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UNIVERSITY OF WARMIA AND MAZURY IN OLSZTYN (Poland)
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CONTENT

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ADVANTAGES OF USING QGIS TO SOLVE SPATIAL PLANNING TASKS

Hoptsii Dmytro, Siedov Arkadii, Anopriienko Tetiana, Khainus Dmytro, Yaremko Denys
State Biotechnological University

Abstract
The article discusses the prospects and advantages of using QGIS for solving spatial planning tasks. Attention is focused on the strengths of QGIS compared to other geographic information system software and the programme's potential to eliminate the monopoly position in the market by well-known geographic information system software manufacturers. Even though QGIS is open-source software, this software product is generally not inferior to expensive geographic information system software. At the same time, the advantages of QGIS include cross-platform, rich functionality, the ability to use different geographic information databases, and the ability to connect and integrate various plug-ins into the programme. Particular attention should be paid to the ability to independently write plug-ins for solving specific highly specialised tasks in the Python programming language and their quick integration into the QGIS software environment. Examples of QGIS software for solving specific spatial planning problems are given. The possibilities of using QGIS in solving the issues of settlement planning, territory management, land management and environmental monitoring are considered. The conducted research gives grounds to recommend QGIS for wide application by developers of project documentation, as well as by executive authorities and local self-government bodies for analysing cartographic and project materials in making management decisions. This approach will help create a competitive environment among developers of urban planning and land management documentation. After all, today, many specialists cannot afford expensive commercial licenses of well-known geographic information system software developers. And any legislative requirements that oblige them to use them in practice lead to monopolisation of the market for these services by individual enterprises. At the same time, it has been proven that using the open-source geographic information system software QGIS will not lead to a deterioration in the quality of project documentation. The programme can ensure the proper quality, accuracy and interoperability of design and mapping materials created with its help and solve a wide range of tasks in spatial planning.
Key words: geographic information system software (GIS software), spatial planning, project documentation, cartographic materials, territory management

Introduction

Today, spatial planning is hard to imagine without modern geographic information systems. Geographic information systems are being improved daily and expanding their application scope. In addition to solving traditional problems of physics, geodesy, geography and geology, modern geographic information systems allow solving problems in other, seemingly unrelated areas, such as statistics, demography, medicine and ecology. The widespread use of geographic information systems in spatial planning in Ukraine is primarily driven by digital transformation and the development of cadastral systems, as well as the decentralisation reform and the empowerment of local communities to manage their territories. The Russian aggression and the full-scale war in Ukraine have stimulated the expansion of the scope of geographic information systems. For example, for military purposes, the use of geographic information systems is intended, among other things, to solve the problems of humanitarian demining, assessing the degree of soil contamination with heavy metals and chemical compounds, the degree of destruction of settlements caused by hostilities, etc.

In many cases, remote sensing data processing using geographic information systems remains almost the only way to obtain up-to-date information about specific areas. At the same time, in Ukraine, many users involved in spatial analysis, assessment and planning of territories are limited in using well-known commercial geographic information system software (GIS software). Therefore, the issue of using alternative software products arises, provided they are suitable for solving the above tasks without losing accuracy, quality and information content. In our opinion, QGIS is a promising GIS software in this regard. The advantages of using this software for solving spatial planning problems in the current conditions in Ukraine have determined the relevance of this study.

The study of the capabilities of free GIS software and their comparison with commercial software products is dedicated (Benduch, 2017; Khan, Aaqib, 2017; Khan, Mohiuddin, 2018). The use of QGIS and various plug-ins based on it for solving practical problems in various fields is discussed in the following works (Nowak et.al., 2023 ; Ajaj et al. 2023; Kpiebaya et al. 2022; Nielsen et al. 2021; Ellsäßer et al. 2020; Fang et al. 2020; Çalışkan, Anbaroğlu 2020; Blanco-Gómez et al. 2023; Zaki et al. 2023). While highly appreciating the contribution of scientists to solving this problem, it should be noted that the issue of using QGIS as a full-featured alternative to commercial GIS software has not been studied sufficiently.

Research methodology and materials

This paper aims to prove that QGIS is not inferior to commercial software in terms of functionality and accuracy of geospatial data analysis and processing. Also, to identify the strengths of QGIS and specific tasks that can be solved with the help of this software in spatial planning.

