LATVIA UNIVERSITY OF LIFE SCIENCES AND TECHNOLOGIES

UNIVERSITY OF WARMIA AND MAZURY IN OLSZTYN (Poland)

VITAUTAS MAGNUS UNIVERSITY (Lithuania)

BALTIC SURVEYING

INTERNATIONAL SCIENTIFIC JOURNAL

2019

Volume 10

ISSN 2255 – 999X (online)

ISSN 2255 – 999X (online)

DOI: 10.22616/j.balticsurveying

LATVIA UNIVERSITY OF LIFE SCIENCES AND TECHNOLOGIES
VYTAUTAS MAGNUS UNIVERSITY (Lithuania)
UNIVERSITY OF WARMIA AND MAZURY IN OLSZTYN (Poland)

BALTIC SURVEYING

INTERNATIONAL SCIENTIFIC JOURNAL

2019 / 1

Volume 10

Published since 2014

Technical Editor: Vita Cintina, Mg.sc.ing. (Latvia)

The English Language Editor: Vilnis Auziņš (Latvia)

REVIEWERS

1. **Abalikštiene Edita**, PhD, Kaunas Forestry and Environmental Engineering University of Applied Sciences, Lithuania
2. **Bydlosz Jaroslaw**, Dr hab. eng., AGH University of Science and Technology
3. **Celms Armands,** Dr.sc.ing., Latvia University of Life Sciences and Technologies
4. **Jankava Anda**, Dr.oec., Latvia University of Life Sciences and Technologies
5. **Kriaučiūnaite-Neklejonoviene Vilma,** Doctor of technology sciences, Kaunas University of Technology, Lithuania
6. **Kryshenyk Nadiia**, Ph.D, Lviv National Agrarian University, Ukraine
7. **Mamai Oksana**, Doctor of Economic Sciences, Samara State Agricultural University, Russia
8. **Marian Madalina – Cristina**, PhD, University of Pitesti, Romania
9. **Pisetskaya Olga**, PhD, Belarusian State Agricultural Academy
10. **Popescu Gheorghe Cristian**, PhD, University of Pitesti, Romania
11. **Rekus Donatas**, Doctor of Technology science, Kaunas University of Technology, Lithuania
12. **Rzasa Krzysztof**, PhD, University of Warmia and Mazury in Olsztyn, Poland
13. **Soltys Olha**, Ph.D. in Economic Science, Lviv National Agrarian University, Ukraine
14. **Stoiko Nataliia,** Ph.D in Economic Science, Lviv National Agrarian University, Ukraine
15. **Vlasov Alexandr**, Candidate of technical sciences, Samara State University of Economics, Russia

FOREWORD

BALTIC SURVEYING is an international, cross-disciplinary, scientific, peer-reviewed and open access journal, issued as online (ISSN 2255 – 999X) edition. The periodicity of the journal is 1 or 2 volume per year.

Journal is jointly issued by consortium of:

- Department of Land Management and Geodesy of Latvia University of Life Sciences and Technologies, Latvia
- Institute of Geospatial Engineering and Real Estate of University of Warmia and Mazury in Olsztyn, Poland
- Institute of Geodesy of University of Warmia and Mazury in Olsztyn, Poland
- Institute of Land Management and Geomatics of Vytautas Magnus University, Lithuania

The journal includes original articles on land administration, land management, real property cadastre, land use, rural development, geodesy and cartography, remote sensing, geoinformatics, other related fields, as well as education in land management and geodesy throughout the Baltic countries, Western and Eastern Europe and elsewhere. The journal is the first one in the Baltic countries dealing with the mentioned issues.
Journal disseminates the latest scientific findings, theoretical and experimental research and is extremely useful for young scientists.

Scientific journal BALTIC SURVEYING contains peer-review articles. International reviewing of articles is provided by Editorial Committee. For academic quality each article is anonymously reviewed by two independent anonymous academic reviewers having Doctors of science degree. Names of reviewers are published in the reviewer's list. Articles have passed cross-ref test as well. Each author himself is responsible for high quality and correct information of his/ her article.
Editorial Committee makes the final decision on the acceptance for publication of articles.

Scientific journal BALTIC SURVEYING is indexed in databases Agris, CAB Abstracts, EBSCO Applied Science & Technology Source Ultimate, EBSCO Discovery Service, Complementary Index and Primo Central (ExLibris).

Information about the journal is placed on the website: www.balticsurveying.eu

Editorial Committee
(baltic.surveying1@gmail.com)

CONTENT

DOI: 10.22616/j.balticsurveying.2019.001

EVALUATION OF THE LOCAL GEODETIC NETWORK IN JURMALA CITY

Celms Armands, Reke Ilona, Brinkmanis-Brimanis Miks, Vivita Pukite
Latvia University of Life Sciences and Technologies

Abstract
In order to evaluate the accuracy of the local geodetic network of Jurmala City, in research, comparison of forty-seven selected polygonometry network point coordinates with the obtained data was made by performing measurements by real time cinematic (RTK) method in LatPos base station system. Points were chosen so in order to cover evenly the entire territory of the city. At present, gradual renewal and improvement of the local geodetic network takes place in Jurmala. The linear discrepancy of coordinates obtained in measurements varies from 0.016 m to 0.259 m, mean linear discrepancy in the measured points is fixed 0.110 m. Discrepancy of plane coordinates in different regions of Jurmala is not even. It is rather even within approximate boundaries of the determined regions, this is indicated by different directions of offset vectors, which in eastern part of the city are pointed mainly in NW direction, in central part directions are pointed in W direction, but in the western part of the city pointed in NE direction. Concerning heights, only for 3 of measured points discrepancy exceeds 0.05 m error and there are no connection concerning some specific region. 15% of the measured points of the local geodetic network are with appropriate accuracy of plane coordinates. The linear discrepancy of plane coordinates for points of the local geodetic network, which are measured by RTK method and compared with data from the improved network is 0.024 (m), which indicates the high accuracy of RTK method in measurement data. In Jurmala City, obtaining of data by GNNS data receivers is encumbered by large density of trees. Therefore the local geodetic network in city has very important role in order to ensure performance of geodetic measurements of high quality in the territory of the city. Aim of the research is to evaluate the accuracy of the local geodetic network of Jurmala City. The following tasks have been set for achieving the aim: research of the given problem, visit of the local geodetic network points, performing control measurements, data processing and analysis.
Key words: RTK, LatPos, LKS-92, GNNS, Local Geodetic Network

Introduction

In the last decade, geodetic infrastructure in world-wide scale has developed very rapidly. The growth of the industry was furthered mainly by the demand in diverse sectors of economics, both in civil sector and in national defense sector. Development of global satellite navigation system (GNSS) nowadays has given a possibility to establish geodetic networks with high accuracy providing possibility of geodetic measurements with millimeter accuracy.

In Latvia, set of geodetic points forms basic networks of two types – national geodetic network and local geodetic network. Both geodetic networks are functioning in Latvian coordinate system LKS-92 (Celms et al, 2018).

The national geodetic network provides the united geodetic reference system in the entire territory of Latvia (Balodis et al, 2016). It includes GPS, Leveling, Gravimetric, Geomagnetic and LatPos base station network. These networks are maintained by Latvian Geospatial Information Agency (LĢIA). Its main tasks are implementation of state policy in area of geodesy, cartography and geospatial information. The local geodetic network is necessary in order to provide united coordinate system for surveying works in specific administrative territory. In Latvia, geodetic reference points are necessary for cadastral surveying, provision of operation of real estate state cadastre information system, obtaining of topographic data of high minuteness and performance of other geodetic works: designing, construction and operation of objects. The local geodetic network is maintained by the corresponding local municipality according to Regulations of the Minister Cabinet of 24 July, 2012 No. 497„Regulations of the local geodetic network" (Vieteja geodeziska…, 2012).

Accuracy of the local networks corresponds to the time, when they were established.

As the technologies and methods in geodesy develop, possibility arises to draw conclusions on condition and accuracy of the network according of contemporary requirements. Point 4 of Regulations of the Minister Cabinet No.497 prescribes that the local geodetic network is created by linking to the national

geodetic network with 3-6 cm accuracy. Not always this prescribed accuracy against the national geodetic network can be observed. As a result problems arise to align measurement data obtained from the same network at different time.
In order to evaluate the accuracy of the local geodetic network of Jurmala City, purpose of the research was to determine offsets of plane coordinates of the local geodetic network in relation to national geodetic network by GNSS receiver in LatPos base station system.
For the achievement of the purpose following tasks were set: inspect and survey points of the local geodetic network in the territory of Jurmala by GNSS RTK (real time cinematic method) in LATPOS station network system; carry out processing of measurement data and analysis of the obtained results; create cartographic material by depicting the obtained offsets.
Research is suitable for usage of information for municipality of Jurmala concerning compliance of the local network with requirements

Methodology of research and materials

For obtaining of data, GNNS receiver in the method RTK in 180 seconds sessions was used. In data processing, software Microsoft Office and software Bentley Microstation was used (Dobelis, Zvirgzds, 2016; Dobelis, Zvirgzds, Kalinka, 2016).
In municipality of Jurmala City according to Point 64 of Regulations of the Minister Cabinet No.497 the first time inspection and evaluation is carried out. According to local network inspection report, 740 points were inspected in the territory of Jurmala City. Act on destroying of points of the local network is compiled for 204 points (Fig. 1)

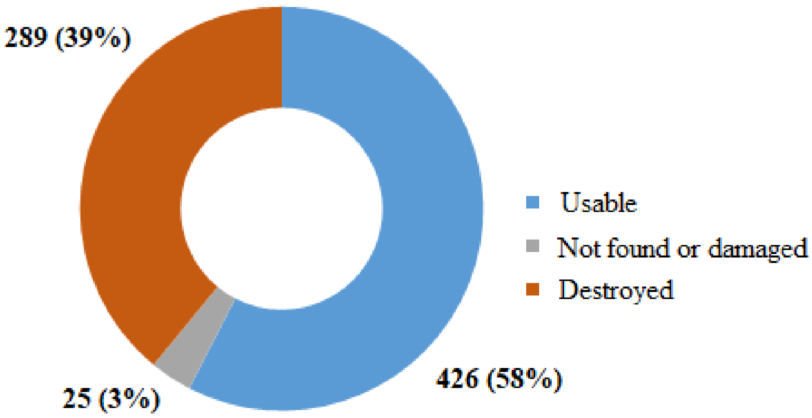


Fig. 1 Distribution of points of the local network of Jurmala City *(Compiled by the Author).*

After the inspection and evaluation it was stated that the local network does not comply with requirements mentioned in the point 4 of the Regulations of the Minister Cabinet No. 479: "The local network is created by linking it to the national geodetic network (hereinafter – national network) with 3–6 cm accuracy: heights of geodetic points are determined with standard deviation up to 1 cm, coordinates – up to 2 cm" Report: (Atskaite: Vieteja geodeziska…, 2012).
For Jurmala City, descriptions of improvement of points of the local network are elaborated and opinions of Latvian Geospatial Information Agency on above-mentioned descriptions are received.
Jurmala City is covered by pine forests and individually growing pines, as well as by dense build-up areas, which encumbered possibility to carry out surveying and determination of coordinates of geodetic points by GNSS methods.
Taking into account the above and based on point 14 of the first part of the Article 15, point 23 of the first part of article 21 of the law "On municipalities" and point 17 of the Regulations of the Minister Cabinet of 24 July, 2012 No. 497 „Regulations of the local geodetic network", Council of Jurmala City decided to carry out gradual improvement of the local network of Jurmala City and renewal of geodetic data, as well as to improve the local network of Jurmala City according to descriptions of improvement.
The prioritary territories of improvement of the local network were determined:
- Buļļuciems, Lielupe, Bulduri, part of Dzintari – stage 1, 2;
- part of Dzintari, Majori, part of Dubulti – stage 3;

- part of Dubulti, Jaundubulti, Pumpuri, Druvciems, part of Melluži – stage 4;
- part of Melluži, Asari, part of Vaivari, Valteri – stage 5;
- part of Vaivari, Krastciems – stage 6;
- Sloka, Kauguri, Kaugurciems, part of Jaunķemeri – stage 7;
- Ķemeri – stage 8.

It was decided to carry out improvement of the local network situated in area of Jurmala City bypass road A10, Priedaine, Vārnukrogs, Buļļuciems (area of port), planned Jaundubulti bridge and P128 bypass road in the framework of construction works envisaged in the future. Decision was taken to do not improve the local network in forests of Priedaine, Druvciems, Valteri, Krastciems, Ķemeri, Jaunķemeri and Kūdra, where economic activity is absent. Until now, the improvement of the local geodetic network is carried out only in eastern part of the city in Buļļuciems, Lielupe, Bulduri and in western part of the City along Talsi Highway up to Kolka Street.

Discussion and results

Evaluation of accuracy of plane coordinates of the local geodetic network in Jurmala City. In order to carry out evaluation of plane coordinates of the local geodetic network of Jurmala in relation to the National geodetic network that is in system LKS-92 TM, before the performance of measurements cartographic material with locations of polygonometry points was analyzed. Map material in question was in DGN format. By use of Bentley Microstation software and alignment with ADTI city mapsheets, it is possible to make first conclusions on location of the point and surroundings - buildings, trees, roads and other objects of urban environment. When points, plane coordinates of which are to evaluate, were chosen, the main requirement was that they should cover evenly the entire territory of Jurmala City –in each region of city at least 2-3 polygonometry points.

For the selected points, sketches with distances to the nearest objects were prepared. Inspection of the selected points of the local geodetic network was started from the easternmost part of city (region Vārnukrogs) and went to the western part (region Ķemeri). As the points were inspected a large part of the selected points was declared inappropriate, because it is not possible to determine coordinates by GNSS data receiver in appropriate accuracy. The main reason is cover of trees that does not allow to receive signal broadcasted by satellites. In the inspection of poligonometry points, author's knowledge about a part of the selected points and their accurate location acquired, when he worked in area of surveying in Jurmala city, was helpful. Fact that the local geodetic network of Jurmala is used practically in everyday life for the purposes of performance of geodetic works. Most of points of polygonometry network is practically used, and as a result of activities of surveyors there are unclosed holes around points or inserted signal pole.

Out of the selected points,

47 points of the local geodetic network of Jurmala City complied with measurements. Still such obstacles as the dense tree cover or points of polygonometry network destroyed in some parts of the city limited the possibility to carry out measurements evenly, covering the entire territory of the city.

For the selected 47 points of the local geodetic network, determination of X,Y coordinates by GNSS data receiver in RTK method in 180 seconds sessions, in LatPos base system was carried out.

For the determination of coordinates GNSS data receiver CHC x91 was used. The receiver has 220 channels that receive following GNSS satellite signals:

- NAVSTAR : (L1C/A,L2C, L2E, L5)
- GLONASS: (L1C/A, L1P, L2C/A, L2P)
- SBAS: (WAAS, EGNOS, MSAS)
- GALILEO: (GIOVEA and GIOVEB) (CHC to supply…, 2013; Getting started guide…, 2010).

GNSS receiver gives possibility to see DOP values, as well as measuring in RTK method with following accuracy parameters:

- Horizontal accuracy up to ± 10mm
- Vertical accuracy up to ± 20mm
- Initialization time 10 s
- Initialization reliability >99.9 % (Atskaite: Vieteja geodeziska…, 2012).

Analysis of the RTK measurements of the local geodetic network. Control measurements were performed in March 2018, in 47 polygonometry points of the local geodetic network (See Fig. 2) during two weeks. Plane coordinates are determined in RTK method, in 180 seconds session, by placing GNSS data receiver over polygonometry points, and by use of carbon fiber spoke with spherical level. All measurements are carried out in FIXED position that guarantees data flow from at least 5 GNSS satellites.

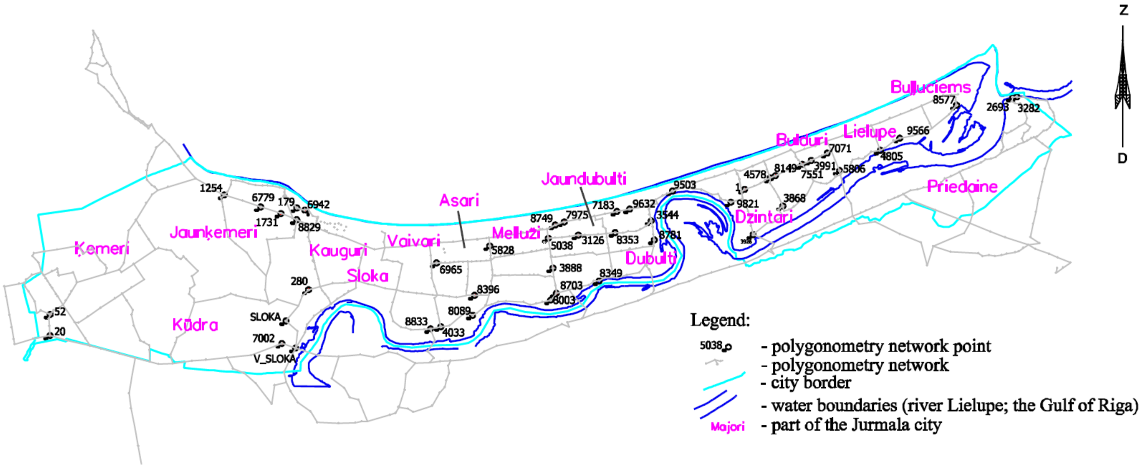


Fig. 2 Scheme of polygonometry network of Jurmala City *(Compiled by the Author).*

In order to compare plane coordinates obtained in RTK measurements with coordinates from catalogue of polygonometry points more demonstratively, calculations of linear discrepancy are made by use of Pithagorean theorem. Calculations are carried out according to formula:

$$f = \sqrt{fx^2 + fy^2} \qquad (1)$$

f-linear discrepancy

f_x-coordinate discrepancy along x axis

f_y-coordinate discrepancy along y axis

Linear discrepancy of coordinates obtained in control measurements from coordinates from catalogue varies from 0.016 m up to 0.259 m. Mean linear discrepancy in the measured points is fixed 0.110 m. The largest discrepancies are stated in area of Lielupe, Bulduri, Dzintari and Majori, where it is 0.214 m in average. Polygonometry points in most areas of Jurmala City do not comply with requirements of point 4 of Regulations of Minister Cabinet No.497 "Regulations of the local geodetic network". The local network shall be linked to the national geodetic network with 3-6 cm accuracy (Vieteja geodeziska tikla…, 2012). Areas, where control measurements of points of the local geodetic network demonstrated appropriate accuracy are Melluži, Valteri, Druvciems, Krastciems and Ķemeri (Fig.3).

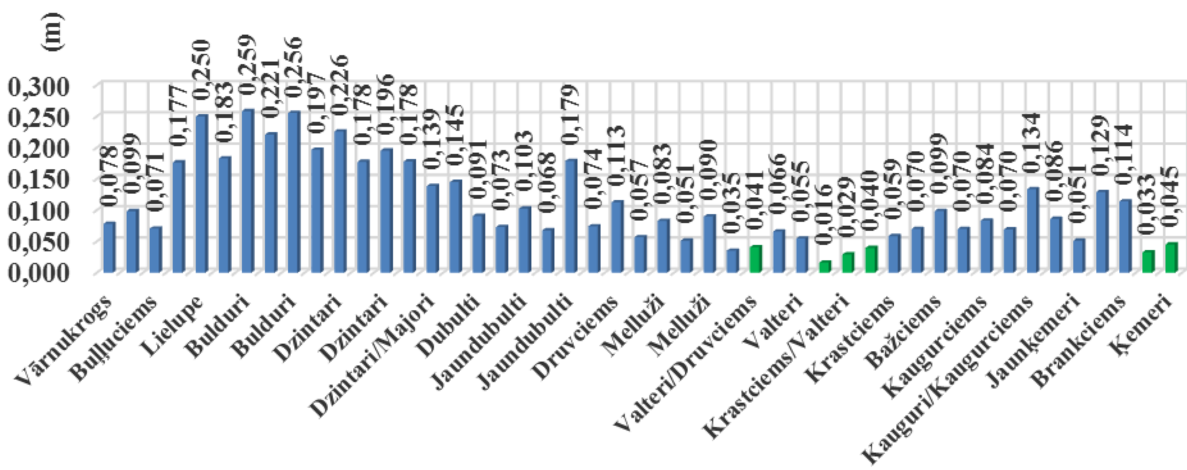


Fig. 3 Linear discrepancies of control measurements of RTK method in LatPos base station system in relation to the local geodetic network *(Compiled by the Author).*

If we compare heights of points of the local geodetic network of control measurements and heights available in catalogue, the situation is much more positive. If we assume that values are positive and do not exceed 0.05m error, then only 3 out of 47 measured points are beyond this limit. No relationships can be observed concerning any specific area (Fig.4).

