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APPLICATION OF GEOGRAPHICAL INFORMATION SYSTEMS FOR THE PURPOSES OF NETWORK SPATIAL MODELING IN QINGHUANGAO CITY (PEOPLE'S REPUBLIC OF CHINA)

The results of network spatial modeling are presented in order to optimize the routes of road transport in the process of routine transport work, special transport of emergency services and optimization of the location of service points.

The last decades are characterized by intensive growth of production all over the world and the associated increase in the number of vehicles and the intensification of their use. In this regard, there is also a significant increase in the contribution to atmospheric pollution by pollutants contained in the exhaust of internal combustion engines. There are currently over 500 million vehicles in use worldwide. Road transport accounts for more than half of all harmful emissions into the environment, which are the main source of air pollution, especially in large cities. On average, with a run of 15,000 km per year, each car burns 2 tons of fuel and about 26–30 tons of air, including 4.5 tons of oxygen.

As a result of the combustion of liquid fuels, according to various estimates, from 180 to 260 thousand tons of lead are emitted into the air annually, which is 60 to 130 times greater than the natural release of lead into the atmosphere during volcanic eruptions (2–3 thousand tons per year). The current situation requires the adoption of urgent measures aimed at reducing the burden on the environment. Reducing the level of air pollution by vehicle emissions can be achieved by the following measures:

- reducing the number of vehicles produced and operated, which is not possible under conditions of intensive industrial development.
- reducing the intensity of transport operation, where possible.
- optimization of transport routes.

Route optimization is a measure that provides several effects: economic, environmental, ergonomic, etc. Due to the reduction of the vehicle mileage, the mileage is reduced, and, consequently, the fuel consumption and depreciation are reduced, the

engine life is saved, the number of emissions into the atmosphere of pollutants contained in exhaust. Thus, route optimization can have a significant positive impact on the overall situation both locally, regionally, and globally.

Geographic information systems (hereinafter referred to as GIS) in the process of their development have evolved from automated mapping systems to full featured geographically deployed information systems. Currently, GIS tools are used to inventory natural and labor resources, plan healthcare and public services networks, develop cities, design oil pipelines and highways, develop environmental measures and analyze election results, and solve a wide range of scientific and practical problems. The main purpose of GIS is to provide the user with reliable and adequately processed information for solving managerial and analytical problems in a visual form that is convenient for operational analysis. In all industrialized countries, hundreds of GIS of various purposes have been created: land, cadastral, municipal, resource, environmental, oceanographic, navigation, etc. At present, the main task is the development of GIS and operational automated mapping, coordination of programs for obtaining, processing, and distributing geoinformation, creating GIS networks, improving supporting hardware and software. Currently, GIS act as a means of systemic and targeted accumulation of information and environmental management. The development and progress of GIS technologies is largely associated with telecommunication networks that provide a wide range of users with access to geoinformation resources. The combination and interaction of means of telecommunications, geoinformatics and automated mapping greatly enhances their effectiveness and significantly expands the scope. Since on a global scale the development of GIS technologies is dominated by trends towards enlargement, integration and globalization of end products, the purpose of this work was to evaluate the effectiveness of applying spatial analysis methods using GIS tools on a «desktop» scale, i.e. in terms of the possibility of creating small user applications by a wide range of users who do not have special training in the field of GIS technologies.

Optimization modeling of technological transport routes during routine transport work

As an object of optimization, the route of technological transport was chosen, which ensures the delivery of products from the manufacturer to several consumers in the city Qinhuangdao.

Using the ArcView 3.2a toolkit, a vector spatial model of a part of the territory of the city of Qinhuangdao was built. Using the Network Analyst module, network problems were solved to determine the best routes under interactive conditions – changing the directions of entry and exit and the impossibility of moving along several segments of the road network with the formation of a route sheet for each option.

In the case of inaccessibility for passage of certain sections of the road network, this condition was automatically considered when solving the optimization problem, and inaccessible sections were excluded from the route. The user-friendly interface of the ArcView application and the Network Analyst extension module ensured the speed of changing conditions when setting tasks for modeling various route options.