To achieve this goal, dialectical methods of cognition of processes and phenomena were applied. The empirical method was used to compare and identify similarities and differences between GIS software, their functioning, performing of specific tasks, etc. The method of analysis and synthesis was used to study the subject and object of the study. To illustrate the tasks related to the development of urban planning and land management documentation using QGIS, the graphical method was applied.

During the research, a critical analysis of scholars' positions on the advantages and disadvantages of using QGIS to solve spatial planning problems was carried out. Our own experience of using this GIS software was also taken into account. The main criteria for assessing the capabilities of the GIS software were: accuracy of calculations, information content of remote sensing data processed with the help of the GIS software, convenience of the interface and tools, speed of mastering the functionality of the GIS software for an average user, opportunities for improving and developing the software. Based on the conducted research, an unbiased assessment of the prospects of using QGIS to solve the tasks was provided, and specific examples of the GIS software application were given.

Discussions and results

Although GIS software is used in many areas today, its market remains relatively monopolised. Most large companies choose commercial software products, forming specific standards for exchange files and geospatial databases, often becoming official at the legislative level. The most famous developer of GIS software is Esri. As of 2023, the share of the company's most popular software product, ArcGIS, in the geographic information software market alone is 35.20% (according to 6sense.com). At the same time, the market value of the primary desktop version of the software in Ukraine (according to ua.softlist.com.ua) reaches $700. However, advanced software versions are required to solve specific applied tasks, which sometimes cost several times more. The cost of commercial software is prohibitive for small companies and private users, especially given that its basic versions are often insufficient to meet production needs. Due to the war in Ukraine, the property status of developers of land management and urban planning documentation, as well as territorial communities, has deteriorated significantly due to the lack of financial stability and, therefore, orders from designers, the closure of state registers in the area where active hostilities are ongoing, or the direct loss of equipment and software. At the same time, the need for geographic information software to solve spatial planning problems will only grow in the post-war period. Therefore, there is a need to find alternative non-commercial or free software. However, such GIS software should be able to solve spatial planning problems and meet the requirements of interoperability of geographic information data. In our opinion, QGIS is such software.

Since its creation in 2002 by the American geologist Gary Sherman, QGIS has developed rapidly as a promising and progressive GIS software. Today, QGIS is the main competitor of ArcGIS. A large team of volunteers and specialists worldwide, united by the idea of writing open-source software for creating, editing, visualising and publishing geospatial data, is developing and improving QGIS. The scientific community has repeatedly compared the capabilities of ArcGIS and QGIS in solving specific tasks related to geospatial information processing. For example, a study (Benduch, 2017) analysed the capabilities of ArcGIS and QGIS when working with vector and raster data. The author concluded that both programmes showed comparable results when analysing vector data, except for building buffers around objects, especially when such objects were complex polygons. According to the author, this is due to different buffering algorithms. However, it is impossible to answer the question of which programme has the best algorithm. Significant discrepancies in the results were observed when processing raster data, also due to the use of different data processing algorithms. The most notable differences were observed when building a slope map. However, assessing which results are more reliable without specialised knowledge is also impossible. As an alternative, the author suggests using the common part of the results of specific analyses to obtain the most reliable result. A study by (Khan, Aaqib, 2017) on the advantages and disadvantages of ArcGIS and open-source geospatial data processing software did not reveal any significant advantages of commercial software. With some conventionality, the authors include the data format standard, software product warranty and developed technical support as advantages of commercial software.

On the contrary, the study conducted by (Khan, Mohiuddin, 2018) on the evaluation of ArcGIS and QGIS parameters for GIS applications revealed the advantages of open-source software. In particular, the authors mentioned the advantages of QGIS, such as ease of use, better data visualisation capabilities, and multi-platform capabilities. Our experience with various GIS software (Опара В. et.al., 2020; Пілічева М. et.al., 2020; Ачасов, А. et.al., 2015) shows that perhaps the only advantage that commercial GIS systems have today compared to QGIS is access to better remote sensing data, not the software capabilities for their analysis and processing.

Summarising the results of research by scientists and relying on our own experience in the QGIS environment, we will identify the advantages of this GIS software.