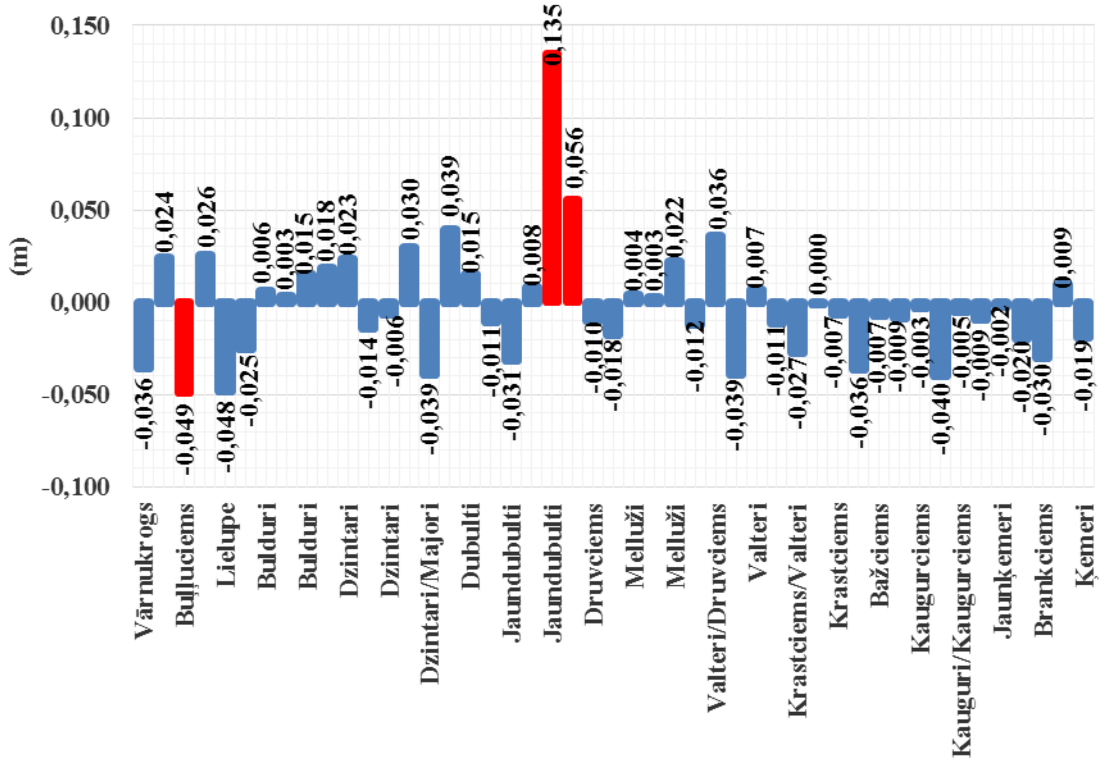


Fig. 4 Vertical discrepancies of control measurements of RTK method in LatPos base station system in relation to heights of the local geodetic network *(Compiled by the Author).*

In percentage terms, only for 15% points, in which control measurements were carried out, XY linear discrepancy complies with requirements of the point 4 of Regulations of Minister Cabinet No.497 “Regulations of the local geodetic network“ concerning 3-6 linking to the national geodetic network. Linear discrepancy of the rest of points is greater than prescribed requirements (Fig. 5)

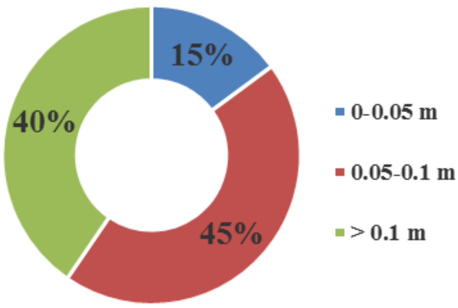


Fig. 5 Distribution of linear discrepancy of control measurements of RTK method in LatPos base station system in percentage terms in relation to the local geodetic network *(Compiled by the Author).*

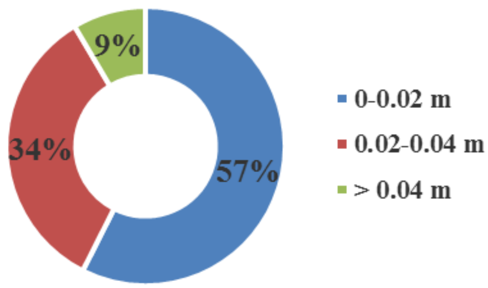


Fig. 6 Distribution of vertical discrepancy of control measurements of RTK method in LatPos base station system in percentage terms in relation to the local geodetic network *(Compiled by the Author).*

Vertical discrepancies in measurements demonstrated much better results, in 57% cases discrepancy did not exceed 0.02 m (See Fig. 6).

Coefficient of geometric placement of satellites PDOP, which has not exceeded 2.5 in any point, certifies about the quality of obtained data in control measurements by use of RTK method. Linear discrepancies of X, Y coordinates obtained in measurements and PDOP values, among which there are no interconnections, also certify about this (Fig. 7).

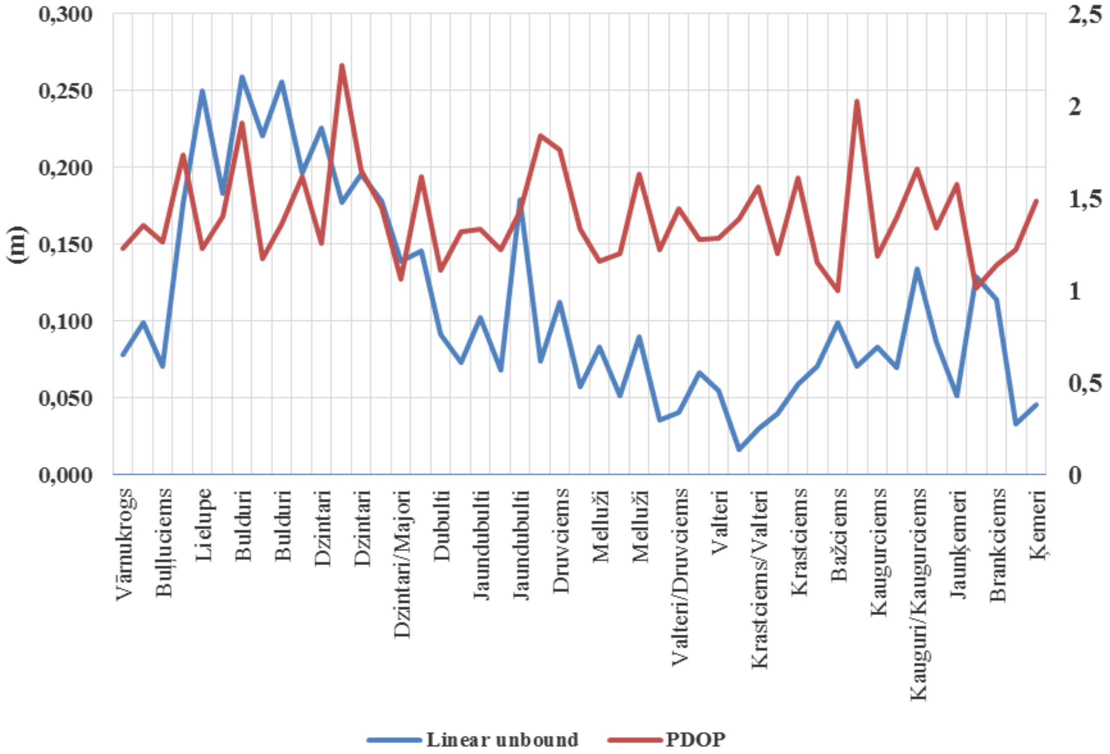


Fig. 7 Impact of geometric placement of satellites (PDOP) on control measurements in RTK method in LatPos base station system *(Compiled by the Author)*.

In order to evaluate stability and accuracy of real time cinematic method control measurements, the obtained results were compared with data from the improved local geodetic network. 26 points were compared (Fig. 8).

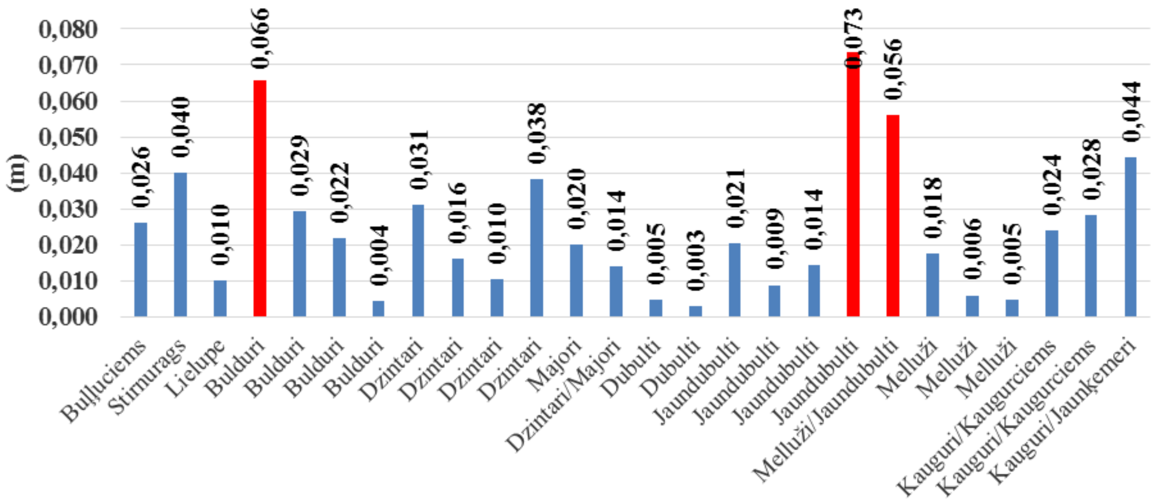


Fig. 8 Linear discrepancy of data of the improved local geodetic network from data obtained in RTK method *(Compiled by the Author)*.

Average linear discrepancy was stated 0.024 m. Only in 3 points of control measurements discrepancy that is greater than 0.04m was fixed. One of points was situated in area of Bulduri, two in Melluži. As these three points were inspected one more time, conclusion was drawn that the possible obstacle for data accuracy was cover of trees (See Fig. 8).

As indices for X and Y axes are taken separately, discrepancy along X axis reaches 0.008, along Y axis 0.007 (Fig. 9)

Fig. 9 Discrepancies along X and Y axes of data of control measurements obtained in RTK method from data of the improved local geodetic network *(Compiled by the Author).*

In order to clarify directions of plane coordinate discrepancies in areas of Jurmala City, cartographic material is created. In the eastern part of the city, vectors mainly are pointed in NW direction, in central part in W direction, but in the western part of the city are pointed mainly in NE direction, except Ķemeri, where vectors are pointed in NW direction. Direction of vectors of points of the eastern part of the city differs from results obtained in other regions, where the consequence is not so large (Fig. 10).

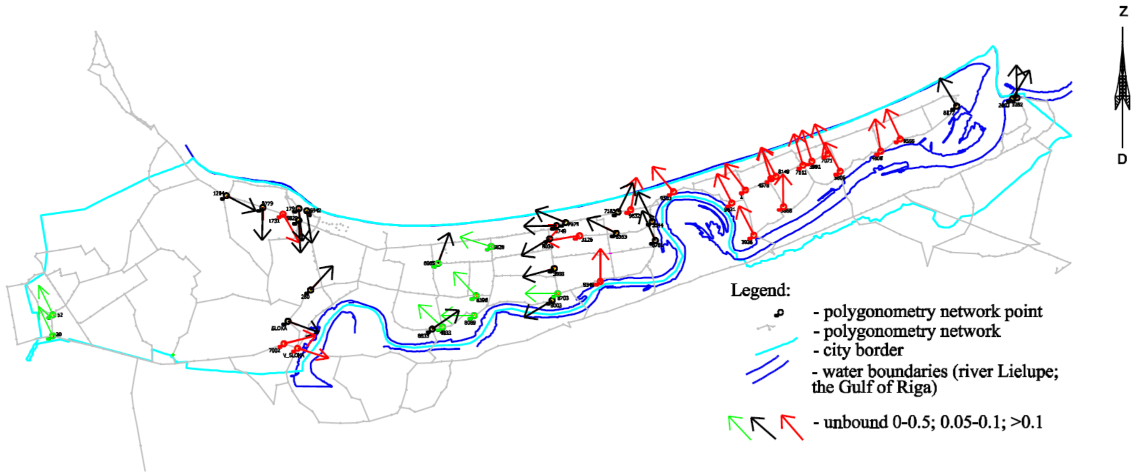


Fig. 10 Directions of vectors of offsets of plane coordinates of Jurmala City *(Compiled by the Author).*

Not equal directions of vectors and linear discrepancies in central and western parts of city certify about the fact that they have lost their accuracy in the result of natural factors and depreciation.

Conclusions and proposals

1. The average linear plane coordinate discrepancy of control measurements carried out by RTK method compared with coordinates of the local geodetic network from catalogue is 0.110 (m), but the average arithmetic discrepancy of heights is 0.022 (m).
2. Discrepancy of plane coordinates in diverse areas of Jurmala is not even. It is rather even within approximate boundaries of the determined areas. Also different directions of offset vectors that in the eastern part are pointed mainly in NW direction, in central part vectors are pointed in W direction, but in western part of the city are pointed in NE direction, except in Ķemeri, where vector is pointed in NW direction.
3. Greatest plane coordinate offsets are fixed in the areas of the center of the city- in Lielupe, Bulduri, Dzintari and Majori. There average arithmetic discrepancy is 0.214 m. Areas, where control measurements of the local geodetic network did not exceed 0.06 m, which can be considered as appropriate accuracy, are Melluži, Valteri, Druvciems, Krastciems and Ķemeri.
4. 15% out of the measured points of the local geodetic network are with appropriate plane coordinate accuracy.
5. Linear discrepancy of plane coordinates for points of the local geodetic network measured by RTK method and compared with data from the improved network is 0.024 (m), which indicates the high accuracy of RTK method in measurement data.
6. In Jurmala City, obtaining of data by GNNS data receivers is encumbered by the dense tree cover. Therefore, the local geodetic network in city has a very important role, in order to provide performance of high quality geodetic measurements in its territory. The local geodetic network shall be maintained according to contemporary actual requirements for accuracy.

References

1. Atskaite: Vietējā ģeodēziskā tīkla pilnveidošanas apraksts (Report: description of local geodetic network optimization) (2012). Ventspils (in Latvian).
2. Balodis J., Morozova K., Silabriedis G., Kalinka M., Balodis K., Mitrofanovs I., Baltmane I., Jumare I. (2016) Changing the national height system and GEOID model in Latvia. Geodesy and Cartography Volume 42, Issue 1, p. 20-24.
3. Celms. A., Parsova V., Reke I., Akmentins J. (2018) Tendencies of development of local geodetic network in Riga city. Baltic Surveying, Volume 9. p. 8-15
4. CHC to supply 90 GNSS Receivers to Chinese National Mapping Bureau . (2013). Viewed 18 April, 2018, https://www.geoconnexion.com/news/chc-to-supply-90-gnss-receivers-to-chinese-national-mapping-bureau
5. Dobelis D., Zvirgzds J. (2016) Network RTK performance analysis: a case study in Latvia. Geodesy and Cartography, Volume 42, Issue 3, p. 69-74.
6. Dobelis D., Zvirgzds J., Kaļinka M. (2017) High ionospheric activity effects on LatPos RTK network performance in Latvia. IOP Conference Series: Materials Science and Engineering. Viewed 18 June, 2018, (http://iopscience.iop.org/article/10.1088/1757-899X/251/1/012064/meta).
7. Getting started guide X91GNSS (2010). Viewed 19 April, 2018 https://www.geoplan.hr/upute_za_%20radX91.pdf
8. Vietējā ģeodēziskā tīkla noteikumi (Regulation of local geodetic network) (2012). Viewed 25 January, 2018, https://likumi.lv/doc.php?id=250460 (in Latvian).

Information about author

Armands Celms Dr.sc.ing, associate profesor of Department of Land Management and Geodesy at Latvia University of Life Sciences and Tehcnologies, Akademijas iela 19, Jelgava, LV-3001, armands.celms@llu.lv
Ilona Reke Mg.sc.ing, doctoral student of Department of Land Management and Geodesy at Latvia University of Life Sciences and Tehcnologies, Akademijas iela 19, Jelgava, LV-3001, ilona.reke@gmail.com
Miks Brinkmanis-Brimanis Mg.sc.ing, land surveyor at GEO JURMALA Ltd., miksbrinkmanis@inbox.lv
Vivita Pukite, Dr.oec., associate profesor of Department of Land Management and Geodesy at Latvia University of Life Sciences and Tehcnologies, Akademijas iela 19, Jelgava, LV-3001, vivita.pukite@llu.lv

DOI: 10.22616/j.balticsurveying.2019.002

TRANSFORMATION OF LEASED LAND USE OF AGRICULTURAL ENTERPRISES IN UKRAINE IN LIMITED LAND MARKET

Kolosa Liudmyla[1], Hunko Liudmyla[1]
[1]National University of Life and Environmental Sciences of Ukraine

Abstract. The result of the long existence of legal restrictions on the agricultural land market in Ukraine was the formation of a specific leasehold system of land use. Agricultural enterprises and farms do not have land owned. Instead, the peasants who became owners of land during the distribution of collective farms, mostly do not process these parcels of land on their own, but also deprived of the right to alienate them (to sell, give, change). The study shows the development of leased land use of agricultural enterprises in Ukraine, which currently covers 16.8 million hectares of private land and about 1 million hectares of state-owned land. Since 2003, the civil law of Ukraine permitted to apply not only the lease of agricultural land, but also the emphyteusis right (the alienated right to use someone's land for agricultural purposes), the process of transformation of lease into emphyteusis was started, especially in large agricultural holdings. The main advantages of emphyteusis as a substantive law and its attractiveness for agribusiness are considered. The suggestions on improving the legal regulation of land use under conditions of emphyteusis are given.
Key words: land reform, land lease, agricultural land, emphyteusis, land market.

Introduction

The Ukrainian model of land reform can be considered one of the most unique and long-lasting in the world, characterized by a complex of features.

Despite the fact that the reform of land relations in Ukraine has been going on for more than 26 years, this process is characterized by the prolongation of a formal temporary ban (the so-called moratorium) on the alienation of land parcels of agricultural purpose by their owners. In particular, according to the World Bank (Deininger K., Nizalov D., 2016) of 41 million hectares of such land, 27.7 million hectares are banned from the alienation of land shares (shares) in kind (on the ground); 10.5 - as agricultural lands of state and communal property; 1.5 - as land for commercial agricultural production (except for share parcels); 1.3 - as non-agricultural lands on agricultural lands of state and communal property; 0.02 million hectares - as uncalled shares. In the conditions of the ban on the alienation of agricultural land, the possibility of their transfer to the lease remained one of the few economic freedoms available to their owners. With the 2003 adoption of the Civil Code (Chapter 33), it became possible to apply not only the lease of agricultural land, but also the rights of the emperor (the alienated right to use someone else's land for agricultural purposes). The use of emphyteusis is gradually becoming more popular among tenants of agricultural land, since it is more profitable and provides flexibility in harmonizing essential conditions of land use.

Regarding the consequences of the land reform and its directions, there are ongoing discussions among leading Ukrainian scientists such as D. Dobryak, R. Kuriltsev, A. Martyn, L. Novakovsky, A. Sokhnich, A. Tretyak, M. Hweisick and many others. However, specific directions of development of rural agricultural land use requires more in-depth research. There remains a debatable problem of improving rental relations on the basis of new legal titles of land use, in particular the rights of emphyteusis.

That is why the article analyzes the consequences of land reform in Ukraine and proposes to improve the legal regulation of land use in terms of emphyteusis.

Methodology of research and materials

The methodology of studying the problem of transformation of the leased land use of agricultural enterprises determines that the subject of the research is leasehold land relations and the relevant state policy on their regulation. This is characterized by a change in the old forms of organization of lease relations by the new, which is due to the emergence of fundamentally new ties, relations and patterns that determine the tendency of their development in the new conditions of management. The study of these relationships, relations and regularities leads to the scientific knowledge of truth, that is, the objective processes of state regulation of land relations in a market economy.

Discussion and results

Land reform is a complex of legal, economic, technical and organizational measures, the implementation of which is aimed at improving, transition to a new land system, an adequate character of a regulated, socially oriented market economy country (Sabluk, 2006).

Independent Ukraine faced an extremely important and difficult task: the creation of a new legal basis for land relations, which would be significantly different from the then, essentially socialist scheme, built on the principles of monopoly law of state ownership of land (Martyn, 2013).

A retrospective analysis of the land reform, an assessment of its positive and negative effects shows that in general, a significant amount of work on the transformation of land ownership, the transfer of most of it, especially agricultural land, to the property of citizens. At the same time, the ultimate goal of reform was not achieved: high-efficiency, ecologically safe use of land resources is not ensured; land relations do not fully meet the requirements of a market economy (Tretyak, 2003).

In Ukraine, for the protection of private property rights of peasants to land (share) in January 2001 a moratorium on the sale of land parcels (shares). In the conditions of the ban on the alienation of agricultural land, the possibility of their transfer to the lease remained one of the few economic freedoms available to their owners. The lease made it possible not to restrict access to land resources of entrepreneurs who had the resources and opportunity for their cultivation. The rent helps to maintain high profitability of agribusiness for a long time, which provided technical re-equipment and modernization of agricultural production.

Implementation of lease relations, in practice, provides additional income to obtain landlord and tenant in accordance with the delivery of the units to rent and use of leased land. In addition, lease relations should be profitable for the state (Kareba, 2012).

