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## **Transport logistics optimization by QGIS**

*The main areas of application of GIS in geology are defined. Well-founded possibilities of modeling, analysis and display of the geological situation of the object with the functional means of Quantum GIS. Information is presented about the Network Analysis module in the QGIS program, which implements the basic methods of graph theory (in particular, it works on the Dijkstra algorithm) and allows you to determine the shortest distances between two objects. Useful plugins for the analysis of traffic routes or cargo delivery are described.*

Recently, new tools have been created for working with geodata, which are used in various areas of human activity. The traditional field of application of geoinformation systems are transport and logistics. The impetus for the development of transport GIS was the widespread use of satellite navigation. Software for network analysis and solving routing problems is of particular importance. Most fully functional GIS programs offer an expensive license, and therefore the issue of studying freely distributed GIS applications becomes relevant. One recent example is a geographic information system which increases the efficiency of urban passenger transport usage. QGIS unlike proprietary software suites (e.g. ArcGIS and MapInfo) is open source and freely available for use at no cost. Moreover, it does not have any license fees associated with it, which determine the use of certain tools within the program. QGIS can be extended and redistributed to other organizations, hence appropriate for developing countries with limited budgets. In addition, it allows one to work with PostGIS: a powerful geodatabase extension for PostgreSQL. QGIS has a large and active community of developers and users who work collaboratively to share mapping and analysis solutions capable of benefiting all consumers including non-programmers.

Optimization of the route of the vehicle makes it possible to achieve a significant reduction in costs, a reduction in mileage, a reduction in fuel consumption, a decrease in the amount of pollutants emitted into the atmosphere, contained in the exhaust, and an increase in the quality of customer service [1].

QGIS3 Network Analyst tool was used to compute and model realistic road networks of the study area for an efficient cargo delivery system. Other functionalities of the tool include: (a) drive time analysis, (b) route directions, (c) point to point routing, (d) shortest path calculation, and (e) optimum route selection. These functionalities are usually used by organizations involved in transportation, health care, logistics, education, public safety, and local government to optimize their transport operations.

The network analysis tool provides a good decision support system for computing optimal routes, locating nearest facilities and determining drive times from one location to the other. In an urban transportation system, the most significant

indicators of travel time are the length and speed restrictions of a route being traversed [2]. The shorter the route, and lower speed restriction, the shorter the travel time.

Using an implementation of Dijkstra's algorithm, the Shortest Path algorithm (Network Analysis) calculates the geometry and cost of the shortest path between two points. The algorithm for using the network-analysis library can be written in three steps:

1. Get a graph from geographic data
2. Analyze the graph
3. Use the result of the analysis for your purposes, for example, to visualize.

The default Processing network analysis tools are provided out of the box. They provide functionality to compute least cost paths and service areas (distance or time) based on your own network data. Inputs can be individual points or layers of points. The result of the Shortest Path algorithm is shown in Figure 1.

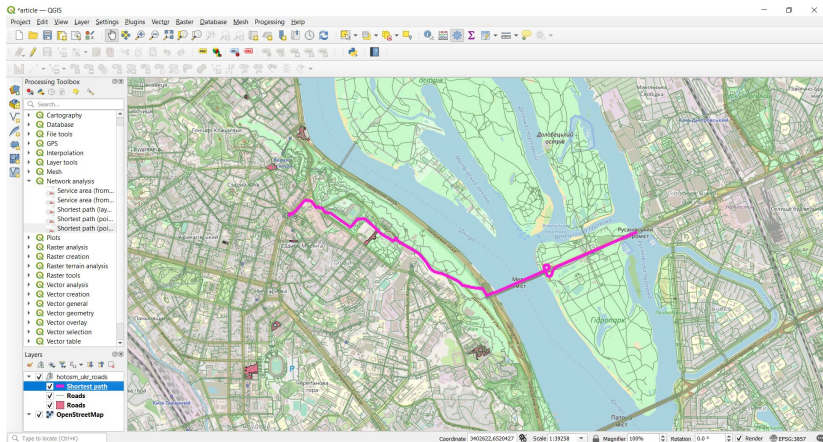


Fig.1. The result of using the function Shortest path (point to point)

For the visualization of the data base, OpenStreetMap was tagged, OpenStreetMap, it is a free editable map of the world, which can be used, edited, allows you to add to the map everything you see, such as buildings, roads, or places of interest. Using OSM data in QGIS enables you to easily create maps with layers for roads and buildings, and also features vector-based rendering.

If you simply want to view OSM data as a base map, then the Quick Map Services plugin is perfect for you. QuickOSM is one of the most useful plugins for geodata collection. It allows you to upload any data from OpenStreetMap directly to the project without restrictions on the size of the upload area.

QuickOSM has very flexible settings - you can choose the category of objects (roads, buildings, natural objects), the type of geometry (point, polygon, line), as well as the type of data (vector, tabular). However, for high-quality work with the plugin, you need to know the OpenStreetMap tags and the rules for unloading objects.

Although the standard OSM basemap is free to use, an API key is required for any of the following: Cycle Map, TF Landscape, TF Outdoors, TF Transport Dark, Transportation, Veloroad.

ORS Tools provides access to the [openrouteservice.org](http://openrouteservice.org) service, a sister project of OpenStreetMap in the field of routing and traffic. The plugin adds tools for building routes and isochrones to QGIS. The tool set includes routing, isochrones and matrix calculations, either interactive in the map canvas or from point files within the processing framework. Extensive attributes are set for output files, incl. duration, length and start/end locations.

You can build the shortest route for multiple locations, calculate travel times and see alternative travel options. You can work with routes for cars, bicycles, pedestrians. ORS Tools also takes into account data on elevation changes and has additional presets for calculating routes in the mountains.

Another useful plugin for route optimization is this TravelTime Plugin in QGIS. The TravelTime QGIS plugin is a powerful tool that allows you to create isochrone maps to analyze where you can travel within a time limit. You can use this within your geospatial analysis to determine where to locate new facilities, for urban transport planning and much more. This plugin adds a toolbar and processing algorithms allowing to query the TravelTime platform API directly from QGIS. The TravelTime platform API allows to obtain polygons based on actual travel time using several transport modes rather, allowing for much more accurate results than simple distance calculations.

**Conclusions:** The results of the study allow us to conclude on the effectiveness of the application of geographic information systems technology to solve the problems of interactive spatial modeling of optimal routes based on vector spatial network models. The optimization of routes of transport networks can have a positive impact on the situation both locally and regionally and globally. The most important plug-ins can be successfully used for operational planning and optimization of technological transport routes in order to improve the environmental and economic performance of enterprises in the field of production, trade, utilities, etc. The reviewed plug-ins with the help of GIS-packages allow to be significantly more accurate models, more operatively update and navigate with maps that are updated in real time.

## References

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2. Kealeboga K. Moreri, Lopang Maphale, Nyalazdani Nkhwanana. Optimizing dispatch and home delivery services utilizing GIS in Botswana: Botswana Post case study. *Spatial Information Research*, 2017. DOI: 10.1007/s41324-017-0123-5.