1. QGIS is open-source software. Open-source software can be freely used, studied, copied and modified. This fact makes it an affordable option for small organisations and individuals who cannot afford expensive commercial software. In addition, the availability of open source code provides an opportunity to independently improve the programme and adapt it to your production tasks. Of course, the ability to make changes to the software requires specialised knowledge that ordinary users usually do not have. The disadvantage of such software is the possibility of

a large number of unstable builds, i.e. versions of the programme that may not work correctly or in test mode. However, in the case of QGIS, the official website (https://www.qgis.org/en/site/) offers both the latest release, which may interest potential software developers and experienced users, and a stable build of the software that has been comprehensively tested and is free of errors. Such software versions are labelled «long-term release» and should be chosen by the average user.

2. QGIS has a user-friendly and intuitive interface. This easy-to-understand interface makes it easier for beginners to learn and work with. Moreover, today there is a large number of training materials available in the public domain, both in the form of manuals and articles and in the form of videos. This fact provides ample opportunities for self-education and independent search for answers to questions that may arise when solving production problems.

3. QGIS has officially registered user groups. Today, there are officially registered QGIS user groups in 34 countries worldwide. The QGIS user community provides an opportunity to get help from experienced users in solving specific production problems or get advice on using the software more efficiently. The QGIS user community is being actively formed in Ukraine, but so far, it is represented at the level of a Telegram channel.

4. Availability of extensive QGIS functionality. The software has a wide range of functions that allow users to perform various geospatial data analysis and spatial planning tasks. These functions include database creation, data management, visualisation, geoprocessing and geocoding. For this purpose, the software has powerful tools for customising attribute forms, creating and configuring layer symbols, and an easy-to-use field calculator.

5. QGIS compatibility with other GIS software. QGIS supports a wide range of file and database formats, including shapefiles, GeoJSON, KML and many others. Thus, users can work with data from various sources and use them to analyse and solve production problems.

6. Extensive possibilities to customise QGIS and create your own working environment. QGIS has a modular architecture, which provides a wide range of options for customising and installing additional plug-ins to solve specific production tasks. Plug-ins are divided into core and external modules. The QGIS development team develops core plug-ins that are automatically included in each new software release. External plug-ins are located in external repositories and are maintained by their authors. The plug-ins are written in C++ and Python programming languages. Thus, provided you know the programming language, the user can write modules for their own needs. This fact makes QGIS a flexible tool that can be adapted to a wide range of spatial planning tasks.

The above advantages make it possible to use QGIS to solve scientific problems in various fields. For example, (Nowak et.al., 2023) investigated the use of QGIS to design forest belts. The authors note that the QGIS Tree Belt Designer plug-in allows for the design of forest belts and the assessment of the effect of design decisions, taking into account the choice of tree and shrub species; their height, width and crown shape; and the suitability of the habitat represented by soil type, topography and vegetation cover. A study by (Ajaj et.al., 2023) assessed the impact of cement plant emissions on land cover by modelling a Gaussian plume using QGIS. The authors used Python to write a plug-in that allowed them to build maps of the distribution of emissions from the cement plant depending on the season and wind strength, as well as to measure the area of the territory affected by pollution. In the study (Kpiebaya et.al., 2022), QGIS was used to assess groundwater potential spatially. Based on the analysis results, the study area was divided into zones depending on the volume of groundwater. Based on the analysis, test drilling of wells in the aquifers was carried out, confirming the calculations' high accuracy. The study (Nielsen et.al., 2021) proved the QGIS Water Ecosystems Tool plug-in's high efficiency for modelling aquatic ecosystems. In the study (Ellsäßer et.al., 2020) the QWaterModel plug-in was used to predict evaporation based on the ground surface temperature. The authors also proved the high representativeness and reliability of the data obtained. The study (Fang et.al., 2020) was aimed at solving tectonic geodesy problems using QGIS. The authors note that QGIS-based tectonic mapping software has the advantages of ease of use, low training costs, and a user-friendly interface. According to the authors, the software has a high potential for mapping geological features, seismicity and deformation of the earth's crust and coseismic deformation. The study (Çalışkan, Anbaroğlu, 2020) proposed the use of a plug-in for QGIS that determines the MST (Minimum Spanning Tree) on geographic data using the Kruskal algorithm. Minimum spanning tree is used in many areas, particularly when assessing the optimal cost and complexity of building engineering networks or logistics systems. The authors note that using the QGIS plug-in allows for much faster MST determination. In addition, it provides the ability to work with raster data. Thus, continuous geographical characteristics can be considered when estimating the cost of edges in addition to discrete distance measurement. The plug-in also allows for barrier (obstacle) prediction to ensure that the MST is fit for purpose, as political boundaries or other limiting socio-economic factors can be taken into account. In a study (Blanco-Gómez et.al., 2023), the Colour Pattern Regression (CPR) algorithm for QGIS was considered to identify and quantify the relationship between aerial images and raster maps. Using this plug-in in QGIS allows studying the relationship between aerial images and objects on the earth's surface, such as soil moisture content, vegetation cover, vegetation and forest conditions, soils, urban heat islands, etc.