Table 1

Average indices of the area of leased land and rent in the regions of Ukraine (Kolosa, 2018)

Region	Total area of land leased under contracts, ths. ha	Annual rent, USD / ha
Vinnitsa	1051.5	56.5
Volyn	205.2	40.08
Dnipropetrovsk	1276.8	38.02
Donetsk	727.8	32.98
Zhytomyr	588.4	47.56
Zakarpattya	16.7	26.97
Zaporozhye	1144.6	29.83
Ivano-Frankivsk	110.3	41.47
Kiev	797.8	57.78
Kirovograd	1010.6	52.93
Lugansk	637.3	32.16
Lviv	297.7	55.3
Nikolaev	883.4	30.99
Odesa	1085.3	36.63
Poltava	1147.4	95.91
Rivne	256.2	56.2
Sumy	712.6	78.89
Ternopil	502.0	46.66
Kharkiv	1074.9	79.3
Kherson	831.1	31.63
Khmelnitsky	780.1	60.18
Cherkassy	784.3	111.24
Chernivtsi	111.3	49.7
Chernihiv	825.3	44.74
Total for Ukraine	**16858.5**	51.43

According to the World Bank, the average rent of 1 hectare of arable land of Denmark reaches 780.8 dollars USA, Netherlands - 672.1, Ireland - 592.2, Bulgaria - 278.9, Luxembourg - 256.2, Spain - 227.3, Germany - 219.4, Belgium - 123.8, Lithuania - 53.7 dollars. US (Deininger, Nizalov, 2016).
At the same time, the rent for agricultural land in Ukraine is 6-8 times lower and equals about $ 37. USA. O On the one hand, this is explained by considerably higher incomes of agribusiness in the EU, which, in particular, are formed as a result of the implementation of the EU Common Agricultural Policy. However, there are obviously some disproportions regarding the redistribution of land rent in our state. We show the average cost of land lease in the regions of Ukraine (Table 1).
As can be seen, a significantly higher rent for land use in Cherkassy and Poltava regions is 111.24 and 95.91 USD / ha, while in other areas it ranges from 30-55 USD / ha.
The total amount of payments for the lease of land shares in 2015 amounted to about 368 million dollars USA, including tenants having entered into contracts with pensioners-peasants at 158 million dollars, which equals 42.9% of the total payments for this year (StateGeoCadastre, 2015).
In total, in 2015, land parcel holders concluded 4741.4 thousand land lease agreements, of which the majority - 2477.5 thousand were signed by peasant pensioners; 1863.7 thousand land lease agreements were registered for 4-5 years, 2004.2 for 6-10 years, 659 for 10 years or more, ie 95.5% of contracts are long-term (StateGeoCadastre, 2015).
In addition, 74.4% of contracts concluded with a rent of 3% or more of the normative monetary valuation of land parcels. The average rent amount for the year is 21,18 USD / ha, and the area of land leased by the owners of land shares reaches 17.5 million ha (Table 2) (StateGeoCadastre, 2015).

Table 2

Conclusion of lease agreements for state-owned land in the regions of Ukraine, 2015 *

Region	Lease agreements for maintenance are concluded					
	Commodity agricultural production		Farming		Private peasant farming	
	units	area, ha	units	area, ha	units	area, ha
Vinnitsa	1852	60190.56	558	19124.44	16	13.50
Volyn	433	12155.52	261	5047.54	159	131.10
Dnipropetrovsk	1103	31929.32	722	18219.61	22	120.31
Donetsk	998	42208.20	447	19700.08	22	32.58
Zhytomyr	212	5535.93	311	9895.51	41	288.76
Zakarpattya	41	1497.13	49	462.51	33	84.72
Zaporozhye	1595	51893.69	373	14813,38	55	97.44
Ivano-Frankivsk	35	373.82	98	1620.90	11	88.69
Kiev	361	10421.45	301	8545.67	40	516.83
Kirovograd	4074	133592.29	398	11224.62	164	186.48
Lugansk	413	22417.76	243	8923.55	128	751.80
Lviv	79	1613.96	113	1593.46	11	8.90
Nikolaev	1676	49767.89	387	10618.83	21	33.61
Odesa	479	28535.62	163	5044.58	76	78.97
Poltava	3757	89032.53	469	12594.88	310	574.88
Rivne	78	584.80	40	495.95	7	15.72
Sumy	1389	66624.37	137	7897.29	48	28.26
Ternopil	370	6384.94	229	4900.61	72	58.48
Kharkiv	2643	82304.24	490	13558.36	33	76.36
Kherson	1185	94743.99	354	20652.51	67	595.94
Khmelnitsky	921	34684.52	539	17937.99	33	142.62
Cherkassy	2183	109615.23	267	8942.32	4012	1440.72
Chernivtsi	77	605.02	51	457.01	53	73.63
Chernihiv	931	39196.85	529	20066,16	356	611.61
Kiev city	0	0.00	0	0.00	0	0.00
Sevastopol city	31	5104.44	0	0.00	0	0.00

Total for Ukraine	**27627**	**1042589**	**7735**	**251807**	**5816**	**6126**

* Source: developed according to the data of the StateGeoCadastre for 2015.

Analyzing the above data, one can conclude that, in general, in Ukraine, in 2015, 27627 land lease agreements for commodity agricultural production were concluded on the area of 1042589 hectares; 7735 contracts with an area of 251807 hectares - for a farm and 5816 contracts on an area of 6126 hectares - for a private farm.

In the context of the increase in the cost of renting agricultural land in connection with the adoption of amendments to the Tax Code of Ukraine, the search for alternative, more economically profitable tools for the use of these lands is becoming more and more relevant. Changes in the Tax Code of Ukraine stipulate, as already noted, that rent for land parcels of state and communal property is not less than 3% of its normative monetary valuation.

One such instrument is the emphyteusis - the right to use the land parcel for agricultural needs as a separate type of property right provided for by the Civil Code of Ukraine. The use of this tool is gradually becoming more popular among tenants of agricultural land, since it is more profitable and provides flexibility in harmonizing the essential conditions of land use (Cherkaska, Fordui, 2013).

Ukraine integrated the legal title of emphyteusis as a right to use another land parcel for agricultural needs in the legal system with the 2003 adoption of the Civil Code (Chapter 33), as well as the introduction of appropriate amendments to the Land Code (Chapter 16). Emphystease may be established by agreement between the owner of the land parcel and the person who has expressed the desire to use it for agricultural needs (the emphyteut). In the future, emphyteut may dispose of its right to use other persons, as well as transfer it to inheritance. As a rule, the contract sets a one-time fee for the transfer of the right to transfer (possibly free of charge) and / or the fee for using it, which is to be paid by the issuer to the owner in a definite manner and agreed time.

Table 3

Number of registered records on the right to use the land for agricultural purposes (emphyteusis), 2013-2015 *

Region, district	2013	2014	2015 (as of 22.11.15)
Crimea	18	2	0
Vinnitsa	28	172	428
Volyn	0	0	1
Dnipropetrovsk	98	289	420
Donetsk	284	767	406
Zhytomyr	1	7	4
Zakarpattya	2	6	13
Zaporozhye	250	775	824
Ivano-Frankivsk	0	193	1
Kyiv city	1	3	0
Kiev	29	736	364
Kirovograd	217	606	782
Lugansk	34	266	141
Lviv	0	0	13
Nikolaev	12	34	89
Odesa	9	66	178
Poltava	230	696	1 954
Rivne	0	2	0
Sevastopol	1	0	0
Sumy	0	43	162
Ternopil	325	1	10
Kharkiv	397	101	385
Kherson	570	1 692	76
Khmelnitsky	23	244	387
Cherkassy	335	397	964
Chernivtsi	42	262	239
Chernihiv	0	0	31

The total number of	**2 906**	**7 360**	**7 872**

* Source: developed according to the StateGeoCadastre.

Legislation directly provides for the possibility of concluding an indefinite agreement on emphyteusis. In accordance with this agreement, each party may terminate it at any time by notifying the other party not later than one year before. However, for lands of state and communal ownership, the terms of emphyteusis, as well as lease, can not exceed 50 years. For land that is privately owned, the maximum term of the contract is not limited. In practice, there are cases where the contract is concluded for a period of 100 years.

In contrast to the lease, the size of the payment for the use of the land parcel for a contract concluded, to arrange and charge its payments to be settled exclusively by the parties to the contract.

According to the analysis of the given data the conclusion of the agreements on emphyteusis in Ukraine is becoming more and more popular (Table 3).

As a whole, analyzing the dynamics of concluded contracts of emphyteusis in the period 2011 - I quarter of 2016, it should be emphasized its significant growth over the last two years (Fig. 1).

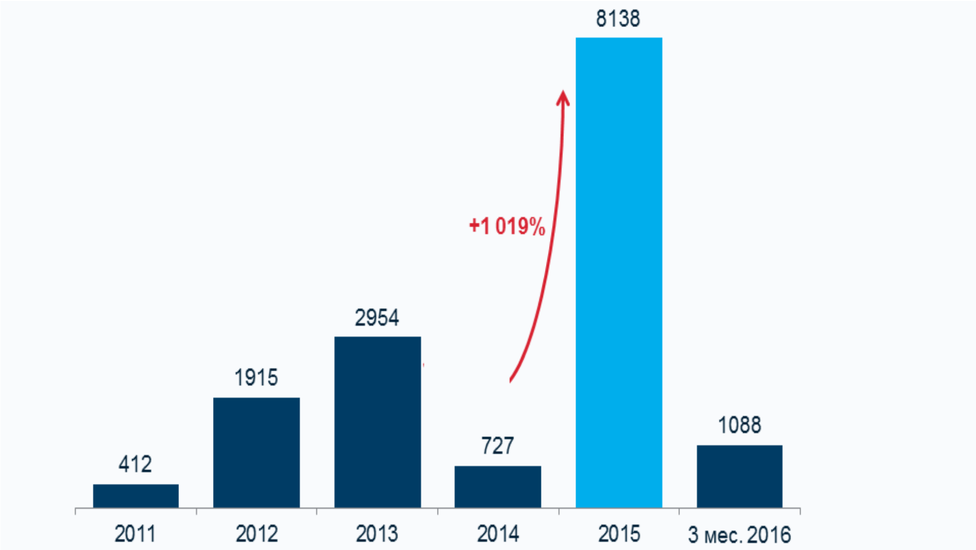


Fig. 1. Dynamics of the number of contracts for emphyteusis (according to the data of the State Geocadaster of Ukraine and Baker-Tilly company)

Rental of state and communal agricultural lands on the basis of lease agreements became significantly more costly for the tenant.

The parties to the agreement on emphyteusis may agree on a substantially lower rent or more favourable conditions for its payment than is provided by the legislation for land lease agreements.

The presence of such an opportunity makes the use of emphyteusis extremely cost-effective for the tenant, which contributes to the intensive development of the practice of concluding these agreements in modern conditions.

The parties are obliged to agree in the agreement of emphyteusis only those conditions which they consider essential. It gives the parties much more freedom and allows them to adjust only those conditions that are important to them, which is especially important for foreign investors.

A special distinction between the right to leverage is the possibility of its alienation and inheritance in relation to the land parcel that is privately owned.

In the case of the alienation of the right to leverage, the land user must notify the owner of his intention not later than one month before such alienation, since the holder has a preferential right to acquire the right to the emphyteum.

In addition, an emphyteus agreement may provide for the owner to receive a portion of a percentage of the cost of selling the right to leverage to his land (Cherkaska, Fordui, 2013).

The possibility of alienating the right to the emphyteus actually should mean transferring it into a pledge, however, unfortunately, in practice this is unrealistic, since the right to leverage is almost not subject to assessment, and registration of its transition on the basis of a pledge agreement is not provided for by law.

Rental of state and communal agricultural lands on the basis of lease agreements became significantly more costly for the tenant.

The parties to the agreement on emphyteusis may agree on a substantially lower rent or more favorable conditions for its payment than is provided by the legislation for land lease agreements.

The presence of such an opportunity makes the use of emphyteusis extremely cost-effective for the tenant, which contributes to the intensive development of the practice of concluding these agreements in modern conditions.

The parties are obliged to agree in the agreement of emphyteusis only those conditions which they consider essential. It gives the parties much more freedom and allows them to adjust only those conditions that are important to them, which is especially important for foreign investors.

A special distinction between the right to leverage is the possibility of its alienation and inheritance in relation to the land parcel that is privately owned.

In case of the alienation of the right to leverage, the land user must notify the owner of his intention not later than one month before such alienation. The proprietor has a preferential right to acquire the right to the emphyteum.

In addition, an emphyteus agreement may provide for the owner to receive a portion of a percentage of the cost of selling the right to leverage to his land [35].

The possibility of alienating the right of emphyteusis must in fact mean transferring it into a pledge, but unfortunately, in practice, it is unrealistic to do so. The right to emphyteusis is almost not subject to evaluation, and registration of its transition on the basis of a collateral agreement is not provided for by law.

Thus, the agreement on emphyteusis is an interesting alternative to the lease of agricultural land and has a number of significant advantages due to the lack of significant regulation of this instrument in Ukrainian legislation.

Emphyteusis is defined as the right to use a parcel of land for agricultural purposes. It is established by an agreement between the owner of the land parcel and the person who has expressed the desire to use it for agricultural needs (land user, emphyteut). In the future, emphyteut may dispose of its right to use and transfer it to inheritance. The agreement establishes the cost of transferring the right to lease money (possibly a free transfer) and payment for the use of this right, which the issuer must pay to the owner in a certain way and for a specified period.

The term of the land use contract for agricultural needs is not limited by law. But for the land state and communal ownership, this period can not exceed 50 years.

First of all, emphyteusis is necessary for those owners of agricultural land, which urgently need money, and their only asset is the land that can not be sold under the terms of the moratorium. Under a lease agreement, they will receive funds in instalments, and under the agreement of emphyteusis - at once a significant amount. The latter is determined by agreement of the parties when signing the contract. It is best to calculate the amount, taking into account the size of the rental rate for this or a similar parcel for the same period. The basis for calculating the cost in the case of a lease is the valuation of the parcel (Vakarash, 2010).

The owner of the land parcel for which the emphyteusis has been established has the right:

- to require the land user to use it according to the purpose established in the contract;
- to receive a fee for using it;
- in case of sale of the right to use the land parcel, the right to purchase it prevails over other persons for the price declared for sale and on other equal terms;
- in case of sale by the land user of the right to use the land parcel for agricultural needs to another person the right to receive the percentage of the sale price (the value of the right) established by the contract. The obligation of the owner of the land parcel is not an obstacle to the land user in the exercise of his rights.

The land user (emphyteut) has the right to use the land parcel in full in accordance with the contract, as well as to dispose of the right to use the land for agricultural purposes, unless otherwise provided by law. In addition, he is obliged: to use the land parcel for the intended purpose, established in the contract; pay the owner of the site a fee for using it; to start using the site for agricultural needs before the expiration of a three-year period from the moment of the establishment of emphyteusis; in case of discontinuation of use, bring the area to the condition in which it was before the establishment of emphyteusis; apply environmental technologies of production; to comply with the requirements of the legislation on the protection of the environment; not to violate the rights of owners of adjacent land parcels and land users; to increase the soil fertility and to preserve other beneficial properties of the earth; adhere to the rules of good-neighbourliness and restrictions related to the installation of land easements and security zones; keep geodetic marks, anti-erosion structures, networks of irrigation and drainage systems; provide timely information on the status and use of land and other natural resources to the executive and local governments.

Consequently, from the moment of the acquisition of the status of emotion in the land user there are also obligations to the state. In particular, the obligation to pay a land tax is not the owner of the land, but the land user. they can not at the same time be tax payers for the same land parcel. In case of violations of land or environmental legislation concerning a parcel that is subject to emphyteusis, legal responsibility will be borne by the land user, and not the land parcel owner.

Emphyteusis terminates on the following grounds: death, destruction of the land parcel or such damage, which excludes the possibility of its use for the intended purpose; agreement of the parties on the termination or refusal of the emotion law (mediation); combination in one person of both parties as a result of consolidation (buy-back by the owner of the emphyteutic right) or embezzlement (buy-back by the owner of the ownership of the land); use of land for non-agricultural needs for three consecutive years; redemption of a land parcel in connection with social necessity; the term for which the right of use has been granted has expired. During the sale of the leverage right to a third party at the request of the owner of the owner, a laudemia be paid in the amount established by the contract in the form of a percentage of the sale price.

The right to use the land parcel under the conditions of emphyteusis increasingly attracts the attention of the subjects of agricultural land use. In connection with this, a comparative description of the legal norms set forth in the Law of Ukraine "On Land Lease" (concerning lease) and the Civil Code of Ukraine (concerning the substantive right to another's property - emphyteusis) has been fulfilled (Table 4).

After analyzing the information provided, there are grounds to argue that there are a large number of both common and distinctive features of rental rights and emphyteusis. In accordance with the current situation in the field of agricultural land use in Ukraine, it is worthwhile to identify the strong points that we believe have the right to emphyteusis, namely:

- emphyteut may take advantage of the right to alienate the emphyteusis to another person by concluding a contract of sale, purchase, sale, donation, etc., but the owner of the land will have a pre-emptive right to acquire the right of emphyteusis, which will mean his termination;

- the emphyteusis, like the lease, is payable, however, the amount and frequency of the payment for the use of the emphyteusis is established by the agreement between the owner and the issuer, and not by law, as in the case of a lease. When entering into an agreement on the emphyteusis, it is possible to negotiate either periodic payments or regular provision of certain services, or a one-time payment of a certain amount for the entire period of use of the site;

- if the agreement of the emphyteusis is concluded, for example, for a term more than 30 years and provides for a one-time payment for the use of the site by the owner, then such payment is usually close to the market value of the parcel;

- in contrast to the right to lease, only the agricultural land can be used for the right of emphyteusis, that is, private parcels, parcels for cottage or garage construction and other non-agricultural land can not be granted for use in the right of emphyteusis;

- the agreement on the emphyteusis is concluded by the owner and the land user in an arbitrary form;

- if the agreement on the establishment of emphyteusis was certified notarially, the right to use land under these conditions is registered by a notary public, and in the other case registration should be carried out in the local unit of the State Registration Service of Ukraine;

- the agreement on the emphyteusis for land parcel s of private property may be concluded for a certain or indefinite period. If such an agreement is concluded regarding land parcels of state and communal property, the period of its validity can not exceed 50 years;

- when entering into an agreement for an indefinite period, each party may cancel the contract by notifying the other party not less than one year before the desired date of its termination;

- the right to use a foreign land parcel of private property for agricultural needs (emphyteusis) may be alienated and transferred in order of inheritance. That is, if the desire is to transfer the right to use the site to another person, the new user must comply with all obligations of the previous user before the owner;

- in the case of the sale of the user's emotion, the owner of the land parcel prefers, before other persons, the right to purchase it at the price declared for sale and on other equal terms;

- in case of sale by the land user of the right to use the land parcel for agricultural needs to another person, the owner of the land is entitled to receive percentages from the sale price (value of the right) established by the contract.

Table 4

Comparative analysis of the conditions of use of land parcels on the legal titles of lease and emphyteusis

Condition of the use of the site	Right to lease	The right to emphyteusis	Benefits (+) and disadvantages (-)	
			Rent	Emphyteusis
Form of provision	Can be provided to any person	It is established in favour of the landowner or land user	+	+
Form of acquisition	According to the contract	Acquired accordingly to the contract	+/–	+
Notarization	A lease (emphyteusis) may be certified by a notary public with the consent of the parties		+	+
State registration	The contract is subject to state registration	The contract is not subject to mandatory state registration	+/–	+
Status of the land parcel	The land parcel is in exclusive possession and use of the tenant for the duration of the contract	The land parcel is in exclusive use of the tenant for the duration of the contract	+	+
The status of the right of the landowner for the period of transfer for use	During the period of the lease agreement (emphyteusis), the landowner is deprived of the right to use the land parcel		+	+
Fees for usage	The fee for the use of land is set at the legislative level in the amount of not less than 3% of the monetary valuation of such a parcel	Land use can be carried out both on a fee and on a royalty-free basis	–	+
Duration of use	The term of use of land parcels of all forms of ownership is necessarily set by the lease, but may not exceed 50 years	The use of land parcels of private property in accordance with the agreement of emphyteusis may be established both for a definite and indefinite period; for land parcels of state or communal property - up to 50 years	–	+

Ability to re-transfer for use	May be transferred to a sublease, feel at the court's decision (if it is necessary for public needs)	May be alienated and transferred in order of inheritance	+/–	+
Status of the right when returning to the landowner	The right of use for the land user is not preserved, which is accompanied by the termination of the contract		+	+
Result			**6.5**	**10**

Thus, the contracts of emphyteusis have certain advantages over lease agreements. They can foresee the alienation and the transfer of the right to use a foreign land for agricultural needs. Unlike the lease agreement, for which the maximum term of the agreement must not exceed 49 years, the emphyteusis has an unlimited period of validity. In addition, in the contract, on the one hand, there is a prohibition on using the land parcel not for its intended purpose, and on the other - the owner of the land parcel guarantees non-interference with the activity of the user of the land. In addition, the list of clearly identified cases where the contract can be terminated is limited.

According to many scholars, emphyteusis is advantageous to agricultural producers, however, this is not quite the way we see it. Agricultural enterprises will be able to use and cultivate land for a long period of time (for example, 15-20 years) and will be interested in maintaining a high level of fertility, and landowners will be able to have a stable long-term income based on market value.

In turn, lease of land can only be effective if the open land market is used for commercial agricultural production with a view to its real alienation. Without this, the rental has fundamental disadvantages. It leads not only to the depletion of land due to inefficient use, but also, absorbing a significant portion of nutrients, greatly reduces the potential for intensive farming.

For a long-term basis, the right to use land for agricultural purposes could be an alternative to such types of loans, such as real estate, vehicles, future crops and foodstuffs.

In view of the above and excessive overregulation of the right to lease land through constant changes to the Law of Ukraine "On land lease", which limit the rights and pose significant risks both to the landowner and land user, we propose to develop set of measures for the transformation of the right to lease into the emphyteusis through legislative and eco-economic instruments.

An important aspect that shows the benefit of emphyteusis is that the permanent registration of lease agreements when changing ownership, inheritance, giving and other civil-law agreements involves significant costs for notarial services. These difficulties are a burden on agricultural enterprises and households.

Emphyteusis is a more universal right, which will enable eliminating the above extraordinary transaction costs and promoting the development of leased farm land use.

Consequently, the new mechanism for the formation and redistribution of differential rent between large agricultural producers and small peasant and farmer farms, based on the economic evaluation of agricultural land, should stimulate long-term land use, increase production volumes and become the main factor for changing the ecological, economic and social situation in the countryside.

An important task is to improve the mechanism of sale at the auction of the right of use for agricultural needs (emphytevisis) by land parcels of state and communal property. Under current law, this right may be traded, but the terms for charging for such use (one-time amount or payment of periodic annual payments) are not specified. Proceeding from the traditional understanding of the conditions of land use, it is expedient to sell such a right for a one-time payment, with the starting price of the value of the right to be determined by an expert monetary assessment. We also recommend that amendments be made to the Tax Code of Ukraine, which persons who use land parcels of state and communal ownership on the right to the emphyteusis (and superficies) should be included in the list of land tax payers, and the fee for the use of the right to leverage - to local taxes (on property) by analogy with the rent for such land, since at present, the Budget Code of Ukraine does not specify the procedure for transferring such a payment to local or state budgets.