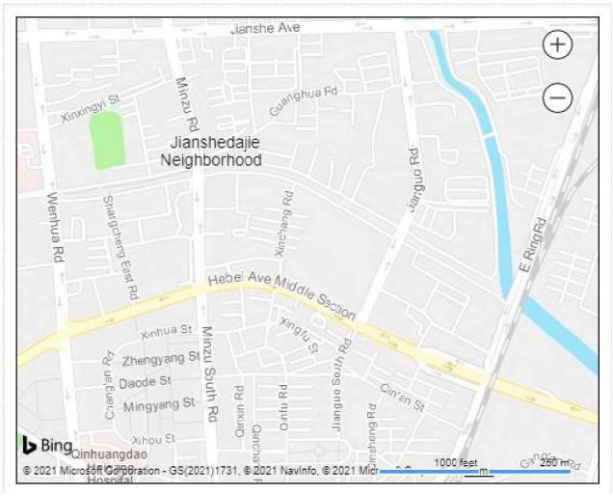

Fig.1. Topographic basis for creating a network spatial model of a part of the territory of the city Qinhuangdao

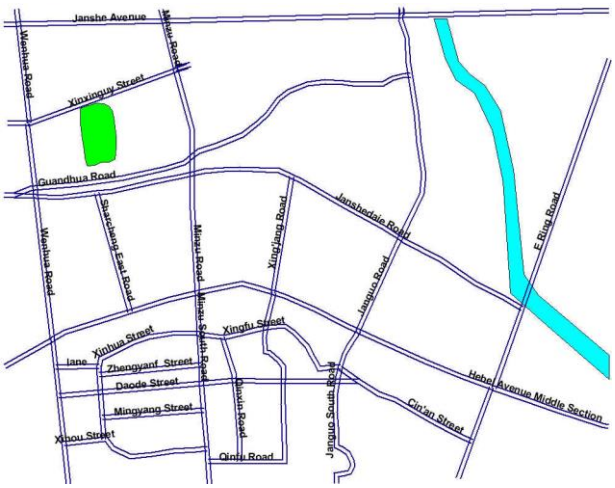

Fig. 2. Network spatial model of the main streets and driveways of the studied part of the city Qinhuangdao

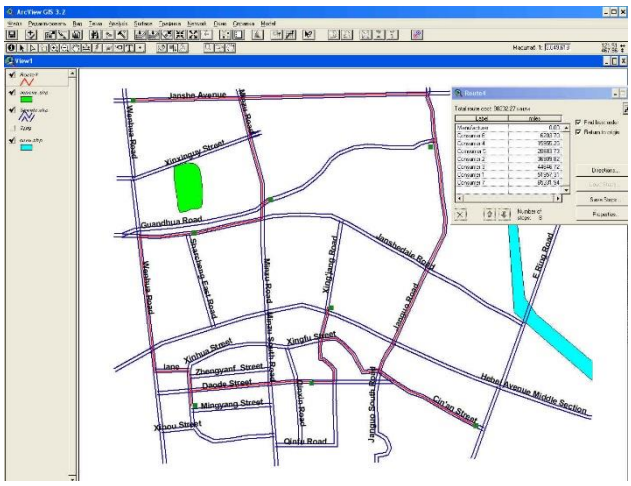

Fig. 3. Optimized route for the delivery of products from the manufacturer to several consumers in the context of routine transport work

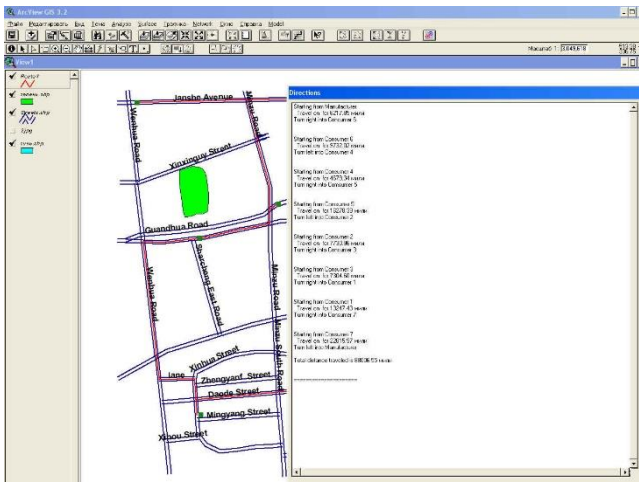

Fig. 4. Route sheet for the movement of technological transport during the delivery of products from the manufacturer to consumers

It is obvious that the use of software tools that implement algorithms for network spatial analysis makes it possible to solve the problems of operational modeling of traffic routes with dynamic initial conditions and optimization according to specified criteria. Thus, the technique of network spatial modeling based on the technology of geographic information systems can be effectively used in the implementation of measures to systematically reduce the mileage of road transport to improve economic and environmental performance.