As we can see, the scope of application of QGIS is vast. However, the capabilities of QGIS are best revealed when solving spatial planning tasks. For example, Object-based Image Analysis (OBIA) based on QGIS, which was studied in (Zaki et.al., 2023), has a high potential for solving spatial planning problems. This method is promising for a comprehensive assessment and forecast of territory use based on a progressive raster image analysis algorithm. All of the above confirms the expediency of using QGIS in spatial planning, as it makes it possible to analyse and provide substantiated conclusions on a wide range of issues and tasks. Thus, QGIS allows to successfully perform routine tasks related to urban planning and land management documentation development. One of these tasks is creating buffers around objects. Buffering is a tool widely used in territorial planning to define protection zones, sanitary

protection zones, urban planning restrictions and other areas with a particular legal regime. Buffer zones are created automatically according to the specified parameters, and QGIS allows you to build them around objects of any type and shape (Fig. 1).

Fig. 1. River vector with a constructed buffer of the 100 m coastal protection zone.

QGIS provides convenient functionality for creating map layouts for printing and visualisation at a given scale. Layouts can be saved, modified, and supplemented. This is especially convenient when attribute information changes periodically, for example, when the structure of sown areas in crop rotation changes (Fig. 2).

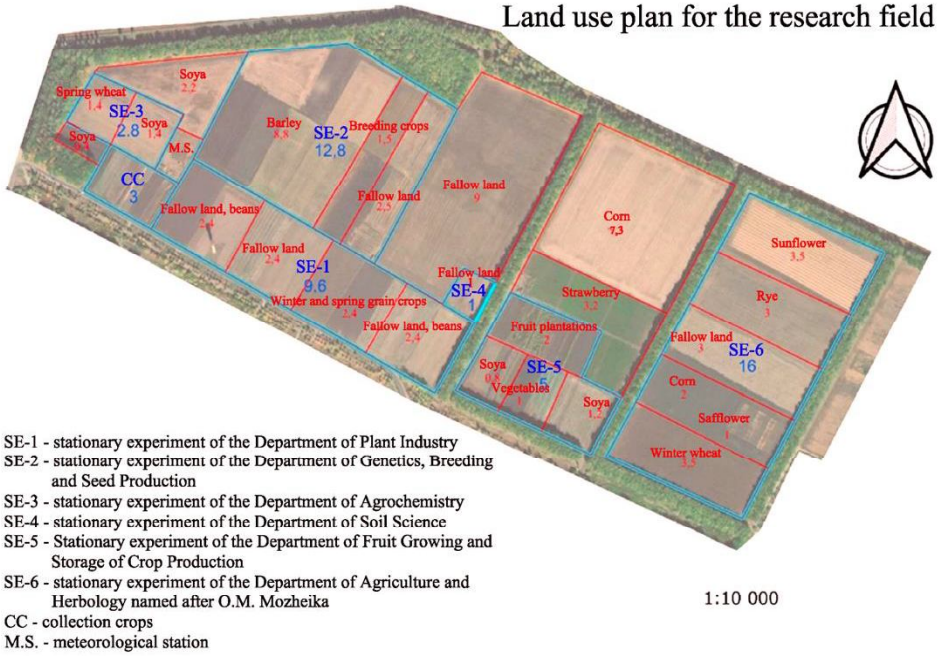

Fig. 2. Plan of the experimental field of the State Biotechnological University.

QGIS allows to work with various geospatial databases. In particular, connecting a layer of the public cadastral map enables to obtain information on the location and parameters of objects of the State Land Cadastre. At the same time, the wide range of options for setting up attribute tables and data processing algorithms using the field calculator allows you to systematise and summarise information according to the specified parameters (Fig. 3).