Conclusions and proposals

The main problem of the rental model of agricultural land use is, first of all, the actual removal of the peasants - owners of parcels of land from entrepreneurship and turning them into a rentier who are mainly interested in hiring their own property. As a result of the transformation processes of the Ukrainian economy, alternative models of agricultural land use formation in the agrarian sector are lease and emphyteusis.

The right to emotion as a substantive right includes the powers of ownership and use of another's agricultural land for agricultural needs, and gives the owner of the land and land user greater autonomy in determining the conditions for using the land. It is important that the right of emphyteusis, in contrast to the lease, is a real possibility of its alienation and inheritance. One of the main advantages of the right of emphyteusis is determined by its continuity and the possibility of inheritance. Implementation of this type of right will allow to significantly reduce transaction costs when conducting civil law agreements with land parcels of commodity agricultural production.

So, the agreement on emphyteusis is an interesting alternative to the lease of agricultural land and has a number of significant advantages due to the lack of significant regulation of this instrument in Ukrainian legislation.

References

1. Deininher K., Nizalov, D. (2016). 26 Years of Land Reform: the Glass is Half-Empty or Half-Full. Vox Ukraine. Viewed 7 October, 2016, (http://www.worldbank.org/uk/news/opinion/2016/10/17/26-years-of-land-reform-the-glass-is-half-empty-or-half-full).
2. Sabluk P. (2006) Development of land relations in Ukraine. Kyiv. 396p.
3. Martyn, A. (2013), “Regulation of land market in Ukraine”, Extended abstract of Doctor’s thesis, Economics of Nature and Environmental Protection, Kyiv, Ukraine.
4. Tretiak A. (2003) Scientific fundamentals of land use and land management economics. Kyiv. 337 p.
5. Kareba M. (2012). Status and directions of improvement of lease relations in the agrarian sector of the agro-industrial complex. Business Navigator, Volume 1, pp. 10-15., available at: http://nbuv.gov.ua/UJRN/bnav_2012_27_4.
6. Kolosa, L. (2018), “Transformation and optimization of leased agricultural land use”, Candidate’s thesis, Economics of Nature and Environmental Protection, Kyiv, Ukraine.
7. The State Service of Ukraine for Geodesy, Cartography and Cadastre, available at: http://land.gov.ua/.
8. Cherkaska N., Fordui H. (2013). Concerning the grounds for terminating the agreement on emphyteusis. Law forum, Volume 1, pp. 1135–1140., available at: http://archive.nbuv.gov.ua/e-journals/FP/2013-1/13hnvpde.pdf.
9. Vakarash V., (2010). Formation and use of land-resource potential of agrarian business in the metropolitan region. Scientific Herald of the National University of Life and Environmental Sciences of Ukraine, Volume 154, Issue 23, pp. 215–221.

Information about authors:

Liudmyla Kolosa, PhD (Environmental Economics), Head of the Training, Research and Production Center "Protection of Natural Resources and Land Reform", National University of Life and Environmental Sciences of Ukraine. Address: 17 Valylkivska str., Kyiv, 03040, Ukraine; phone: +380972679955; e-mail: kll_ludmila@ukr.net. Fields of interest: land management, land administration, agricultural land-use.

Liudmyla Hunko, Ph.D, Assoc. Prof., Associate Professor of the Land-Use Planning Department, National University of Life and Environmental Sciences of Ukraine. Address: 17 Valylkivska str., Kyiv, 03040, Ukraine; phone: +380503821744; e-mail: liudmyla_g@ukr.net. Fields of interest: land management, land administration, spatial planning, agricultural land-use.

DOI: 10.22616/j.balticsurveying.2019.003

MATHEMATICAL MODEL FOR ERRORS ESTIMATION OF OBJECT'S LOCATION PARAMETERS DETERMINATION USING FLYING PLATFORM

Korolov Volodimir[1], Savchuk Stepan[2], Korolova Olha[1], Milkovich Ihor[1], Zaec Yaroslav[1]
[1]National Academy of Land Forces named after Hetman Petro Sakhajdachnyj, Ukraine
[2]Lviv Polytechnic National University, Ukraine

Abstract
Some tasks require identification of landmarks in districts beyond the reach of existing optical observation facilities. The accuracy of their determination significantly affects the effectiveness of the use necessary equipment during the task.
In the paper an algorithm to determine the object parameters using a flying platform is offered. An observation point is installed which is equipped with a navigation system to solve this task. This ensures its orientation and positioning.
From the observation point an aerial observation point is displayed. It is suggested to use a flying platform. The coordinates of the flying platform are determined relative to the observation point, the coordinates of the landmarks are determined relative to the flying platform. The mathematical model of the estimation error determination of object coordinates with the help of a flying platform is proposed.
The analysis of errors in determining the parameters of the object using a flying platform is conducted. Analysis of the results of mathematical modeling is conducted using the package of applications Mathcad. The dependence of these parameters on the relative position of the observation point, platforms and object is examined.
It is shown that the main contribution to the error of determining the coordinates of the landmark is given by the errors of determining the observation point location and measuring the range. An analytical correlation is obtained, which allows to estimate the errors of determining the coordinates of the landmark using the flying platform with known errors in determining the observation point coordinates and the range determination of the range finder.
Keywords: object parameters, flying platform, the estimation.

Introduction

Actuality of theme. The accuracy of determining the landmark parameters significantly affects the effectiveness of the use necessary equipment during the task.
Some tasks require identification of landmarks in districts beyond the reach of existing optical observation facilities. For example, if, under the terrain conditions, it is impossible to determine the parameters of the landmark, which is not observed from the observation point.
Analysis of research and publications. An analysis of modern research and publications shows that in most works (Korolov et.al., 2011; Korolov et.al., 2009; Korolov et.al., 2009) tasks on a plane are solved. Approaches are considered for the estimation of the influence of distances to the reference and directional angle, which can be used only within the direct vision.
Formulation of the problem. Since there is a need to act outside that is available to existing optical observation means, the application of the flying platform is one option for solving this problem.
In this case, there is the task of determining the object parameters with the help of additional equipment, which should be located at the observation point and on the flying platform, as well as the evaluation of the accuracy of their determination.
Unresolved part of the common problem. To date, there is no definition:
- list of the object parameters, which are to be found, using the flying platform;
- algorithm of their definition.
No estimation errors have been made in determining the object parameters defined by flying platform.

Setting objectives. Analyze the errors that occur when determining the object coordinates using the flying platform.

Methodology of research and materials

The article investigates the effect of errors in measuring angles and distances on the estimation in determining the landmark coordinates. Coordinate variance is considered as an estimate of the determination error (as a function of many random arguments) using well-known relations in probability theory.

Dependencies of coordinates determination errors on measurement errors (which are assumed to be measured normally) are investigated using the Mathcad software package.

Discussions and results

Often the definition of the object location is executed from the top geodesically unprepared points. To solve this, an observation point is installed which is equipped with a navigation system. This ensures its orientation and determination of coordinates. From the observation point, an aerial observation point is displayed, in which it is proposed to use a flying platform. The coordinates of the flying platform are determined relative to the observation point, the object coordinates are determined relative to the flying platform (Fig. 1).

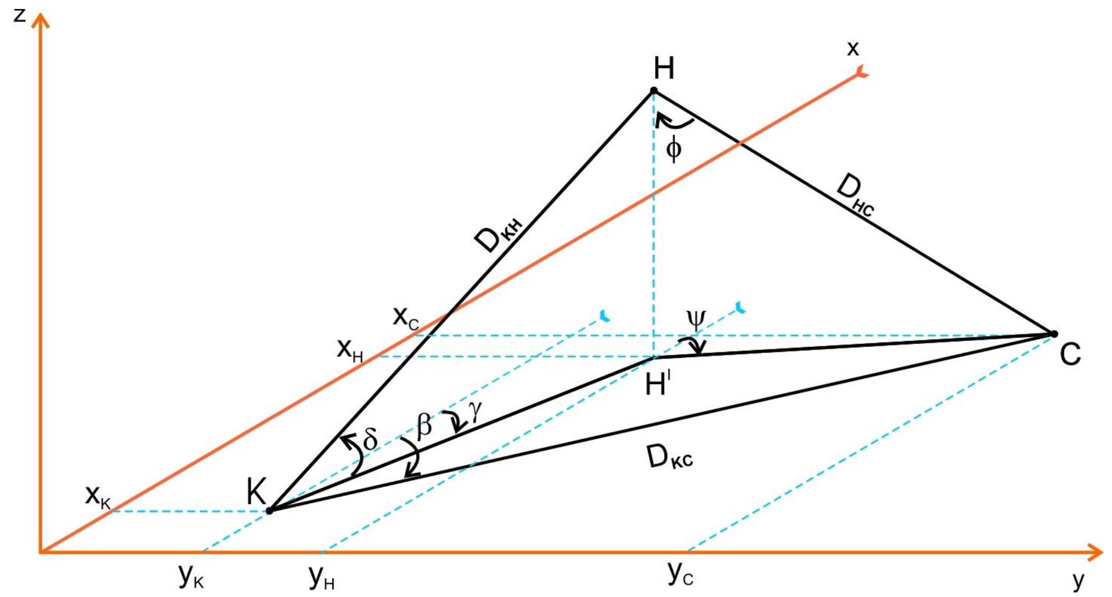


Fig. 1. Calculation of the landmark coordinates using the flying platform

The following symbols are used in the figure 1:

K is the observation point;

H – the flying platform;

C – the object;

x_k, y_k – the coordinates of the observation point;

x_h, y_h – the coordinates of the flying platform;

x_c, y_c – the coordinates of the object;

D_{KH} – the distance between observation point and flying platform;

D_{HC} – the distance between the flying platform and the object;

D_{KC} – the distance between the observation point and the object;

β – the directional angle of reference;

δ – the angle between the horizon and the direction from the observation point to the flying platform;

γ – the angle between the vertical line of the map grid and the horizontal distance projection from the flying platform to the observation point;
φ – the angle between the vertical passing through the flying platform and the direction from the flying platform to the object;
ψ – the angle between the vertical line of the map grid and the distance projection from the flying platform to the object on the plane of the horizon.

As an alternative, consider determining of the object coordinates using the flying platform. The object coordinates x_c, y_c, we obtain from the correlation:

$$x_c = x_k + D_{KH}\cos\delta\cos\gamma + D_{HC}\sin\varphi\cos\psi ,$$
$$y_c = y_k + D_{KH}\cos\delta\sin\gamma + D_{HC}\sin\varphi\sin\psi . \quad (1)$$

Values x_c, y_c are functions of many variables, which in their composition contain errors of a random nature. Thus, these functions can be considered as functions of many random variables. Then, for the errors of their definition, it is advisable to take their dispersion. It is known that the variance of the function $f(\overline{X})$ of random arguments can be calculated by the expression (Ventcel, 1969):

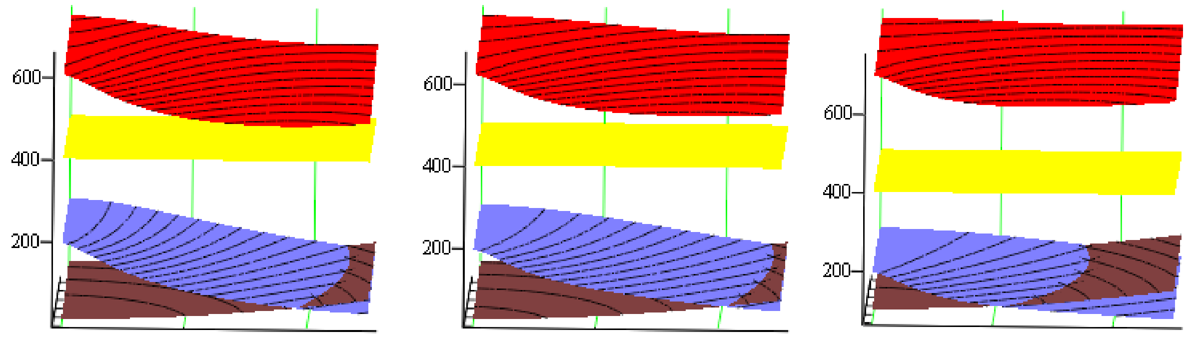
$$\sigma_f^2 = \sum_{i=1}^{N}\left(\frac{\partial f}{\partial x_з}\right)^2 \sigma_{x_i}^2 , \quad (2)$$

where: f – the function of random arguments;
N – number of variables (in our case, 8);
$\overline{X} \equiv \{x_i,...,x_n\}$ – vector of independent variables (in our case x_k, y_k, D_{KH}, D_{HC} δ, γ, φ, ψ);
$\sigma_{x_i}^2$ – variance of the i-th independent variable.

Applying (2) to (1) and taking into account that measurements of linear and angular variables on the observation point and platform are determined with the same accuracy, respectively $\sigma_{D_{KH}}^2 = \sigma_{D_{HC}}^2 \equiv \sigma_D^2$, $\sigma_\delta^2 = \sigma_\gamma^2 = \sigma_\varphi^2 = \sigma_\psi^2 \equiv \sigma_\theta^2$, and the radial error is $\sigma_{r_K}^2 = \sigma_{x_K}^2 + \sigma_{y_K}^2$, then for the estimation of the radial error of the orientation of the coordinates we obtain the following expression:

$$\sigma_{r_C}^2 = \sigma_{r_K}^2 + \sigma_D^2\left(\cos^2\delta + \sin^2\varphi\right) + \sigma_\theta^2\left(D^2{}_{KH} + D^2{}_{HC}\right). \quad (3)$$

We will investigate the behavior of the 1st, 2nd and 3rd additions on the right side of the equation number 3.



A – 3000 м A – 5000 м A – 10000 м

Fig. 2. Dependence of component values $\sigma^2_{r_C}$ from height of the flying platform and range D_{HC}

The horizontal range to the flying platform (KH') denote for 'A', and the horizontal distance from the flying platform to the object ($H'C$) denote for 'B'. We will consider the most typical variants of location the observation point, flying platform and the object.

Mathematical modeling was conducted using the package of applications Mathcad. Analysis of the results of mathematical modeling presented in Fig. 2. It shows that the term, $\sigma^2_D(\cos^2\delta + \sin^2\varphi)$ (it is shown in the picture in blue color) – varies from 0 ÷ 190. The component of the right-hand side expression number (3) equation $\sigma^2_\theta(D^2_{KH} + D^2_{HC})$ (it is shown in brown) is an order less than $\sigma^2_D(\cos^2\delta + \sin^2\varphi)$. We can conclude – the error of the observation point location $\sigma^2_{r_K}$ (it is shown in yellow) is the main element of the total error $\sigma^2_{r_C}$ (it is shown in red). The constituent $\sigma^2_D(\cos^2\delta + \sin^2\varphi)$ is less important, the value of the third term is one order less than the first, and therefore it can be neglected. Then the analytic dependence number (3) takes on the following form:

$$\sigma^2_{r_C} = \sigma^2_{r_K} + \sigma^2_D(\cos^2\delta + \sin^2\varphi). \qquad (4)$$

This correlation allows us to estimate the accuracy of determining the object coordinates using the flying platform, if known $\sigma^2_{r_K}$ and σ^2_D.

Take the typical navigation system, the error of which σ_{r_K} is about 20 m, and according to the technical characteristics, the error of determining the range finder distance σ_D is about 10 m (Korolov et.al., 2000; Korolov et.al., 2003). Then, using the expression number 4, the object coordinates are determined with an accuracy of 25 m.

Also, applying the correlation number 4 can be made requirements for the accuracy of the devices characteristics in view of the given accuracy of determining the object coordinates.

Conclusions and proposals

1. The mathematical model of the estimation error estimation of the object coordinates with using the flying platform is proposed.
2. It is shown that the main contribution to the error of determining the object coordinates is given by errors in determining the observation point location and the measurement of range.
3. An analytical correlation is obtained, which allows us to estimate the errors of determining the object coordinates using the flying platform with known errors in determining the observation point coordinates and determining the distance of the range finder.
4. It is shown that for a typical navigation system with accuracy of 20 m and a range finder with an accuracy of 10 m, the object coordinates are determined with an accuracy of 25 m.

In the future, it is planned to consider the necessary composition of the ground and airborne parts of the equipment and requirements for it.

References

1. Korolov V., Yakovenko V., Korolova O. Аналіз напрямків та проблем застосування навігаційних технологій у сухопутних військах [Analysis of difficulties and problems associated with technological processes in dry conditions]. VIII Міжнародна науково-технічна конференція "Гіротехнології, навігація, керування рухом та конструювання авіаційно-космічної техніки, 2011, Issue 2, Київ: КПІ, pp. 69-80 (in Ukrainian).
2. Korolov V., Rudenko K., Korolova O. Математична модель оцінки похибок визначення напрямку до рухомої цілі з нерухомого об’єкту координатним способом [Mathematical model of estimation of errors of determination of a direction to a mobile target from a fixed object by a coordinate method]. Сучасні досягнення геодезичної науки та виробництва, 2009, Volume 15, Issue 1, pp. 232-236 (in Ukrainian).
3. Korolov V., Rudenko K., Korolova O. Оцінка похибок визначення координат та вектора швидкості цілі з рухомого об’єкту [Estimation of errors of determination of coordinates and velocity vector of a target from a moving object]. VII Міжнародна науково-технічна конференція "Гіротехнології, навігація, керування рухом та конструювання авіаційно-космічної техніки, 2009, Issue 1, Київ: КПІ, pp. 210-215 (in Ukrainian).
4. Ventcel E. Теория вероятностей [Probabilite theory]. – Москва: Наука, 1969. – 576 p.(in Russian).
5. Korolov V. Вимоги до характеристик навігаційної інформації і систем навігації наземних рухомих об′єктів в сучасному штатному процесі [Requirements for the characteristics of navigation information and navigation systems for land mobile objects in the modern staffing process]. Сучасні досягнення геодезичної науки та виробництва, 2000, Volume 5, pp. 280-283 (in Ukrainian).
6. Korolov V. Технічні вимоги до навігаційної інформації та сучасних систем навігації наземних рухомих об’єктів [Technical requirements for navigation information and modern navigation systems for land-based mobile objects]. Сучасні досягнення геодезичної науки та виробництва, 2003, Volume 8, pp. 218-221 (in Ukrainian).

Information about authors:

Volodimir, Korolov, Doctor of Engineering Science, Professor, Leading Researcher of the Research Department Scientific Center of the Ground Forces, National Academy of Land Forces named after Hetman Petro Sakhajdachnyj, 32 Heroes of Maidan street, Lviv, Ukraine, 79026, +380 97 241 0296, kvn_lviv@ukr.net. Navigation systems and complexes (terrestrial and satellite).

Stepan, Savchuk, Doctor of Engineering Science, Professor, Professor of the Department, Department of Higher Geodesy and Astronomy, Lviv Polytechnic National University, Lviv, Ukraine, +380 97 213 3775, ssavchuk@polynet.lviv.ua. Higher geodesy.

Olha, Korolova, Ph.D. in Engineering Science, Senior Research of the Research Department Scientific Center of the Ground Forces, National Academy of Land Forces named after Hetman Petro Sakhajdachnyj, Lviv, Ukraine , +380 67 675 8635, ok_im2@ukr.net. Navigation systems and navigation information sensors.

Ihor, Milkovich, Teacher of the Department, Department of Electromechanics and Electronics, National Academy of Land Forces named after Hetman Petro Sakhajdachnyj, Lviv, Ukraine, +380 66 636 1514, olya_igor@ukr.net. Navigation systems and navigation information sensors

Yaroslav, Zaec, Senior Research of the Research Department Scientific Center of the Ground Forces, National Academy of Land Forces named after Hetman Petro Sakhajdachnyj, Lviv, Ukraine, +380 66 368 6895, YG_nc@i.ua. Navigation and geoinformation systems

DOI: 10.22616/j.balticsurveying.2019.004

THE ROLE OF EFFECTIVE USE OF LAND IN GRAIN-GROWING ENTREPRENEURSHIP IN AZERBAIJAN

Natig Mirzayev
Lankaran State University, Azerbaijan

Abstract
One of the main groups in agriculture is plant cultivation. The crop production combines growing of grain, cotton, vegetable, viticulture, tobacco cultivation, etc. One of the main factors in the activities of plant-growing as well as in grain-growing is the efficient using of land.
Agriculture is characterized by number of specific socio-economic, natural and technological characteristics. Unlike other sectors of the economy, the main means of production is land. Land differs from other agricultural production facilities. Land is not a product of human activity, it is the product of nature. The land area can not be increased nor decreased as other means of production, its natural fertility and productivity can be increased.
Land area has been divided into zones according to its location, quality and rating. Agricultural farming on unfavourable land areas requires more funds than on favourable land plots.
In the article, using grain crops efficiency data, increase of soil fertility and issues in the direction of increasing productivity facing entrepreneurial farms were studied.
Key words: agriculture, efficiency, entrepreneurship, grain-growing, land use

Introduction

Azerbaijan is one of countries where husbandry culture has been founded, there are ancient traditions on grain-growing as well. Archaeological excavations carried out in different regions of Azerbaijan, proves that grain-growing has history at least of 70 centuries. Husbandry and cattle-breeding, being leading spheres, were basic engagement of local population and has formed the base of their economic life. In this period tools of wood, stone and partly of bone for grain-growing were used. There were favourable conditions for development of not irrigated husbandry in mountainous and hilled territories. Of course, in grain-growing dominated local grain sorts and traditional husbandry technologies. In Middle Ages in Azerbaijan such sorts of wheat and barley as gurgani, yellow wheat (saribugda), black awn (garagilchig), blackberry wheat (garagilabugda), topbashbugda, white barley (ag arpa), black barley (gara arpa), sheshari barley, etc. were grown. Most popular in grain-growing economy were autumnal wheat and barley. The experience achieved in development of grain-growing and improvement of husbandry system enabled providing of need of people in grain on territory of Azerbaijan. Historic sources give the information that by end of 19th century the population produced cereals themselves and there was no need to import them. Statistics of the first decade of 20th century shows that grain produced in the Azerbaijan territory was even exported, because grain sowing in large area on appropriate for agriculture production soils allowed it. In 1913 grain crops were sown on area of 67% of territory of Azerbaijan. I coming period area of grain crops decreased. As noticed many scientists, this tendency continued until the beginning of the 90s of the last century, when this issue become very important due to demand of providing of food safety in independent Azerbaijan (Yasimov A. 2005). Grain-growing already about ten years have leading role between tools guaranteeing food safety and financial support for its realization has been improved. Modern demand of husbandry is the basic principle of development of conception of grain-growing. In efficient husbandry system it is suitable source due to minimum resources and labour costs, providing more crop production from land unit (Mirzayev, 2018).
The total area of Republic of Azerbaijan is 8.6 million hectares. In agricultural sphere of national economy land available for agricultural production makes up about 60%, 36% of which makes up arable land and 52% - pastures. Agricultural production depends on quality and location of agricultural land. This creates conditions for more efficient use of the land stock, labor resources and production facilities. Currently, growing of grain, cotton, vegetables, grape, tobacco, tea, fruits and other cultivated plants have been placed in accordance with natural and economic characteristics of the land. Grain-

growing mainly took place in the Republic of Karabagh-Mil, Shirvan, Mughan-Salyan and Sheki-Zagatala.

