indicators, identifying their communication and interaction, conducting grouping of areas, and assessing the sustainability of the processes of socio-economic development of RT.

For these purposes geoinformation map of the Republic of Tatarstan, implementing a relational database containing information on all major natural and social objects of the Republic of Tatarstan, its settlements, municipalities etc. has been developed. The maps is in topographic projection, scale 1:500 000 and is organized into eight layers, each of which has a database. The layers include: boundaries of municipalities of the Republic of Tatarstan, centers and names of municipalities and cities of the region, river network, legend, a subsidiary layer and others. Spatial database, associated with each of the layers allows designers to accumulate numerical and text (descriptive) information about the objects of this layer and conduct economic analysis.

On the basis of the developed layers complex of economic maps on the selected indices (not less than 15), characterizing socio-economic situation of the cities and districts of the Republic of Tatarstan (the example on figure 2) is monthly carried out. For each thematic map the appropriate sections of the databases in the context of municipal districts and cities of Republican subordination are created and filled.

The processes of maps elaboration and their preparation for publication are rather complex and time-consuming. Therefore, the authors have developed software based on the built-in GIS language, which significantly reduces complexity and increases the speed of preparing such series of economic maps. With its help a number of analytical tasks, including grouping/classification of municipalities of the Republic of Tatarstan on selected indicators of socio-economic development are solved.



**Figure.2.** Gross agricultural output (without private plot) per capita (2013, RUR).

Constructed thematic maps can be printed on paper of any size, which significantly facilitate their use. Printing economic maps are produced in two versions - color and black & white. The black-and-white version is built with the use of different types of straight-line tints, convenient for further replication.

The abovementioned circumstances contributed, since 2000, the adoption of series of socio-economic maps that consider the state of the major functional subsystems of the region in monthly report called "Socio-economic situation of the Republic of Tatarstan".

The solution of an operational GIS support tasks for the preparation and publication of the monthly reports exploits only a limited range of opportunities of a geographic information system. Its full version contains additional subset of cartographic objects, including GIS layers with full network of settlements of the Republic of Tatarstan and a number of layers with names of settlements. Layers are correlated with spatial data bases for each village, containing information on the sex and age structure, the ethnic composition, administrative status, the economic functions of settlements etc. based on population censuses, since 1959. It enables to solve wide range of problems of complex analysis of the socio-economic system of the Republic, to carry out research of dynamics of structure of the population, to accomplish a number of problems of the analysis of economic development of cities and municipalities.

On the basis of the full version of GIS, geographic information systems maps of all municipalities of the Republic of Tatarstan were developed, reflecting the development of their social system, including development of a system of settlements, demographic processes, structural characteristics of settlement - morphological, sex and age, industry, genetic structure, the ethnic composition, etc. Data on all socio-economic indicators are stored for a number of years to assess the dynamics of development.

#### 4. Conclusions

GIS maps and spatial database allows economic activity monitoring in regional municipalities, tracking the dynamics of changes of economic indicators, down to small enterprises. Structure of the spatial database creates a basis for monitoring the development of the network of enterprises; assess the state of their production base and directions of its development. In prospect it is planned to use the system GIS maps municipalities in constructing an electronic version of their passports, as well as at creation of Web-sites of municipalities.

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