Fig. 3. Search and display of newly formed land plots on the public cadastral map layer (newly formed land plots are coloured red, existing land plots are coloured green)

QGIS provides the ability to connect and use dynamic WMS such as Sentinel Hub and Planet Explorer. This feature allows to track changes in the territory with a particular frequency, which has become especially relevant in connection with active hostilities in Ukraine. By connecting these services and comparing their data with the public cadastral map, the areas that have been shelled can be recorded. This allows for spatial analysis to identify areas in need of humanitarian demining, as well as agricultural areas that have been chemically contaminated by explosives, etc. (Fig. 4).

Fig. 4. Land plots that have been shelled and may contain explosive ordnance and chemical contamination (red marks craters from explosions)

Conclusions and proposals

The rapid development of geographic information systems and their widespread use in all spheres of life requires equal access to high-quality and functional software. Our research has shown that QGIS is almost as good as expensive commercial GIS systems, while it has even more significant potential in many respects. First, QGIS is an open-source GIS software that allows users to create, edit, visualise, analyse and publish geospatial data and constantly improve the software itself. But even among the open source software, QGIS occupies a particular place due to its extensive officially registered community of users worldwide, which ensures the correct operation and continuous improvement of the programme. Another essential advantage of QGIS is its modular architecture, which provides ample opportunities for solving ordinary and highly specialised tasks. The potential of QGIS for solving spatial planning tasks is undeniable, including planning and organisation of territories at different levels; identification of territories with a particular legal regime; assessment of environmental impact from individual objects or modelling the

consequences of natural disasters and emergencies; calculation of parameters of the transport network and other engineering networks, etc. QGIS has great potential in overcoming the effects of hostilities, particularly in solving humanitarian demining tasks and assessing the level of land and environmental pollution. Thus, QGIS is a full-featured alternative to commercial GIS software and can be used by local governments and specialists in land management and urban planning to solve any spatial planning problems.