Methodology of research and materials

Production of wheat, rice and other grain crops, being considered as food delivery to the end consumers is the main factor which defines the character of food problem. Grain-growing plays an important role in providing of population with main food products, as well as in strengthening of fodder base for cattle-breeding and supply of enterprises with raw material. On national level for solving the problems in guaranteeing of national food safety should be developed detailed conception of grain-growing. At the same time with development of economic prosperity in business, the main principle should be guidelines of innovation policy (Mirzayev, 2016).

The countries being the main exporters of grain products, depending on specific historical stages of development of grain-growing, have accepted different priorities of strategy, giving an advantage to comparative preference. With this purpose as a main means of production the quality of soil resources and level of its use should be estimated. On the basis of analysis of production costs of various crops and comparative analysis of efficiency of its sale the suitable structure of crops has been defined. Suitable sowing structure depends on market economy regulation forms together with activity of economy itself and economic subjects, as well as different property forms.

Factors, influencing rise of productivity of grain area, are:

- implementation into practice of modern regulations on optimal regime of agro-technics;
- increasing of efficiency of use of mineral fertilizers;
- strengthening of measures against diseases and pests;
- enlargement of irrigated sowing areas and broad application of latest achievements of irrigation;
- increase of seed- farming, strengthening of elite seed basis;
- complex mechanization and automation of production processes;
- continuation of selection work at a higher level;
- development of production infrastructure relating to grain cluster;
- precognition of vegetation period for grain and leguminous plants;
- enumerated factors, including specialization and integration, cooperation and corporative management factors (Mirzayev, 2017).

Efficiency of use of grain sowing areas, change of sowing system has a special place within the agro-technical measures carrying out improvement of soil fertility and productivity. Changes in sowing system should be putted in practice taking into consideration soil-climatic statement of land and some other factors. Fertility of the soil is the main factor, selecting efficient schemes of disposition of sowings. It is necessary in disposition of sowings to increase the proportion of main plants, which applies for fertile soils, but on less fertile soils it is necessary to replace the main plant with less demanding plants. On the other hand, if grain plants take nitrogen and phosphorus from soil a lot, but potassium little, leguminous plants take potassium more. Perennial leguminous and grain plants and their mix bring the structure and physical matters of soil alongside providing the protection of planting layer from water and wind erosion. Sort of hard grain "Shirvan3" grows in irrigated and not irrigated places. The best plants before this sort are perennial grass, beans and interlinear plants. High harvest level can be achieved on black soil in not irrigated areas, but it requires a lot of fertilizers. Such soil under main tillage demands at least 90 kg of phosphorus and 50-60 kg potassium, as well as 110-120 kg nitrogen fertilizer per hectare (calculating in influencing matter).

There have been made a lot for development and improvement of legislative acts in accordance with modern stage of agrarian sector in Republic of Azerbaijan. The law "On Land Reforms", "On Food production", "On Selection Achievements" (1996), "On seed-growing" (1997), "On Grain" (2000), "On Giving Tax Privileges to Agriculture Products Consumers" (2001) have been accepted. Priorities in grain growing in regard to the health and safety of the population should be justified applying environmental requirements - soil, water, plants, and animals. Development processes as a leading area of agriculture and the national economy in general should be regulated and managed. Provision of food is one of the global challenges in front of humans in the new millennium. New aspects have been actualized in the problem itself and its solution. So, the problem of food quality was added to the problem of food shortage.

Discussions and results

In development of grain and resources, first of all, the use of land resources is directly related to the dynamics of the share of grains in general planting areas (table 1).

Table 1

Dynamics of proportion of areas of cereals and grain in economic regions of Azerbaijan (2011 – 2017, %)

Economic regions	2011	2012	2013	2014	2015	2016	2017
Absheron	0.2	0.2	0.2	0.2	0.1	0.2	0.3
Ganja–Gazakh	93	9.4	9.2	9.5	9.5	9.0	9.1
Shaki-Zagatala	16.4	15.9	15.5	15.7	15.2	15.0	15.2
Lankaran	9.0	9.0	8.6	8.4	9.1	9.2	9.0
Quba-Khachmaz	8.5	9.4	10.3	9.9	10.4	9.6	9.2
Aran:	31.7	32.8	32.1	32.8	33.8	33.4	34.2
Upper–Karabakh	10.1	8.8	9.1	8.7	8.2	8.1	8.0
Kalbajar-Lachin	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Mountainous Shirvan	10.7	10.5	11.1	11.0	9.6	11.2	11.2
Nachchivan Autonomous Republic	3.8	3.8	3.7	3.6	3.9	4.1	3.6
Total	100	100	100	100	100	100	100

Source: own elaboration, using statistical data of annual reports

Analysis of the dynamics of the proportion of cereals crops in 2011 - 2017 shows that in economic regions Guba-Khachmaz and Aran the share of grain cultivation increased in the total area of crops, but in other economic regions this indicator slightly decreased. In the Upper-Qarabagh and Nakhchivan considerable decrease in this indicator is worthy to the special attention.

Due to specialization of grain farms the dynamics of proportion of areas of cereals and legumes in 2011 – 2017 in Guba-Khachmaz and Aran economic region have increased, so these economic regions provides a great part of the country's needs. The development of agriculture at the modern stages is based on use of application of scientific achievements. As the main means of production of grain is land and also the intensification of relevant production should be primarily based on the rules for the efficient use of land resources. The renewal of melioration and irrigation systems and application of progressive technologies in order to prevent soil erosion, also to reduce dependence of grain-growing from natural conditions is very important. At the same time soil and water pollution is technogenic factor - the result of cereal crops cultivation process, which increases the negative impact of product quality.

One of important tasks characterizes the application of intensive agro technologies in grain production. The analysis based on the parameters of average statistical region showed that it has given negative impact on quality of decisions according implementation of financial and operational functions. As a result in a real economy landscape, humidity, distance to the water basins and other parameters lead to losses in quantity and quality of grain. Therefore functional diagnostics should be based on a reliable data for making effective decisions. First of all diagnosis should be based on extensive statistical material, and should provide opportunities for its realization. Significant changes have taken place in the production structure of individual entrepreneurs, family farmers and households on plant and livestock areas (Kənd təsərrüfatı müəssisələrinin …, 2017). The number of individual entrepreneurship farms and land plots allocated to them had been decreased in agrarian sector in 2011 - 2017 and the average size of land falling to one individual entrepreneur has increased by 2.8 hectares (table 2).

Table 2

Dynamics of the number of individual farms and their provision with land (2011 – 2017)

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Difference, %**
Number of individual farms	2618	2593	2451	2334	1624	1534	1468	- 56
Land allocated to individual farms, thousand hectares	45.7	41.5	47.3	43.1	33.2	32.5	29.8	- 65
Average size of individual farm, hectares	17.5	16.0	19.3	18.5	20.5	21.2	20.3	+ 16

Source: own elaboration, using statistical data of annual reports

In 2011-2017 the size of land plots for a single individual entrepreneur in the country although increased 16 % in average, due to intensification of production of agricultural products. Different regions of Azerbaijan have had different dynamics. On average the size of individual entrepreneur subjected to agriculture in Upper-Karabakh, Kelbejar-Lachin, and Ganja-Qazakh economic zones in 2017 was accordingly is 233, 70 and 54 hectares. These are the highest indicators of economic regions.
The area of land suitable for agriculture in individual entrepreneurship subjects in 2011 - 2017 on average has been increased (Kənd təsərrüfatı müəssisələrinin …, 2017) (table 3).

Table 3

Dynamics of area of land of individual farms suitable for agriculture
on average, 2011-2017, hectares

Economic regions	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2917**	Difference, %
Absheron	8.8	8.2	9.2	6.0	8.2	8.9	6.2	70
Ganja-Gazakh	43.3	39.7	40.2	43.9	56.1	52.1	54.1	125
Shaki-Zagatala	4.5	4.7	4.7	5.7	4.8	5.6	4.3	96
Lankaran	13.3	13.4	13.1	12.2	12.3	12.5	13.8	104
Quba-Khachmaz	7.4	10.6	11.7	5.8	5.3	6.6	7.0	95
Aran	9.3	9.7	10.4	10.6	12.9	13.0	12.8	138
Upper–Karabakh	161.8	125.0	171.2	162.1	172.8	272.8	232.7	144
Kalbajar –Lachin	33.5	37.0	34.5	32.7	58.9	74.3	70.0	208
Mountainous Shirvan	9.9	11.7	10.7	12.0	13.9	13.9	14.7	148
Nakhchivan	2.0	2.2	2.3	2.2	17.1	22.9	22.3	1125
On average in the country	17.5	16.0	19.3	18.5	20.5	21.2	20.3	116

Source: own elaboration, using statistical data of annual reports

The economic regions Ganja-Gazakh and Upper-Garabagh have positive dynamics of agricultural land in terms of one individual entrepreneur. Analysis showed that indicators of development of individual entrepreneurship in economic regions Absheron and Shaki-Zaqatala has been decreased (Azərbaycanın statistik nəticələri …, 2017).
In the some time in Aran economic region average of useful for agriculture soil has been increased by 38%. Such problem appeared in the end of last century. Nevertheless, quality of food products becomes more acute in the last decade. The limited opportunities of traditional approaches to the discussed problem necessitated the involvement of genetic resources into economic turnover.

Conclusions and proposals

As result of research on the efficient use of soil in entrepreneurship subjects in the development of grain-growing in Azerbaijan, author considers, that agro-climate potential in many regions of Azerbaijan allows achieve high yields in grain production in order to increase productivity in the grain farming. It is important to have qualitative seeds, effective materials against weeds, use fertilizers in the optimum regime and effectively organize irrigation.

In modern conditions there is a close link between the effectiveness and development priorities of grain farmers. As key criterions in land use are resources (labor, finance, and others) in economic efficiency accepted by an entrepreneurs. Measures should be taken to improve efficiency both directly and indirectly.

Improving the productivity of grain growing it is possible to carry out agro-technical specifications in the optimum regime, to increase use of mineral fertilizers, means against diseases and pests, to expand regulated planting areas and implement the latest achievements in irrigation, improvement of elite seed base, mechanization and automation of production processes as well.

References

1. Azərbaycanın statistik nəticələri 2011-2017 (Statistic results of Azerbaijan 2011-2017). Viewed 16 March, 2019 (www.stat.gov.az) (in Azerbaijani).
2. Kənd təsərrüfatı müəssisələrinin və fərdi sahibkarlıq təsərrüfatlarının əsas iqtisadi göstəriciləri, 2017 (Key economic indicators of agricultural Enterprises and individual Entrepreneurship farms, 2017) Viewed 16 April, 2019 www.stat.gov.az (in Azerbaijani).
3. Mirzayev N.S. (2017). Azərbaycanda taxılçılıq sahəsində sahibkarlıq subyektlərinin faəliyyət istiqamətləri (Directions of activity of entrepreneurship subjects in grain-growing sphere is Azerbaijan). Monograph. Baku, Publisher "Science and education". pp. 12-13 (in Azerbaijani).
4. Mirzayev N.S. (2018). Effective use of soil in grain producing entrepreneurship. Матеріали VI Міжнародної науково-практичної конференції «Актуальні питання аграрної науки» Уманського НУС, Київ : Видавництво «Основа», pp. 25-27
5. Yasimov A. (2005). Aqrar-sənaye müəssisələrinin iqtisadiyyatı və idarə edilməsi (Economy and management of agrarian-industrial enterprises). Baku, "Nurlan", 312 p. (in Azerbaijani).
6. Mirzayev N.S. (2016). Инновационный фактор в развитии предпринимательства в Азербайджане (Innovative factor in the development of entrepreneurship in Azerbaijan). Материалы 15-ой Международной научно-практической конференции «Проблемы развития предприятий: теория и практика», Том № 3, Самарский государственный экономический университет, Самара, pp. 27-29 (in Russian).

Information about author:
Natig Mirzayev, PhD on economy, associate professor. Azerbaijan, Lankaran city, Hazi Aslanov avenue-50, Tel: (+ 994) 50 664 69 60, mirzoev.n@mail.ru Fields of interest: Development of entrepreneurship in agriculture, efficiency of economic activity of entrepreneurship subjects.

DOI: 10.22616/j.balticsurveying.2019.005

STUDY OF THE NATURAL HERITAGE CONDITION OF THE KURSIU NERIJA NATIONAL PARK USING LIDAR TECHNOLOGY (CASE STUDY OF AGILA DUNE)

Deimantė Pankauskyte [1], Jolanta Valčiukiene [1], Indrius Kuklys [2], Lina Kukliene [2]
[1] Vytautas Magnus University Agriculture Academy
[2] Klaipeda State University

Summary
Analysis of the condition of the Agila dune is presented in this Article. The analysis is based on data collected during accurate geodetic measurements using LIDAR technology. The current state of the Agila dune was compared to the data of the previous year's LIDAR points in order to ensure the reliability and value of the research.
In the course of the study, eleven cross sections were compared by height differences with previous year‘s measurements. The condition of the Agila dune was found to be the worst in three cross sections. First cross section‘s erosion measured at 13,98 meters, erosion in the fifth cross section – 9.90 meters, and erosion in the eighth cross section - 11.34 meters. The main reasons for the deterioration of the natural values of the Kursiu Nerija National Park are climate, wind, high visitor flows and the persistent failure to carry out comprehensive research. Therefore, in order to preserve these unique natural values, it is important to collect large-scale and high-precision data on the status of these values, to systematize, analyze and take appropriate protective measures.
Keywords: Agila dune, values of nature, LIDAR, erosion, accumulation.

Introduction

Protected areas are land and / or water areas with clear boundaries, which have a recognized scientific, ecological, cultural and other value that is subject to a specific protection and use regime by law. The Law on the Protected Areas establishes and regulates the public relations related to protected areas, the system of protected areas, the legal bases for the establishment, protection, management and control of protected areas. Protected areas in Lithuania are divided into reserves, heritage objects and state parks (Lietuvos ..., 2001). There are 5 national parks in the territory of the Republic of Lithuania, one of the most impressive national parks is the Kursiu Nerija. It was included in the UNESCO World Heritage List in December 2000.

The Kursiu Nerija National Park is distinguished by its unique landscape. This is definitely the most valuable protected area in Lithuania. In protected areas such as state parks one of the most important goals should be tourism development (Kulczyk-Dynowska, 2015). The Kursiu Nerija has a great recreational potential, but it is also vulnerable to anthropogenic impact. One of the most visited sites in the Kursiu Nerija is the Agila Dune in Nagliai Nature Reserve. This natural value is really worrying, and the condition of this monument is the worst in the Kursiu Nerija, which is included in the cadastre of all nature monuments. The dunes are sensitive to tourist visits, and previous studies have shown that every person walking around the dune moves a few tons of sand and speeds up the erosion of the dunes.

There are over 209,000 protected areas around the world, of which more than 20,000 are declared World Heritage Sites. The main task of protected areas is to preserve natural and cultural values (Lee, 2016).

Monitoring is required to systematically assess the protection, preservation and representativeness of natural values in protected areas (Regos et al., 2017). The national and international status of the park proves the value and uniqueness of this area and its importance for the Lithuanian landscape. However, visual observations do not make it possible to accurately determine the dune condition and degree of deterioration. Therefore, it would be important to collect data on the state of natural values with accurate geodetic instruments, to systematize and analyze them. It would be useful to integrate the data received into a common spatial data set that would allow analysis and take preventive actions.

The continuous development of measurement technologies also increases the variety of data collection methods. One of the newest and most advanced ways to do this is remote sensing method used for primary data collection. Remote sensing is the science of obtaining information about physical, biological and chemical properties of objects without physical contact. Remote sensing is the main source of spatial information on the Earth's surface (Guo et al., 2017; Schowengerdt, 2007).
Remote research methods are one of the most effective ways to study and monitor the landscape. Laser Scanning (LIDAR) is a way to get data for landscape assessment. For many years, these data have been used in science of nature, technology and geography. Using the LIDAR technology, a 3D point cloud is obtained: X, Y and Z coordinates (Dudzinska et al., 2017; Melin et al., 2017; Traviglia et al., 2017).
LIDAR is a method for obtaining more accurate data than information from orthophotographic maps. Laser scanning is believed to be one of the most accurate measurement methods. This allows to record huge amounts of spatial data at high speed and accuracy (Michalowska, 2015).
Research on the condition of Agila dune was carried out by applying the LIDAR method, which is the most advanced technology that allows to make competent decisions. The results obtained are particularly valuable as they are accurate and complete.
The aim of the study – to analyze the condition of the natural values of the Kursiu Nerija National Park – Agila Dune
Object of research – Natural value of the Kursiu Nerija National Park – Agila Dune.
The following tasks are raised to achieve the goal:
1. To study changes in the surface of Agila Dune by comparing LIDAR data of years 2010 and 2019.
2. To create a 3D model of the Agila Dune surface.

Methodology
At the first stage of the study, natural measurements method was used. During this stage the change of Agila dune was studied. In order to accomplish the tasks, SEZP_0.5LT was used – digital spatial laser scanning of the territory of the Republic of Lithuania for the year 2010, ordered from the website www.geoportal.lt. Also in 2019 In March, new measurements were made on unmanned aircraft using LIDAR technology.
Before commencing measurements, a flight path had to be created (Fig. 1).

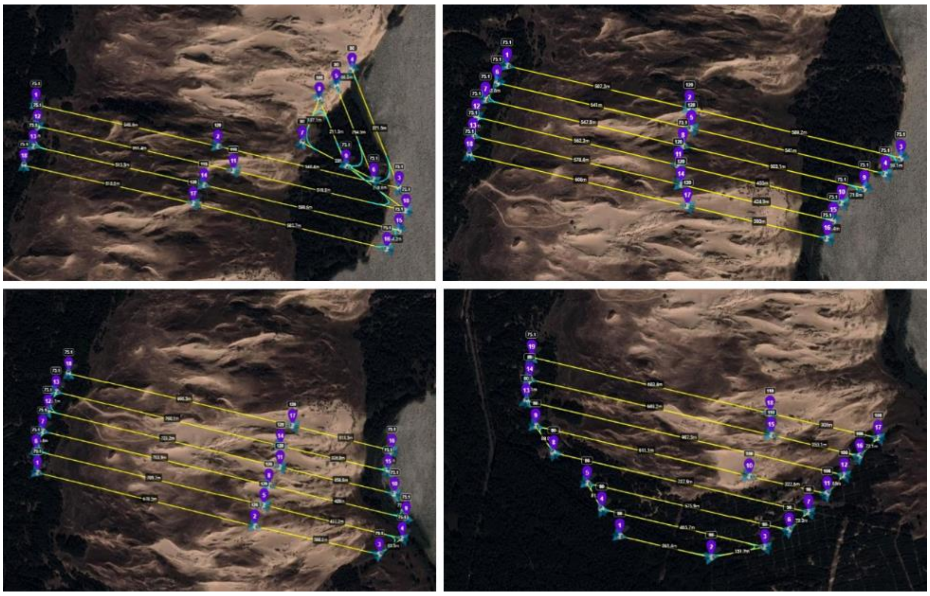


Fig. 1. Flight routes

As the analyzed object covers an area of over 100 ha, four routes were created. The distance between the flight paths is 75 m to cover the entire surface. During the measurements, the flight height was between 75 m and 120 m, depending on the difference in dune height. Measurements of the Agila Dune were started after creating flight routes and acquiring permission to visit the Nagliai Nature Reserve from the Directorate of the Kursiu Nerija National Park. Measurements were performed using the Ibeo first-class LIDAR laser. The density of its measuring points depends on two indicators - speed and altitude (Fig. 2).