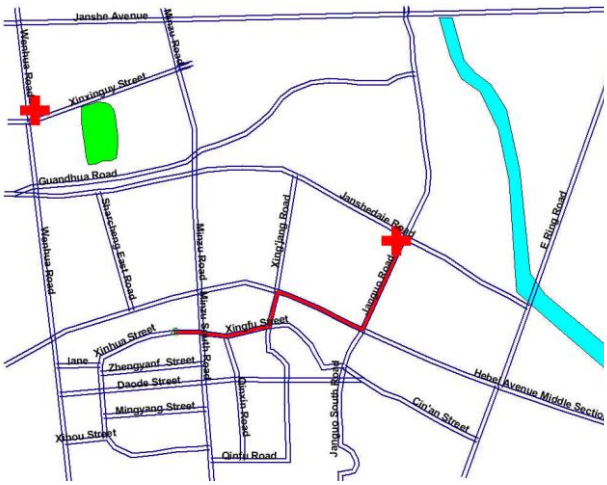

Fig. 5. The results of modeling the optimal routes for the movement of an ambulance brigade at various addresses

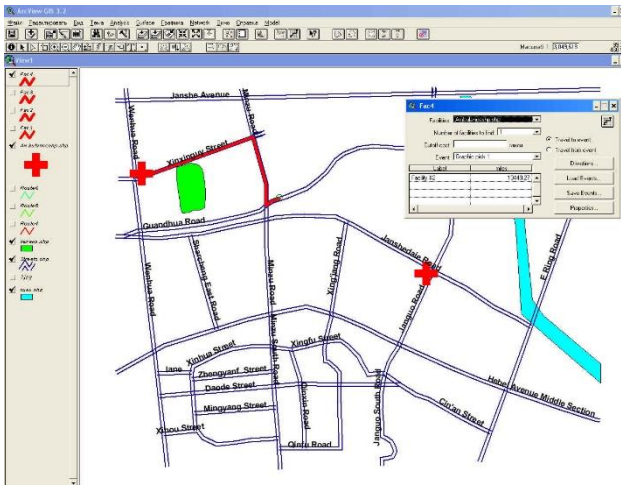

Fig. 6. The results of modeling the optimal routes for the movement of an ambulance brigade at various addresses

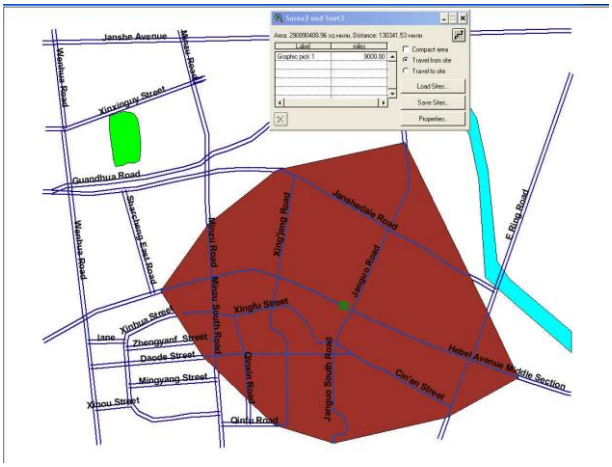

Fig. 7. Optimization of service areas for different location of the service point

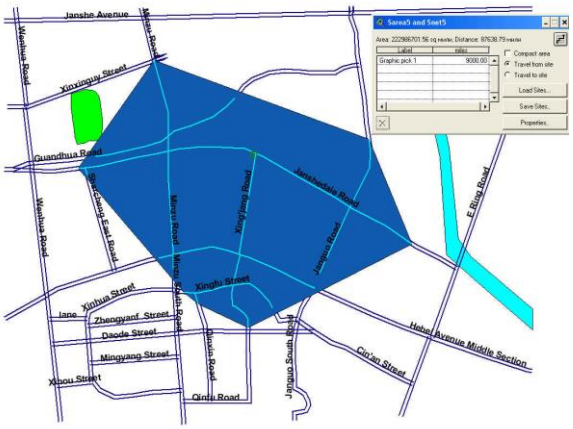

Fig. 8. Optimization of service areas for different location of the service point

Application of geographical information system technology in the activities of emergency service

The simulation of the optimal route for the ambulance crew from the ambulance substations located at different distances from the call address was carried out. Since the routes were optimized by the factor of minimizing the distance traveled, it is obvious that the operational modeling of the optimal route for each call will allow to obtain the effects of reducing the mileage and time to arrival. And a reduction in mileage at one exit, albeit insignificant, considering the intensity of the work of the ambulance service and the number of trips, can have a significant positive impact on reducing the corresponding material costs. Reducing the time before the arrival of this service in general is difficult to overestimate.

Service area ooptimization modeling

The location of the facility was optimized for maximum accessibility to all consumers within the road network using ArcView GIS and the Network Analyst extension. Spatial accessibility models of a service point located at different points of the territory are shown in fig. 7–8.

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