References

1. Benduch P. (2017) Comparison of the Results of Spatial Analyses Performed in ArcGIS and QGIS Software. Infrastruktura i Ekologia Terenów Wiejskich / Infrastructure and Ecology of Rural Areas, № IV/3/2017, pp. 1887–1902. DOI: http://dx.medra.org/10.14597/infraeco.2017.4.3.143
2. Khan S., Aaqib S.M. (2017) Empirical Evaluation of ArcGIS with Contemporary Open Source Solutions - A Study. International Journal of Advance Research in Science and Engineering, Volume 6, Special Issue № (1), pp. 724–736. Viewed 10 April, 2023, (http://www.ijarse.com/images/fullpdf/1511159922_330_IJARSE.pdf)
3. Khan S., Mohiuddin K. (2018) Evaluating the parameters of ArcGIS and QGIS for GIS Applications. International Journal of Advance Research in Science and Engineering, Volume 7, Special Issue № (3), pp. 582–594. Viewed 10 April, 2023, (http://www.ijarse.com/images/fullpdf/1562935336_RIMT346ijarse.pdf)
4. Nowak M.M, Skowronski J., Słupecka K., Nowosad J. (2023) Introducing tree belt designer - A QGIS plug-in for designing agroforestry systems in terms of potential insolation. Ecological Informatics, Volume 75, pp.1–8. DOI: https://doi.org/10.1016/j.ecoinf.2023.102012
5. Ajaj O.M, Shafri H.Z.M, Wayayok A., Ramli M.F. (2023) Assessing the Impact of Kirkuk Cement Plant Emissions on Land cover by Modelling Gaussian Plume with Python and QGIS. The Egyptian Journal of Remote Sensing and Space Science, Volume 26, Issue 1, pp. 1–16. DOI: https://doi.org/10.1016/j.ejrs.2022.12.001
6. Kpiebaya P., Amuah E.E.Y, Shaibu A.G., Baatuuwie B.N., Avornyo V.K., Dekongmen B.W. (2022) Spatial assessment of groundwater potential using Quantum GIS and multi-criteria decision analysis (QGIS-AHP) in the Sawla-Tuna-Kalba district of Ghana. Journal of Hydrology: Regional Studies, Volume 43, pp. 1–22. DOI: https://doi.org/10.1016/j.ejrh.2022.101197
7. Nielsen A., Hu F.R.S, Schnedler-Meyer N.A, Bolding K., Andersen T.K., Trolle D. (2021) Introducing QWET – A QGIS-plugin for application, evaluation and experimentation with the WET model: Environmental Modelling and Software. Environmental Modelling & Software, Volume 135, pp. 1–6. DOI: https://doi.org/10.1016/j.envsoft.2020.104886
8. Ellsäßer F., Röll A., Stiegler C., Hendrayanto, Hölscher D. (2020) Introducing QWaterModel, a QGIS plug-in for predicting evapotranspiration from land surface temperatures. Environmental Modelling & Software, Volume 130, pp. 1–6. DOI: https://doi.org/10.1016/j.envsoft.2020.104739
9. Fang Z., Jiang G., Xu C., Wang S. (2020) A tectonic geodesy mapping software based on QGIS. Geodesy and Geodynamics, Volume 11, Issue 1, pp. 31–39. DOI: https://doi.org/10.1016/j.geog.2019.08.001
10. Çalışkan M., Anbaroğlu B. (2020) Geo-MST: A geographical minimum spanning tree plug-in for QGIS. SoftwareX, Volume 12, pp. 1–6. DOI: https://doi.org/10.1016/j.softx.2020.100553
11. Blanco-Gómez P., Amurrio-Garcia C., Jiménez-García J.L., Cecilia J.M. (2023) CPR Algorithm—A new interpolation methodology and QGIS plug-in for Colour Pattern Regression between aerial images and raster maps. SoftwareX, Volume 22, pp. 1–7. DOI: https://doi.org/10.1016/j.softx.2023.101356.
12. Zaki A., Buchori I., Sejati A.W., Liu Y. (2022) An object-based image analysis in QGIS for image classification and assessment of coastal spatial planning. The Egyptian Journal of Remote Sensing and Space Science, Volume 25, Issue 2, pp. 349–359. DOI: https://doi.org/10.1016/j.ejrs.2022.03.002
13. Опара В., Бузіна І., Хайнус Д., Виноградeнко С., Коваленко Л. (2020) Теоретичні та методичні основи використання ГІС-технологій та створення електронних карт при проведенні землеустрою. Проблеми безперервної географічної освіти і картографії, Вип. 31, С. 50–59 DOI: http://doi.org/10.26565/2075-1893-2020-31-06 (In Ukrainian)
14. Пілічева М., Анопрієнко Т., Маслій Л., Куліш Ю. (2020) Сучасні тенденції інформаційного забезпечення земельного кадастру в Україні та світі. Вчені записки ТНУ імені В. І. Вернадського. Серія: технічні науки, Том 31(70), Ч. 2, № 1, С. 146-152 DOI: https://doi.org/10.32838/2663-5941/2020.1-2/27 (In Ukrainian)
15. Ачасов А., Ачасова А, Селіверстов О, Седов А., Товстокорий О. (2015) Використання геоінформаційних технологій для оцінки просторової неоднорідності вологості орних ґрунтів. Людина та довкілля. Проблеми неоекології, №1-2, С. 18–23 (In Ukrainian)

Information about authors:

Dmytro Hoptsii, doctor of philosophy in economic, assoc. prof., Department of Land Management and Cadastre, State Biotechnological University, Alchevskykh St., 44. Kharkiv, 61002, tel: +38 050 976-05-80,
e-mail: dmytro.goptsii@gmail.com Fields of interest: spatial planning, GIS, land law.

Arkadii Siedov, senior lecture, Department of Land Management and Cadastre, State Biotechnological University, Alchevskykh St., 44. Kharkiv, 61002, tel: +38 066 464-68-15,
e-mail: shakhmet1985@gmail.com Fields of interest: GIS, remote sensing, UAV's, GNSS.

Tetiana Anopriienko, doctor of philosophy in economic, assoc. prof., Department of Land Management and Cadastre, State Biotechnological University, Alchevskykh St., 44. Kharkiv, 61002, tel: +38 067 957-54-00,

e-mail: atatyanav2017@gmail.com Fields of interest: all similar surveying and technology studies, economic.
Dmytro Khainus, doctor of philosophy in economic, assoc. prof., Department of Land Management and Cadastre, State Biotechnological University, Alchevskykh St., 44. Kharkiv, 61002, tel: +38 095 926-61-19,
e-mail: Dmitry.khainus@gmail.com Fields of interest: all similar surveying and technology studies.
research.
Denys Yaremko, first master's degree student, State Biotechnology University, 44 Alchevskikh str., Kharkiv, 62002. Kharkiv, 61002, tel.: +38 095 218-26-99,
e-mail: yaremko.deniska@gmail.com Fields of interest: all similar geodetic and technological studies.