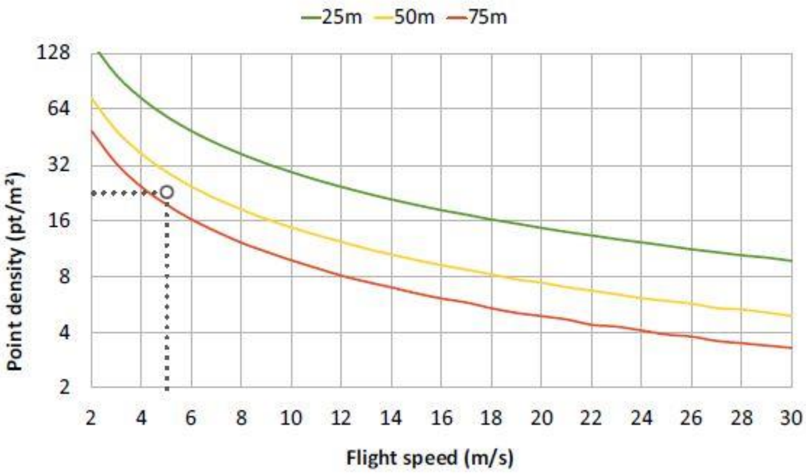


Fig. 2. Used laser flight parameters (YellowScan Mapper II…, 2019)

When flying high, the field of laser vision increases, therefore the density of points decreases. During the measurements, the flight speed was 9 m/s, height – from 75 m. up to 120 m. Average density of points resulted in 6 to 8 points per square meter.

After field measurements and processing of LIDAR data, further analysis was performed using GIS technologies, i.e. ArcGIS application ArcMap, programs ArcCatalog, ArcScene, and Excel. Total area of the Agila dune selected for the study is 107.11 ha. The dune condition study was carried out using height comparison method in cross sections divided by a distance of 100 m among them. A 3D surface model was created in ArcScene program, using specially designed algorithms that take dots and convert them to a digital 3D surface. The study was carried out to collect data on the condition of the dune, which would identify sites of sand erosion and accumulation.

In the second stage, an electronically performed questionnaire analysis method was used. 172 respondents from all over Lithuania participated in the survey. Duration of the survey – since 2019 March 5 until April 2. During the survey, 10 questions were presented which helped to reveal the public's attitude towards the natural values of the Kursiu Nerija National Park.

Discussion and results

The study was performed by creating cross sections (11 in total) and comparing them by height (Fig. 3).

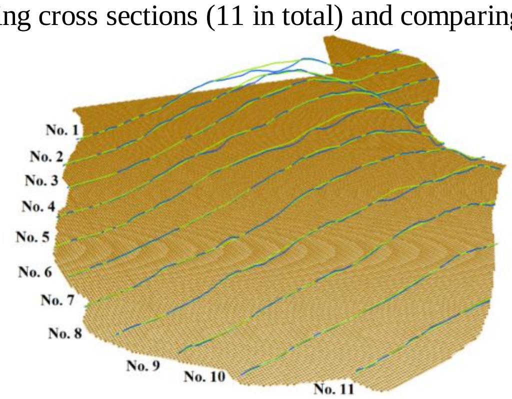


Fig. 3. 3D model of cross sections

The figure below illustrates the 3D model of all cross sections, on the basis of which Agila dune analysis was performed.
Below are the cross sections showing the most significant dune change.

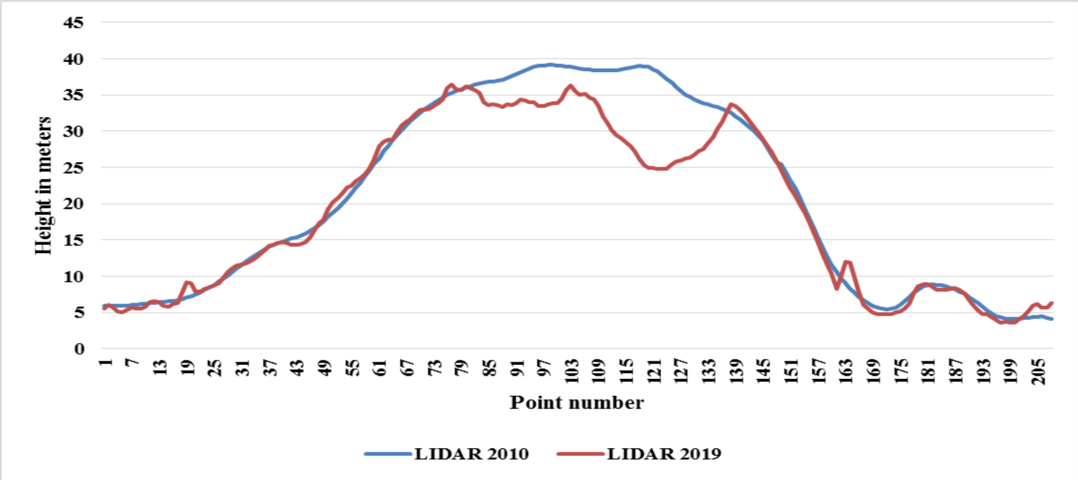


Fig. 4. Cross section No. 1

After creating cross section 1 (Fig. 4), the change of dune relief was calculated using the height difference method. With the help of Excel, the change in heights was calculated - the highest and lowest values were identified (erosion and accumulation). The highest sand erosion is recorded in the cross section at point 120, the dune in this place has dropped even 13.98 m. At point 164, sand accumulation was recorded at 3.59 m. Such changes of the surface of the dune are captured in this cross section because the dune descends and spreads sideways, and the first cross section is created on the very side of the dune.

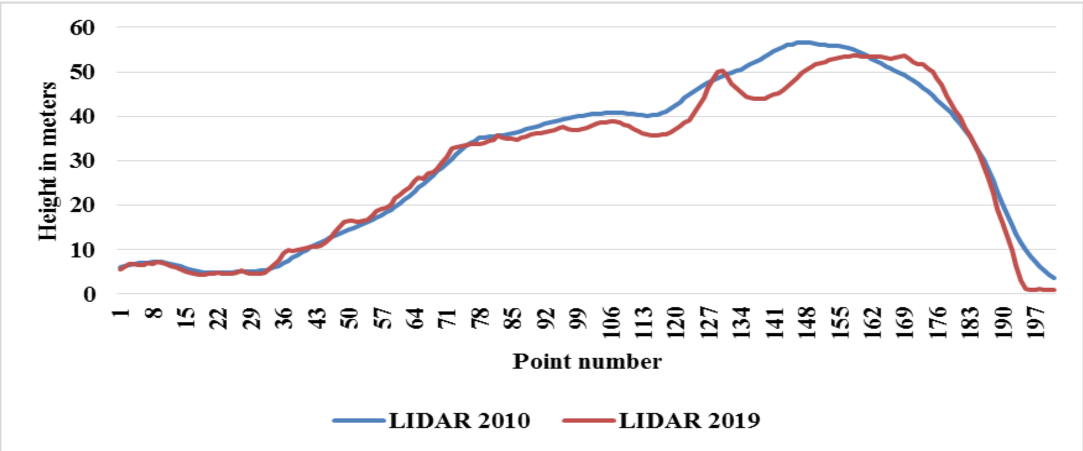


Fig. 5. Cross section No. 5

In cross section 5 (Fig. 5), two segments are visible, where significant sand erosion is observed. The highest sand erosion is recorded in the cross section at point 142. The heigth of dune in this place decreased by 9.90 m. The sand accumulation at point 175 point reaches 5.22 m. According to the chart, we can say that the dune in this section slides into the lagoon. This cross section is created at the trail of the Nagliai Nature Reserve, so we can assume that in this place such a change of terrain arose due to excessive flows of visitors and walking in forbidden areas, i.e. outside the trail.

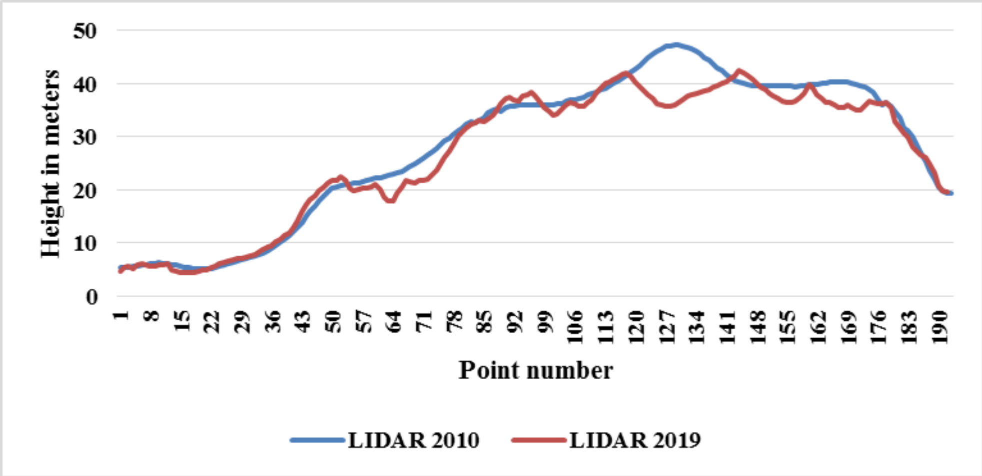
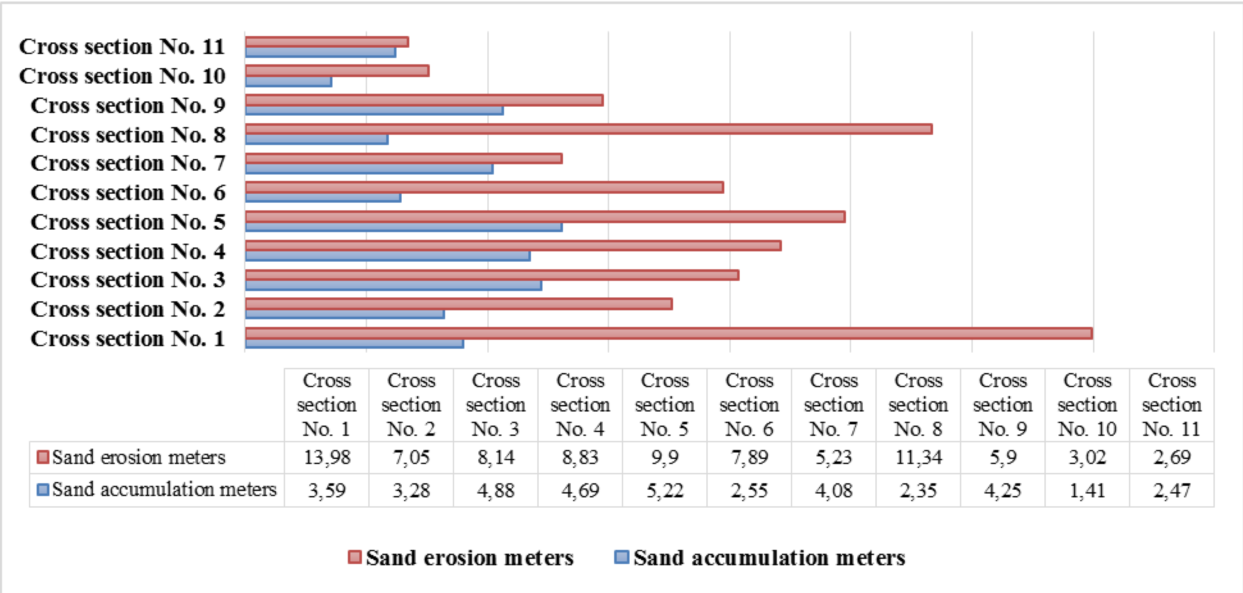


Fig. 6. Cross section No. 8

Cross section 8 (Fig. 6) shows a noticeable change in dune's terrain. The highest sand erosion is recorded at point 128 – the height of dune in this place decreased by 11.34 m. At point 96, the sand accumulates to 2.35 m. This cross section was created on the right side from the Nagliai trail. Dune sand is drooping and expanding sideways.



	Cross section No. 1	Cross section No. 2	Cross section No. 3	Cross section No. 4	Cross section No. 5	Cross section No. 6	Cross section No. 7	Cross section No. 8	Cross section No. 9	Cross section No. 10	Cross section No. 11
Sand erosion meters	13,98	7,05	8,14	8,83	9,9	7,89	5,23	11,34	5,9	3,02	2,69
Sand accumulation meters	3,59	3,28	4,88	4,69	5,22	2,55	4,08	2,35	4,25	1,41	2,47

Fig. 7. Sand height changes in cross sections

The diagram (Fig. 7) provides information on all cross sections. Based on the results obtained, we can state that the most aggressive change is seen in the section no. 1, where the height of the dune has dropped by even 13.98 m. Sand accumulation in this section reaches up to 3.59 m. Also significant sand erosion is recorded in section no. 8 – 11.34 m. and accumulation – 2.35 m. The highest dune accumulation of 5.2 m. is observed in section no. 5, where dune erosion is recorded up to 9.9 m.

A visual model developed by ArcScene software was used for visual comparison of the dune surface (Fig. 8). Visual results of dune changes were obtained by overlaying 2010 and 2019 LIDAR laser scanning data. In the program, altitude data was classified and displayed on the selected color scale. LIDAR 2010 in the case of the dune ascending the color red intensifies, in the case of LIDAR 2019 data – the color purple intensifies once the heigth is increasing.

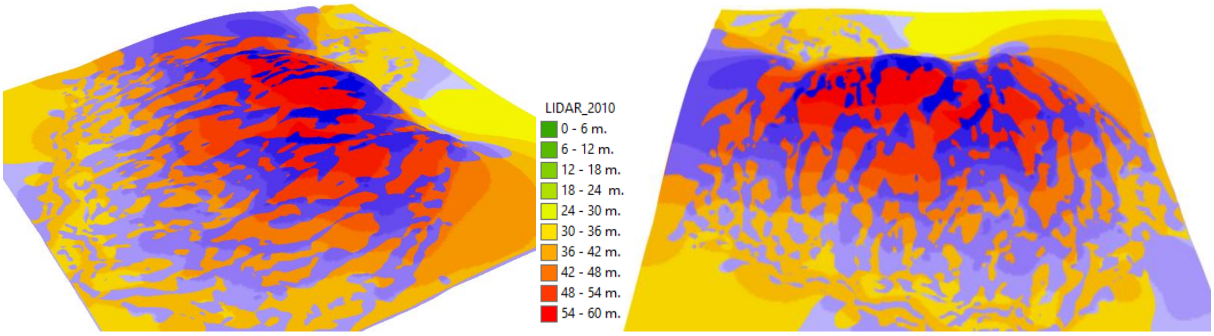


Fig. 8. 3D model of Agila dune surface

With the help of the created 3D model we can see the most problematic places of Agila dune, the biggest loss of sand (erosion) in the picture is marked in red.

In order to substantiate the full value of the research, a questionnaire was conducted (Fig. 9), in which 172 respondents participated. The survey showed that this unique landscape of the Kursiu Nerija, created by natural and human forces, is proven to be an area of exceptional value not only by specialists and scientists, but also by opinion of respondents. According to the survey data, 72.1% of respondents appreciate Kursiu Nerija as the most popular resort in Lithuania, and according to 78.5% of the respondents, this is determined by the uniqueness of the landscape.

Fig. 9. Partial results of the survey

During the survey, respondents were asked whether they often see people walking in dunes where it is forbidden to do so. 44.2% of those surveyed said that they see visitors walking in the restricted areas every time they are visiting the resort, and even 24% of the respondents said they liked to go out to the forbidden zones themselves. In the respondents' opinion, the greatest impact on the deterioration of the environment is the lack of awareness of the people, and the most effective way to preserve natural values from extinction is more intensive control and funds of the European Union, which would ensure effective protection and preservation of natural values.

To summarize, we can state that in 9 years the dune has changed its shape, the structure of sand has changed, dunes are moving to the Kursiu Lagoon.

Conclusions and recommendations

1. The study showed that the most aggressive change in Agila Dune was noticeable in cross section no. 1 - dune erosion reaches 13.98 m. and sand accumulation in this section is 3.59 m. Also significant sand erosion is recorded in section no. 8 – 11.34 m. and accumulation – 2.35 m. The highest dune accumulation of 5.2 m. is observed in section no. 5, where dune erosion is recorded up to 9.9 m. In 9 years the dune has changed its shape, the structure of the sand has changed, the dunes are moving to the Kursiu Lagoon, the winds are causing the greatest damage to the dune, but irresponsible human behavior also contributes to it.

2. With the help of the created 3D model we can see the most problematic places of Agila Dune, the identification and monitoring of which can help to take appropriate protection measures in these zones in order to preserve this unique natural value of the Kursiu Nerija National Park.

References

1. Dudzinska A., Szpakowska B., Walerzak M. (2017). The Use of Lidar Data to ASSESS Elements of Rural Landscape Architecture. Science, Nature, Technologies / Nauka, Przyroda, Technologie. Vol. 54, Issue 2, pp. 239-252.
2. Guo, M., Li, J., Sheng, Ch., Xu, J., Wu, L. (2017). A Review of Wetland Remote Sensing. Sensors. Vol. 17, 777 p.
3. YellowScan Mapper II. Viewed 19 March, 2019, (https://www.yellowscan-lidar.com/products/yellowscan-mapper2).
4. Kulczyk-Dynowska, A. (2015). The Spatial and Financial Aspects of a **Protected Area** as Exemplified By the Roztocze National Park. Research Papers of the Wroclaw University of Economics / Prace Naukowe Uniwersytetu Ekonomicznego we Wroclawiu. Issue 394, p45-53. 9p.
5. Lee, E. (2016) **Protected Areas**, Country and Value: The **Nature**-Culture Tyranny of the IUCN's **Protected Area** Guidelines for Indigenous Australians. Antipode. Vol. 48 Issue 2, p355-374. 20p.
6. Lietuvos Respublikos saugomų teritorijų įstatymas. Iš: Valstybės žinios, 2001, Nr. 58-1703.
7. Michalowska, K. (2015). Modelowanie i wizualizacja danych 3D na podstawie pomiarow fotogrametrycznych i skaningu laserowego. Rzeszow. 61p.
8. Melin, M., C.Shapiro, A., Glover-Kapfer, P. (2017). Remote Sensing: LIDAR. United Kingdom: WWF Conservation Technology Series 1(3), 10 p.
9. Regos, A., Tapia, L., Gil-Carrera, A., Dominguez, J. (2017). Monitoring **Protected Areas** from Space: A multi-temporal assessment using raptors as biodiversity surrogates. Plos One. Vol. 12 (7), pp. e0181769.
10. Schowengerdt, R. A. (2007). Remote sensing: models and methods for image processing. Academic Press.
11. Traviglia, A., Torsello, A. (2017). Landscape Pattern Detection in Archaeological Remote Sensing. Geosciences (2076-3263). Vol. 7 Issue 4, p128. 16p.

Information about authors:

Deimantė Pankauskytė student of Master degree in Faculty of Water and Land Management, Vytautas Magnus University Agriculture Academy. Address: Universiteto 10, LT-53361, Akademija, Kaunas distr., Lithuania, Phone No. +37065883659, E-mail: deimantepan@gmail.com.

Jolanta Valčiukienė director and associate professor at the Institut of Land Management and Geomatics in Faculty of Water and Land Management, Vytautas Magnus University Agriculture Academy. Address: Universiteto 10, LT-53361, Akademija, Kaunas distr., Lithuania, Phone No. +37037752372, E-mail: jolanta.valciukiene@vdu.lt. Fields of interest: spatial planning, balanced urban development, rational land use, land law.

Indrius Kuklys lecturer in Klaipeda State University of Applied Sciences, Faculty of Technologies, Department of Environment and Construction Engineering. Address: **Bijūnų str. 10, LT- 91223 Klaipėda, Lithuania, Phone No. +37069973057,** E-mail: i.kuklys@kvk.lt. Fields of interest: geoinformation systems, accuracy of measurements, remote sensing technologies (LIDAR).

Lina Kuklienė lecturer in Klaipeda State University of Applied Sciences, Faculty of Technologies, Department of Environment and Construction Engineering. Address: **Bijūnų str. 10, LT- 91223 Klaipėda, Lithuania, Phone No. +37069973076,** E-mail: l.kukliene@kvk.lt. Fields of interest: geoinformation systems, digital mapping.

DOI: 10.22616/j.balticsurveying.2019.006

ASSESSING THE IMPACT OF THE NUMBER OF GCPS ON THE ACCURACY OF PHOTOGRAMMETRIC MAPPING FROM UAV IMAGERY

Saponaro Mirko, Tarantino Eufemia, Reina Alessandro,
Furfaro Giuseppe, Fratino Umberto

Polytechnic University of Bari

Abstract

With recent advances in aerial data acquisition technologies from aircraft and Unmanned Aerial Vehicles (UAVs) very large datasets can be collected rapidly, covering significant surfaces with centimetre-scale resolution, with the consequence possibility to analyse geological structures of coastal areas within those datasets digitally. The monitoring of erosion mechanisms in fact requires high standards of precision to appreciate their effects. With the availability of a regular coastal monitoring programme being carried out in a large territory, UAVs can replace many of the conventional flights, with considerable advantages in the cost of data acquisition and without any loss in the quality of topographic and aerial imagery data.

Several works in literature have been focused on finding an effective and sustainable survey strategy to limit costs and work times. However, it is necessary to refine the photogrammetric mapping process to optimize its geometrical accuracy and ensure the multi-temporal and multi-scaling repeatability of final products.

The aim of this work is to test the accuracy obtainable from various photogrammetric workflows concerning the 3D modelling of a coastline area that is subject to hydrogeological instability. To this purpose, a set of image data acquired with a UAV, equipped with a non-metric camera and a low-accuracy GNSS/INS receiver, was processed. To maintain and test the accuracy of the whole process, an adequate number of Ground Control Points (GCPs) was acquired by means of a high precision GNSS surveying.

Keywords: GCPs, UAV imagery, PhotoScan, Direct-Georeferencing, Coastline monitoring

Introduction

The advent of UAV (Unmanned Aerial Vehicle) systems has fuelled a technological evolution of survey methodologies and data processing methods, extending as consequence the interconnections between different application fields (Green et al. 2019; Manfreda et al. 2018; Saponaro, Tarantino, and Fratino 2018). The possibility of also using low-cost and non-calibrated sensors has widened the geographic information range that can be acquired. Useful datasets can be obtained for photogrammetric 3D reconstructions or 2D topographic products as orthophotos and Digital Elevation Model (DEM), ensuring a geometric accuracy suitable for a GIS environment as well as for the cartographic field. In evidence, with recent advances in aerial data acquisition technologies from aircraft and UAVs, it is now possible to capture high-resolution rock surface images and analyse geological structures within those datasets digitally (Irvine, Roberts, and Oldham 2018). Coastal erosion management has become an increasingly crucial task in environmental protection and risk assessment (Papakonstantinou, Doukari, and Topouzelis 2017) as it requires multi-scale, suitable and up-to-date information on small movements. In the last few years, satellite images processing has proved to be a key technology in dealing with such problems but, as demonstrated in several works (Papakonstantinou, Topouzelis, and Pavlogeorgatos 2016), it has not been shown as an effective and sustainable solution in terms of spatial (over 50 cm) and temporal resolution. A methodological advancement was achieved by adopting LiDAR technologies capable of generating models with sub-centrimetric accuracy but downstream of a specialized field activity timely and costly expensive. Nowadays, very large UAV-datasets can be collected rapidly and inexpensively, covering significant surface areas with centimetre-scale resolution (2-5 cm) in a matter of minutes. Thus, georeferenced UAV photogrammetric products can be considered as practical to measure and depict the morphology of coastline stretches at risk, comparable with LiDAR works (Caroti, Piemonte, and Pieracci 2018; Talavera Madrigal et al. 2018), which allow the assessment of changes due to extreme wave phenomena or the securing from possible fall hazards of rock masses.

However, upstream of the potentials highlighted, it is necessary to refine the photogrammetric mapping process to optimize its geometrical accuracy and ensure the multi-temporal and multi-scaling repeatability of final products. The accuracy of Structure from Motion (SfM) algorithm-derived products is highly variable, and the causes are still not fully understood (James et al. 2017). Different factors may affect the precision of UAV-derived data, such as flight parameters, image quality, processing software, the morphology of the studied area and, above all, the modalities of georeferencing. The ordinary use of Ground Control Points (GCPs) greatly improves the precision of SfM products, but at the same time their collection represents a laborious and time-intensive part of UAV campaigns (Manfreda et al. 2019). For this reason, several works in literature have been focused on finding an effective and sustainable GCPs-survey strategy to limit costs and work times (Agüera-Vega, Carvajal-Ramírez, and Martínez-Carricondo 2017; Rangel, Gonçalves, and Pérez 2018; Sanz-Ablanedo et al. 2018; Skarlatos et al. 2013). It has already been proved that at least three GCPs are necessary for the software platform to take advantage of such information, but the minimum number of GCPs needed to produce an optimal quality is still uncertain. On this topic, (Manfreda et al. 2019) proposes a useful table to review the accuracy values obtained by varying the GCPs number extrapolated by different UAV-works. (James et al. 2017) recommends a minimum of five GCPs, combined with an accurate calibration of the camera, for reliable achievements. In most cases, a significant accuracy improvement can be observed when passing from three to six GCPs, although results may obviously be influenced by the morphology of the study area, the equipment on-board and the processing workflow adopted. Therefore, developing a comprehensive understanding of the correlation between georeferencing and Bundle Adjustment (BA) processes of 3D models seems crucial.

In this work we tested the accuracy achievable from various photogrammetric workflows for a 3D coastline reconstruction, subject to hydrogeological instability. The monitoring of erosion mechanisms requires high standards of precision to appreciate their effects (Tarantino 2012; Valentini, Saponieri, and Damiani 2017; Valentini et al. 2017). To this purpose, image data acquired with a UAV, equipped with a non-metric camera and a low-accuracy GNSS/INS receiver, were processed using Agisoft PhotoScan software platform. To test the accuracy of the whole process, 20 GCPs were acquired by means of a high precision GNSS surveying. Several BA processes were run, varying the GCPs number used in the georeferencing step, thus recording the relative root-mean-square error (RMSE) values on the Control Points (CPs), considered as impact index on the quality of the final product.

Methodology of research and materials

The UAV surveyed area is a coastline stretch of about 400 m, located South of Bari (Apulia, Italy) (Fig. 1). The territory in question is bounded towards the sea by a low coast with banks, with elevations between one 1 meter and 5 meters. This such morphological element is the latest in a series of slope falls associated with the Pleistocene marine abrasion terraces that characterize the coastal strip and which give the South-Eastern slopes of the Murge hills a their characteristic stepped profile.

The UAV flight was performed using a commercial quadcopter DJI Inspire 1 equipped with a non-metric camera DJI ZenMuse X3 (focal length of 3.61 mm, pixel size of 1.56 μm, effective pixels 12.4M). The flight was planned through the iOS app DJI Ground Station Pro, in order to maintain a nadir-position of the camera at a constant altitude of 70 m Above Ground Level (AGL), with an average Ground Sample Distance (GSD) equal to 0.03 m/pix. 89 waypoints were outlined in 7 strips, at a cruising speed of 5.5 m/s, scheduling an overlap of 80% between the images in the longitudinal direction of the flight and 70% in the lateral direction. Each image was related to the information about its synchronized positioning at the time of shooting. More precisely, the UAV used was equipped with a low-cost GNSS/INS receiver with an average accuracy of 2.54 m along the axes. This information is fundamental when processing imagery to obtain photogrammetric products for Direct Georeferencing (DG).

Fig. 1. Location of the study area (Google Earth image)

Two Chunks from the same imagery-dataset were generated through Agisoft Photoscan platform (v. 1.4.1). The first chunk was named "1- 70 m", while the second one '2- 70 m TI", where TI means "treated images". In particular, each image was treated in order to mask water pixels and to assign an homogeneous brightness to the entire dataset (Fig. 2). As discussed in (Gonçalves and Henriques 2015), masking techniques may be used to avoid that large water bodies and other moving features being used in the point detection and matching step in order to achieve uncompromised results. Moreover, SfM algorithms can benefit from a regular brightness in the whole dataset, thus returning lower projection errors.

Fig. 2. Examples of masking techniques and exposure management of an image

A high-accuracy ground-truths measurement was performed: 20 GCPs were measured with Global Navigation Satellite System (GNSS) equipment, i.e. Leica Viva CS10/GS10 receivers. The points were detected with centimeter precisions (0.02 m) by performing measurements in Network Real Time Kinematic (nRTK) leaning to a local permanent station of the Leica SmartNet Italpos network, a commercial Countinously Operating Reference Station (CORS). The fixed points were searched in the area after mindful planning (visible edges, manholes, road signs, etc.), in order to have a uniform distribution along the coastline stretch under study. As suggested by (Scaioni et al. 2018), the transformation from ellipsoidal altitude obtained from GNSS survey to orthometric height is a key topic, because the latter is indispensable to compare the derived products. In this study case the ellipsoidal altitude was transformed into orthometric height using an accurate local geodetic model, comparing these heights with the barometric values acquired by the UAV. A systematic vertical shift was registered due to the its low-accuracy. The most diffused solution, in such case, is to acquire a UAV image on the ground before starting the mission or after the landing near or on a measured GCP in order to record the shift between the altitude coordinates. The value will then be fundamental to analyze the results of the DG.

Firstly, a reasonable setting of the system and the workspace was chosen (Mayer, Gomes Pereira, and Kersten 2018). To remove images that were not suitable for photogrammetric process, the mean image quality was computed using the PhotoScan tool that explores images one by one, estimating for each image a value between a low quality of 0 and and high quality equal to 1. No images were removed, having obtained values higher than the threshold of 0.5 (mean value equal to 0.862), moreover no evident distortions or blur effects were present in the imagery.

In the Reference Settings pane, the workspace was then set: the reference system WGS84 (EPSG::4326) was indicated for the imagery due to the geo-tags reference system, whereas the reference system RDN2008/UTM zone 33N (NE) (EPSG::6708) was set for the surveyed GCPs. Following the prompts in (Mayer, Gomes Pereira, and Kersten 2018), a value of 3 m was put in Accuracy Image (m) parameter as a conservative setting, although the UAV-positioning accuracy value was known as equal to 2.54 m. Furthermore, the precision of this value was related to the receiver rate of position measurements per second (Hz) and hence to the mean speed of the vehicle. Although the imagery was acquired in a hovering 'stop&go' mode, a conservative value was preferred as precautionary. To follow, in Accuracy Image (deg), the default value of 10 deg was retained, since there was no manufacturing information, to also include the negative effects caused by the low accuracy of the IMU-onboard. A mean value of 0.02 m was fixed under the Precision Marker (m) option: as already mentioned, this parameter represents the mean precisionof GCPs coordinates in the object space. Finally, for the calibration of the image coordinates in the displayed workspace, a more reasonable Marker Precision (pix) value of 0.5 pix was selected, to define the effective ability of the operator to identify the target in the image. The accuracy of the tie points was retained at the default value of 1 pix. This parameter depends on the image quality since tie point positions are detected on the base of the key features showing in the images. Tie points were accurately localized when the images were sharp. A subpixel value avoids the distortion of the photogrammetric block, but at the same time it cuts-off the points re-projection number. The accuracy of Tie points, the Precision Marker (pix) and the Precision Marker (m) parameters are fundamental to generate the variance-covariance matrix within the stochastic model and therefore functional to the BA optimization.

Camera calibration, as mentioned in (James et al. 2017), is a critical step in order to obtain a well-defined interior orientation of imagery, and thus to avoid the error propagation in the final accuracy. There are various ways of calibrating the camera and each of them affects the final results of accuracy. It is often preferred to apply the parameters obtained by a self-calibration using the algorithms implemented in the software platform, noting that this produces optimized values compared to those obtainable from a raw calibration in the laboratory. Therefore, in the Camera Calibration panel, the task of estimating the aforementioned parameters was assigned to the software in the Camera Alignment process, which was then optimized in the BA procedures of the following phase.

Another basic operation was the set-up of the GPS/INS Offset in order to reach the lever-arm value corrections measured in the laboratory. In particular, the rough displacement vector (X, Y, Z) measured was (0.005, 0.10, 0.25) m with a precision of about 0.01 m, while the IMU values calibration (yaw, pitch, roll) was 0 deg with an accuracy considered equal to 2 deg. In the following phases these values were optimized too.

Once the workspace was structured, the Camera Alignment process was launched in ‘Highest’ accuracy, choosing the Limit of Key Points and Tie Points as equals to 0. Photoscan generated the sparse points clouds and, at same time, estimated the interior and exterior orientation, evaluating a systematic error compensation such as the lens non-linear distortions. The points clouds obtained showed a Gradual Selection as reported in Table 1. Briefly, the inaccurate points computed were cleaned out from the clouds for accuracy optimization and 20 GCPs were identified in the imagery, assigning a marker in the workspace displayed to the fixed points on the ground.

Table 1

Gradual Selection step: tie points resulting from the removing of inaccurate points for accuracy optimization

Chunk	Initial n° tie points	Reconstruction Uncertainity	Projection Accuracy	Reprojection Error
1- 70 m	1451042	1118218	999538	933305
2- 70 m TI	1315819	1020920	932268	872548

In order to comprehend the impact of the number of GCPs on the final accuracy achievable at the end of the georeferencing process, 21 copies were generated for each Chunk, in a total of 42 sparse points clouds in the workspace. These clouds were georeferenced by implementing from a maximum of 20 to a minimum of 0 GCPs, thus also analysing the cases of Complete Indirect Georeferencing (CIG) and DG respectively. The implemented GCPs were chosen in such a way to maintain a homogeneous distribuition between central and border zones (Fig. 3). The remaining number of the non-implemented fixed points in each process were consequently defined as Check Points (CPs).

The BA was launched through the Optimize Cameras process. During these step, the BA algorithms regulate estimated points coordinates, the values of camera parameters and lever-arm offset, reducing the sum of re-projection and reference coordinate misalignment errors.

Fig. 3. Distribution of the GCPs implemented in the sparse points cloud

Discussions and results

Launching the alignment of cameras in each Chunk can have a positive impact when managing a cleaning clouds process utilizing three picking criteria implemented in the Gradual Selection tool.

The Reconstruction Uncertainty criterion allows to remove points with low base-to-height ratios. Namely, tie points situated in the margin areas of images generally have a higher degree of reconstruction uncertainty than central ones, due to the low sidelapping of the images. Removing such points doesn't impact on the accuracy, but it does lighten the clouds.

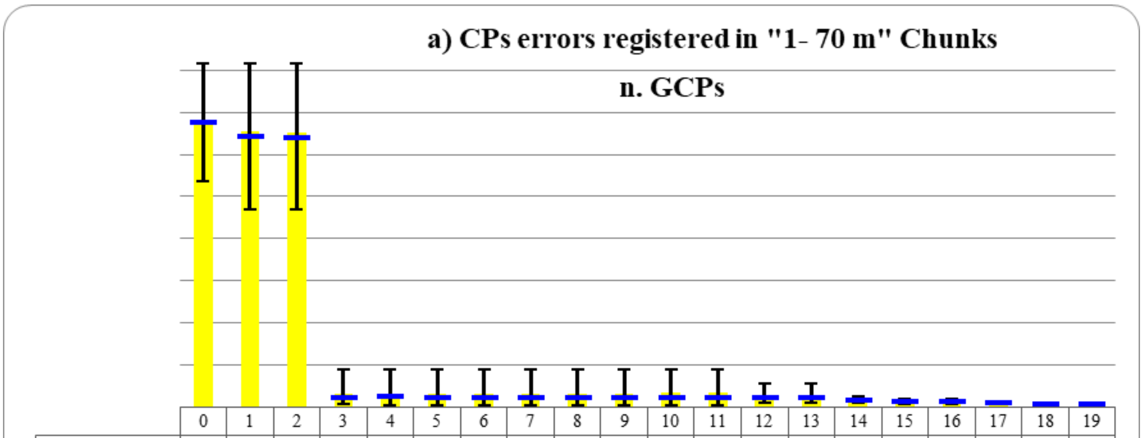
The second criterion applied, named Projection Accuracy, allows to recognise less reliable tie points. Setting this parameter as equal to 10 means that the points recognized have an uncertainty 10 times higher than the points characterized by a minimum uncertainty.

The Re-projection Error criterion was run to remove erroneous points with large residuals implying the largest direct influence on the root-mean-square-error (RMSE) of the GCPs and CPs. This parameter improved the orientation parameters conspicuously.

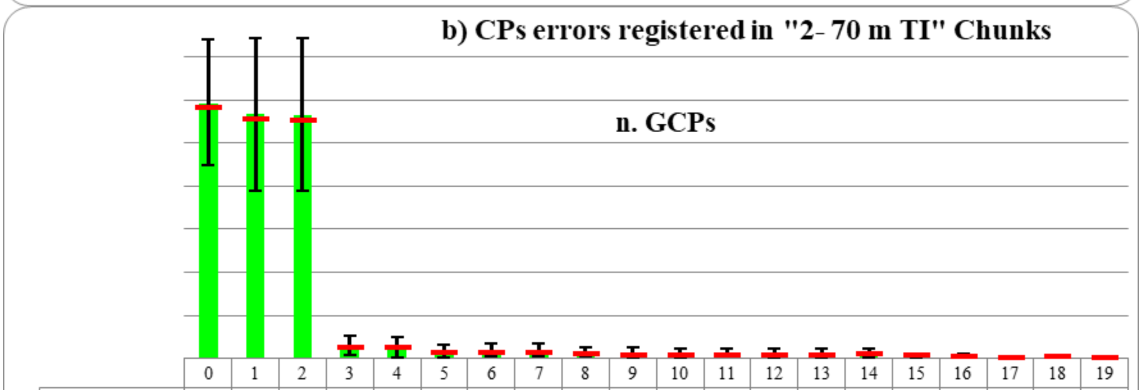
To follow, the impact of the number of GCPs on the geometric quality of the derived photogrammetric products was also studied. Several criteria discussed in many scientific works allow the assessment of the model quality in terms of its 3D coordinates accuracy (Manfreda et al. 2019).

Commonly, these checks are based on comparing some estimated ground-points by SfM-algorithms and the same points measured with high accuracy, i.e. in a GNSS-campaign. Usually, the planimetric and altimetric accuracies are explained in terms of root-mean-square error (RMSE) registered on CPs or GCPs. The RMSE value can be considered as a cumulative result of all errors, i.e. both random and systematic errors with a Gaussian distribution (Saponaro, Tarantino, and Fratino 2018), and accordingly representative of the absolute accuracy of each point. Fig. 4 shows a complete view of mean errors, max e min errors registered in CPs for each process. The mean error represents the effective systematic displacement between the estimated points and the truth-points measured: a stable and recognizable discrepancy. A RMSE value much higher than the recorded mean error would indicate a prevalence of accidental errors and therefore a strong instability of the results. Vice versa, RMSE and mean errors comparable, verified by the bias values (min-max errors), clarify the statistical robustness of results.

Fig. 4 shows the $RMSE_{xyz}$ values in CPs related to the 20 processed Chunks respectively, escluding the CIG case: its results are shown in Table 2.



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
RMSE [m]	6,822	6,552	6,514	0,297	0,305	0,299	0,299	0,307	0,310	0,321	0,332	0,351	0,255	0,261	0,157	0,138	0,121	0,091	0,069	0,051
Max Error [m]	8,164	8,177	8,177	0,894	0,887	0,892	0,893	0,890	0,881	0,879	0,884	0,888	0,549	0,551	0,243	0,182	0,183	0,120	0,084	0,051
Min Error [m]	5,350	4,680	4,680	0,061	0,029	0,027	0,032	0,024	0,031	0,030	0,036	0,043	0,100	0,097	0,088	0,052	0,054	0,052	0,049	0,051
Mean Error [m]	6,755	6,428	6,385	0,226	0,230	0,211	0,202	0,207	0,204	0,209	0,209	0,229	0,216	0,220	0,150	0,131	0,111	0,087	0,067	0,051



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
RMSE [m]	5,904	5,682	5,645	0,299	0,301	0,166	0,156	0,153	0,121	0,113	0,106	0,110	0,111	0,114	0,121	0,088	0,065	0,042	0,049	0,032
Max Error [m]	7,385	7,418	7,418	0,518	0,503	0,329	0,347	0,338	0,258	0,257	0,234	0,232	0,232	0,228	0,228	0,127	0,101	0,063	0,062	0,032
Min Error [m]	4,470	3,886	3,886	0,071	0,036	0,032	0,047	0,045	0,043	0,039	0,039	0,041	0,030	0,030	0,029	0,030	0,023	0,019	0,031	0,032
Mean Error [m]	5,834	5,556	5,514	0,270	0,269	0,147	0,133	0,129	0,107	0,095	0,089	0,095	0,091	0,094	0,102	0,079	0,059	0,038	0,047	0,032

Fig. 4. a) CPs errors registered in "1- 70 m" Chunks varying the GCPs number implemented b) CPs errors registered in "2- 70 m TI" Chunks varying the GCPs number implemented

Analyzing the DG case, i.e. without GCPs assistance and only using only the image positional tags checked in the box pane before starting the process, the accuracies achieved show large gaps for a possible use in the cartographic field. The low accuracy of the sensors mounted does not allow the achievement of a high positional accuracy in the DG and, on the other hand, the lack of raw position data does not allow to identify the causes in order to improve its estimates.

It is also necessary to consider an efficient amount of GCPs in the data georeferencing workflow to achieve highly accurate geospatial products.

Overall, the two datasets show a similar behavior in terms of number of GCPs implemented. There is a reduction in $RMSE_{xyz}$ values in the transition from a number of GCPs used from 2 to 3, with a $RMSE_{xyz}$ leap of about 5.5 m. The following configurations attest the same order of magnitude achieved with slight centimetric fluctuations, linked to the Re-projection Errors in the images of GCPs implemented.

Table 2

Full description of the $RMSE_{xyz}$ values [m] and the Re-projection Errors [pix] recorded in the 42 generated Chunks. The red box highlights the results considered as optimal for the model georeferencing. In the green box, the results obtained for the CIG cases.

n.GCPs		1- 70 m		2 - 70 m TI	
		$RMSE_{xyz}$ (m)	Error (pix)	$RMSE_{xyz}$ (m)	Error (pix)
0	GCPs				
	CPs	6.822	2.466	5.904	0.481
1	GCPs	6.820	0.390	5.908	0.484
	CPs	6.552	2.536	5.682	0.480
2	GCPs	7.015	0.312	6.106	0.431
	CPs	6.514	2.656	5.645	0.487
3	GCPs	0.096	0.409	0.099	0.414
	CPs	0.297	2.800	0.299	0.498
4	GCPs	0.085	0.415	0.088	0.501
	CPs	0.305	2.894	0.301	0.475
5	GCPs	0.077	0.415	0.084	0.493
	CPs	0.299	2.986	0.166	0.480
6	GCPs	0.072	0.435	0.078	0.487
	CPs	0.299	3.047	0.156	0.484
7	GCPs	0.071	0.688	0.078	0.497
	CPs	0.307	3.168	0.153	0.477
8	GCPs	0.088	0.681	0.102	0.519
	CPs	0.310	3.394	0.121	0.457
9	GCPs	0.084	0.668	0.099	0.508
	CPs	0.321	3.470	0.113	0.464
11	GCPs	0.076	0.639	0.088	0.487
	CPs	0.351	3.917	0.110	0.484
12	GCPs	0.244	2.990	0.087	0.507
	CPs	0.255	0.502	0.111	0.445
13	GCPs	0.236	2.888	0.084	0.504
	CPs	0.261	0.493	0.114	0.442
14	GCPs	0.263	2.835	0.081	0.502
	CPs	0.157	0.495	0.121	0.441
15	GCPs	0.256	2.752	0.089	0.513
	CPs	0.138	0.395	0.088	0.380
16	GCPs	0.249	2.706	0.087	0.507
	CPs	0.121	0.391	0.065	0.395
17	GCPs	0.245	2.689	0.087	0.503
	CPs	0.091	0.365	0.042	0.399
18	GCPs	0.239	2.605	0.084	0.493
	CPs	0.069	0.369	0.049	0.432
19	GCPs	0.234	2.558	0.082	0.494
	CPs	0.051	0.422	0.032	0.392
20	GCPs	0.227	2.466	0.081	0.486
	CPs				

10	GCPs	0.080	0.662	0.093	0.506
	CPs	0.332	3.572	0.106	0.465

The optimal solutions were searched, based on the simultaneous occurrence of low RMSE values on both CPs and GCPs: a necessary condition to demonstrate the consistency of the RMSE values recorded on the CPs. The values in Table 2 show an optimal geometrical accuracy achieved with 6-7 GCPs implemented for both Chunks, thus confirming the results achieved by (James et al. 2017).

Focusing on the differences between the two processed Chunks, some considerations can be drawn. With reference to Table 2, Chunks "2 - 70 m TI" show Re-Projection Errors (pix), for both ground points, lower than the Chunks "1- 70 m" and, at the same time, these improve the geometric accuracy achievable on CPs. It can be therefore maintained that the techniques of masking and brightness adjustment effectively improve the detecting and matching of tie points, providing more robust results. On the other hand, however, these techniques may undermine the development of complete 3D models by not accurately masking particular areas. In the case of this work a punctual masking of the rocky coastline could only be achieved through a complicated and above all time-consuming process. Its use is therefore recommended in morphologically regular areas.

Conclusions and proposals

A photogrammetric processing workflow was explored in this study for the accuracy optimization of UAV-based products, analysing a coastline stretch subject to hydrogeological instability.

Generally. the common low-precision equipment on board of a UAV does not guarantee the achievement of precision standards for topographic purposes: sparse points clouds have to be managed by firstly identifying and then removing tie points with low quality matching and high re-projection errors. A reasonable management of the clouds may impact on the model malleability and therefore on the final accuracy of results achievable. Further benefits can be observed in the final results as a result of masking and brightness adjustment techniques applied on the image dataset. These techniques, as demonstrated in this study, improve the final RMSE values by almost 50% but, at the same time, they may prove unsuitable in morphologically complicated scenarios. Their use is therefore recommended in regular areas, in order to lighten the algorithms and obtain more robust results.

The aim of this work was to carry out a comprehensive assessment of the impact of the number of GCPs on the absolute geometric accuracy of photogrammetric products. The results obtained are in line with those presented in several previous works in literature: clear gaps show in the DG cases, noting the need of only 3 GCPs for a reasonable georeferencing. An efficient results may be obtained using 6-7 GCPs, attesting $RMSE_{xyz}$ values in CPs at about 0.30 m in the first Chunk and 0.15 m in the second one, which is practical for GIS applications. More than 15 GCPs are instead necessary to produce accurate cartographic works.

Further studies to make the photogrammetric process autonomously efficient will be carried out in the future, integrating the workflow with an automatic research of the optimal spatial and numerical distribution of GCPs.

References

1. Agüera-Vega, Francisco, Fernando Carvajal-Ramírez, and Patricio Martínez-Carricondo. 2017. 'Assessment of photogrammetric mapping accuracy based on variation ground control points number using unmanned aerial vehicle', Measurement, 98: 221-27.
2. Caroti, Gabriella, Andrea Piemonte, and Yari Pieracci. 2018. "Low-Altitude UAV-Borne Remote Sensing in Dunes Environment: Shoreline Monitoring and Coastal Resilience." In, 281-93. Cham: Springer International Publishing.
3. Gonçalves, J. A., and R. Henriques. 2015. 'UAV photogrammetry for topographic monitoring of coastal areas', ISPRS Journal of Photogrammetry and Remote Sensing, 104: 101-11.
4. Green, David R, Jason J Hagon, Cristina Gómez, and Billy J Gregory. 2019. 'Using Low-Cost UAVs for Environmental Monitoring, Mapping, and Modelling: Examples From the Coastal Zone.' in, Coastal Management (Elsevier).

5. Irvine, M, G Roberts, and L Oldham. 2018. 'Assessing the Applicability of Unmanned Aerial Vehicle (UAV) Data in Environmental Monitoring of Coastal Environments: St. David's, Newfoundland'.
6. James, M. R., S. Robson, S. d'Oleire-Oltmanns, and U. Niethammer. 2017. 'Optimising UAV topographic surveys processed with structure-from-motion: Ground control quality, quantity and bundle adjustment', Geomorphology, 280: 51-66.
7. Manfreda, Salvatore, Petr Dvorak, Jana Mullerova, Sorin Herban, Pietro Vuono, José Juan Arranz Justel, and Matthew Perks. 2019. 'Assessing the Accuracy of Digital Surface Models Derived from Optical Imagery Acquired with Unmanned Aerial Systems', Drones, 3: 15.
8. Manfreda, Salvatore, Matthew F. McCabe, Pauline E. Miller, Richard Lucas, Victor Pajuelo Madrigal, Giorgos Mallinis, Eyal Ben Dor, David Helman, Lyndon Estes, Giuseppe Ciraolo, Jana Müllerová, Flavia Tauro, M. Isabel De Lima, João L. M. P. De Lima, Antonino Maltese, Felix Frances, Kelly Caylor, Marko Kohv, Matthew Perks, Guiomar Ruiz-Pérez, Zhongbo Su, Giulia Vico, and Brigitta Toth. 2018. 'On the Use of Unmanned Aerial Systems for Environmental Monitoring', Remote Sensing, 10: 641.
9. Mayer, Cedric, LM Gomes Pereira, and Thomas P Kersten. 2018. "A Comprehensive Workflow to Process UAV Images for the Efficient Production of Accurate Geo-information." In IX National Conference on Cartography and Geodesy.
10. Papakonstantinou, Apostolos, Michaela Doukari, and Konstantinos Topouzelis. 2017. Coastline Change Detection Using Unmanned Aerial Vehicles and Image Processing Techniques.
11. Papakonstantinou, Apostolos, Konstantinos Topouzelis, and Gerasimos Pavlogeorgatos. 2016. 'Coastline Zones Identification and 3D Coastal Mapping Using UAV Spatial Data', ISPRS International Journal of Geo-Information, 5: 75.
12. Rangel, José Manuel Galván, Gil Rito Gonçalves, and Juan Antonio Pérez. 2018. 'The impact of number and spatial distribution of GCPs on the positional accuracy of geospatial products derived from low-cost UASs', International Journal of Remote Sensing, 39: 7154-71.
13. Sanz-Ablanedo, Enoc, Jim H. Chandler, José Ramón Rodríguez-Pérez, and Celestino Ordóñez. 2018. 'Accuracy of Unmanned Aerial Vehicle (UAV) and SfM Photogrammetry Survey as a Function of the Number and Location of Ground Control Points Used', Remote Sensing, 10: 1606.
14. Saponaro, Mirko, Eufemia Tarantino, and Umberto Fratino. 2018. "Geometric Accuracy Evaluation of Geospatial Data Using Low-Cost Sensors on Small UAVs." In Computational Science and Its Applications – *ICCSA 2018*, edited by Osvaldo Gervasi, Beniamino Murgante, Sanjay Misra, Elena Stankova, Carmelo M. Torre, Ana Maria A. C. Rocha, David Taniar, Bernady O. Apduhan, Eufemia Tarantino and Yeonseung Ryu, 364-74. Cham: Springer International Publishing.
15. Scaioni, M., J. Crippa, M. Corti, L. Barazzetti, D. Fugazza, R. Azzoni, M. Cernuschi, and G. A. Diolaiuti. 2018. 'Technical Aspects Related to the Application of SfM Photogrammetry in High Mountain', Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLII-2: 1029-36.
16. Skarlatos, D., E. Procopiou, G. Stavrou, and M. Gregoriou. 2013. "Accuracy assessment of minimum control points for UAV photography and georeferencing." In First International Conference on Remote Sensing and Geoinformation of Environment, 9. SPIE.
17. Talavera Madrigal, Lara, Laura Del Río, Javier Benavente, Luis Barbero, and J. López-Ramírez. 2018. UAS as tools for rapid detection of storm-induced morphodynamic changes at Camposoto beach, SW Spain.
18. Tarantino, Eufemia. 2012. 'Monitoring spatial and temporal distribution of Sea Surface Temperature with TIR sensor data', Italian Journal of Remote Sensing/Rivista Italiana di Telerilevamento, 44.
19. Valentini, Nico, Alessandra Saponieri, and Leonardo Damiani. 2017. 'A new video monitoring system in support of Coastal Zone Management at Apulia Region, Italy', Ocean & Coastal Management, 142: 122-35.
20. Valentini, Nico, Alessandra Saponieri, Matteo Gianluca Molfetta, and Leonardo Damiani. 2017. 'New algorithms for shoreline monitoring from coastal video systems', Earth Science Informatics, 10: 495-506.

Information about authors:
Mirko Saponaro. Master's Degree in Civil and Environmental Engineering. PhD student. Polytechnic University of Bari. Via Orabona n.4. 70125 Bari (Italy). +39 3490062790. mirko.saponaro@poliba.it . Fields of interest: UAV imagery processing. Photogrammetric Accuracy.
Eufemia Tarantino. Associate Professor of Geomatics. Polytechnic University of Bari. Via Orabona n.4. 70125 Bari (Italy). +39 0805963417. eufemia.tarantino@poliba.it Fields of interest: Remote Sensng. GIS. Cartography.
Alessandro Reina. Assistant Professor of Environmental Geology. Polytechnic University of Bari. Via Orabona n.4. 70125 Bari (Italy). +39 0805963493. alessandro.reina@poliba.it Fields of interest: Giacimentology, Mineral resources, Coastal erosion

Giuseppe Furfaro. Surveying Technician. external collaborator. g.furfaro@stf-survey.com . Fields of interest: UAV survey, Photogrammetry, GNSS survey.
Umberto Fratino. Full Professor in Hydraulic Enginering. Polytechnic University of Bari. Via Orabona n.4. 70125 Bari (Italy). +39 0805963321. umberto.fratino@poliba.it Fields of interest: Environmental modelling, water resources, hydrogeological risk.

DOI: 10.22616/j.balticsurveying.2019.007

THE DEVELOPMENT OF LOCAL ECOLOGICAL NETWORKS IN UKRAINE: THE EXAMPLE OF LVIV REGION

Nataliia Stoiko, Oksana Cherechon
Lviv National Agrarian University

Abstract
The conservation and renovation of biological diversity of territories are of vital importance in Ukraine. The concept of ecological networks has laid the foundation of these issues. In Ukraine, the law "On the ecological network" was adopted, and ecological networks were developed at the regional level. However, most developments do not fully take into account the location of reserved territories and places of concentration of valuable flora and fauna, and also often do not correspond to the principle of formation of a holistic system, which significantly reduces their environmental significance and the expediency of practical implementation. The authors of the article consider that one should estimate the natural potential of the territories in detail and objectively, as well as provide recommendations for practical actions for the renovation of biological and landscape diversity. One can do it in the process of the development of local ecological networks (at the level of separate administrative regions and territorial communities). One has developed the structure of the ecological network on the example of Stryi district of Lviv region and determined the estimation of the spatial connectivity of its crucial elements. The problem is that most of the connecting territories are formed from semi-natural and unnatural lands (hayfields, pastures, arable lands), which complicates the practical side of the project implementation. One needs to develop an effective mechanism to encourage landowners and land users to carry out environmental activities; to increase investments in re-naturalization of lands; to conduct environmental education and environmental public awareness campaign; to provide local government and other stakeholders with consulting services for the development of ecological network development programs at the local level in Ukraine.
Key words: ecological network, local level, biological and landscape diversity, re-naturalization of lands.

Introduction

To begin with, the concept of ecological networks includes the creation of the model for conservation of biological diversity of territories, and at the same time it maintains the sustainable use of natural resources (Bennett G., Wit P., 2001). First of all, ecological networks combine natural ecosystems in order to preserve habitats and the growth of valuable flora and fauna species, the development of ways of animals' migration due to a combination of territories that are of vital importance for the environment protection. Thus it facilitates the genetic exchange between diverse populations. In addition, this concept is an instrument for implementing environmental policies, environmental design and physical planning for degraded ecosystems restoration and enhancement of the biodiversity value of anthropogenic landscapes (Bennett G., Mulongoy K. J., 2006; Jongman R.H.G, Külvik M., Kristiansen I., 2004).
Nevertheless the concept of ecological networks contributes to multifunctional landscapes planning (Opdam P., Steingröver E., Van Rooij S., 2006) in spite of the fact that in European countries one still hashes out institutional and financial problems of nature protection and land policies while implementing this concept, and it is criticized (Boitani L., Falcucci A. Maiorano L, Rondinini C., 2007).
Ukraine supports the idea of creating European Ecological network as the single spatial system of territories of European countries with a natural or partially altered landscape state. In Ukraine an appropriate legislation has been developed regarding the formation of the National Ecological network and ecological networks at the regional and local levels. The environmental policy of Ukraine implies an increase in the areas of protected territories, which are the foundation for ecological networks formation. The indicator of the reservation of the territory of the country (the ratio of the actual area of the Nature Reserve Fund to the area of the state) as at the 1st of January 2018 was 6.6%. Although this indicator is significantly lower than the one of European countries, there is still a positive tendency to increase the reserved areas in Ukraine. So, the quantity of nature reserves and national natural parks increased by 42

objects, and their area increased by 1109.9 thousand hectares during the years of 2000-2017 (Statistical Yearbook …, 2017).

However, Ukrainian territories with natural flora and fauna are located mostly fragmentarily, this fact reduces their resistance to negative natural phenomena and anthropogenic processes as well as it also weakens the reproduction possibilities of living organisms. This situation presents the momentousness of the formation of ecological network, mainly green corridors, in order to connect the centers of the existence of natural flora and fauna and its migration.

In the Ukrainian legislation, the structural elements of the ecological network include: key territories which are intended to preserve the most valuable and typical landscape and biodiversity components for a certain region; connecting territories which are intended to combine key areas among themselves in order to ensure the migration of animals and the exchange of genetic heritage; buffer territories which are intended to protect key and connecting territories from external negative impacts; renewable territories which are intended to form the spatial integrity of the ecological network, within which measures of high priority for the reproduction of the primary natural state should be implemented (On Ecological network …, 2004).

The planning of the national ecological network and ecological networks of the regional level was carried out due to the National Program for Creating the National Ecological network of Ukraine for the years of 2000-2015. It is certainly an essential stage in the implementation of the goal of national environmental policy, which envisages the stabilization and improvement of the natural environment of Ukraine. However, experts suggest that these developments are characterized by certain disadvantages, namely: most of ecological networks have a generalized structure, and the places of concentration of priceless flora and fauna are not fully taken into consideration, which significantly reduces their environmental significance and the feasibility of practical implementation; these networks do not fully correspond to the principle of forming an integral system that maximizes the continuity and interconnectedness of the structural elements of ecological networks; buffer territories, which promote the strengthening of the network and its protection from the influence of negative external factors, are not always designed around the key territories (ecological cores and green corridors) (Kahalo O., 2009; Kostiushyn V., Vasyliuk O., Kolomytsev H., 2011). There is virtually no research on renewable territories, which are means of landscapes re-naturalization in the available materials on the implementation of the concept of ecological networks.

The above-mentioned arguments show that the issue of developing ecological networks at the local level (at the level of certain administrative districts and territorial communities) is relevant for Ukraine. It will allow assessing the natural potential of the territories in detail and objectively, as well as providing recommendations for practical actions to restore biological and landscape diversity.

The aim of the work is to study the possibility of developing an ecological network of the local level as an important prerequisite for the conservation and restoration of biological diversity of territories in Ukraine due to the increase of the area of lands with natural landscapes.

The following tasks have been accomplished in order to achieve the aim: one has determined natural and semi-natural plots that are potentially included in the local ecological network, taking into account the landscape and ecological and biological characteristics of these plots on a specific territory; one has developed the spatial structure of perspective elements of the ecological network and made an assessment of their spatial connectivity; one has discussed the relevance of research results for the practice of local ecological networks formation in Ukraine.

Methodology of research and materials

The study is based on the Convention on Biological Diversity (1992). Its goal is the development of strategies, plans and programs for the conservation and sustainable use of biological diversity in the territories. The methodological basis of the study is functional spatial analysis and synthesis. Spatial analysis involves the decomposition of a complex object (ecosystem) into its more simple elementary parts (biocenoses, biotopes) with the allocation of their individual properties and connections. The synthesis includes connection of components of the complex object (ecosystem) based on certain principles (integrity, systematicity, complexity, balance) and thereby constructs a new system (ecological network).

A lot of methods have been used to achieve the set goals. They are: comparative and geographic method for the establishment of the similarity and distinction of ecosystems by landscape features and the combination of the researched objects into one group on the basis of the systematization of data according to their functional purpose; the statistical method for the collection, systematization, analysis of information on the state of territories that have a special natural, ecological, aesthetic, historical and cultural, recreational value; the cartographic method for the visualization of settlement places of valuable flora and fauna, territories with degraded soils, modelling of structural elements of the ecological network; the geo-information method for analyzing and displaying geographic information about an object.

One has used landscape and ecological, agro-ecological and ecosystem approaches in spatial (territorial) planning of the structural elements of the ecological network.

MapInfo and Digitals software tools have been applied for cartographic works. One has also used photos that are available due to the free Google Earth service on the Internet and data from the Public Cadastral Map of Ukraine.

One has used indicators that characterize the degree of connectivity of its structural elements, calculated by the formulas, in order to assess the effectiveness of the major function of the ecological network, that is, the provision of biotic diversity and genetic heritage due to the migration of species (Hrodzynskyi D., 1993):

$$\alpha = (K - B + 1) / (2\,B - 5), \tag{1}$$

$$\beta = K / B, \tag{2}$$

$$\gamma = L / 3\,(B - 2), \tag{3}$$

where K – number of connecting territories (green corridors), B – number of key territories (biocentres). The higher the values of the α-index, the more alternative ways migration of individuals from the key territory are provided (with α with limit from 0 to 1). The β-index characterizes the degree of development and complexity of the network of connecting territories (with β with limit from 0 to 3): the network does not have any cycle at $\beta < 1$, it has only one cycle at $\beta = 1$ and several ones at $\beta > 1$, all key territories are merged by the connecting territories in cycles that are optimum at $\beta = 3$. The γ-index defines the degree of alternative choice of migration paths from one key territory to the other ones (with γ ϵ with limit from 0 to 1), and the higher its value, the more extensive the network of connecting territories and the shorter migration paths between two arbitrarily selected key territories: none of the key territories is unrelated with each other at $\gamma = 0$, each key territory is connected by the connecting territory, which is optimal at $\gamma = 1$.

One has conducted the research on the example of the Stryi district of Lviv region, the territory of which belongs to the physical and geographical area of the Eastern Carpathian Foothills, and, according to geo-botanical zoning, to the Central European province of Stryi and Drohobych sub-province of oak forests and river and valley vegetation and meadows.

Discussions and results

The foundation of the ecological network formation is the natural ecosystem in the form of forest, shrub, meadow, swamp and other lands. In Stryi district, forest and shrub land vegetation account for 27.5% of the total area, swamps – 0.2%, rivers and streams – 1.2%, ponds and lakes – 0.6%. Natural meadows were preserved mostly in the territories of the nature reserve fund, which is 4.2% (Table 1). Semi-natural lands are represented by hayfields 7.0% and pastures 9.8%. The species composition of flora and fauna within the region is quite diverse. In particular, there are 9 species of flora and 5 species of fauna that are listed in the Red Data Book of Ukraine (State Enterprise…, 2019).

Unfortunately, there is no complete information on the distribution and number of species of flora and fauna on a specific territory in Ukraine. In addition, the Public Cadastral Map does not display the boundaries of the objects of the Nature Reserve Fund of local importance, since the relevant documentation on land management has not been developed.

Table 1

Characteristics of Nature Reserve Fund of Stryi district of Lviv region

Object	**Title**	**Function**	**Area, ha**
		National importance	
Monument of landscape art	Pidhirtsi Park	Preservation of plantations of plane trees and hornbeam of natural origin	8.3
		Local importance	
Park-monument of landscape art	Park of the XIX century	Preservation of the park of the XIX century with oak and beech plantations	3.0
Natural landmark	Birch wood	Preservation of forest massif with birch plantations of natural origin	33.2
	Yosypovychi	Preservation of forest massif with common oak plantations of natural origin	40.0
	Rozhirche	Preservation of forest massif with prototype pure beech plantations	205.7
	Semyhyniv	Preservation of rare vegetation types – Swamp cranberries, the round-leaved sundew	12.7
Landscape reserved area	Morshyn reserved area	Preservation of plantations of beech, oak, hornbeam, silver fir of natural origin. Breeding a red deer population	3084.6
Complex natural monument	Outcropping of Vyhorodskyi sandstone	Preservation of a group of rocks made of sandstone	1.0
Botanical natural monument	Franz Joseph's oak	Preservation of age-old oak. Age of the tree is about 250 years old	0.05
Hydrological natural monument	Well № 6	Preservation of mineral water source	0.3

It is done by the authors on the basis of data (State Enterprise…, 2019; Nature and Reserve Fund…, 2019).

One has allocated crucial territories (ecological nuclei) within the limits of forest massifs, where reserved objects are located, in designing the ecological network of Stryi district. One has also taken into account centers of the existence of species of flora and fauna of the Red Data Book of Ukraine, lands of recreation.

Therefore, in this work, we mapped the approximate location of valuable flora and fauna and objects of Nature Reserve fund within the region (Fig. 1).

The main criteria for selecting plots for connecting territories (green corridors) are: maximum consideration of natural boundaries; sufficiency of latitude and longitude to ensure the migration of species, their reproduction and the experience of their unfavorable conditions; the edaphic factors of the green corridor should be similar or close to the edaphic factors of the ecological nuclei which it unites; there should not be migration barriers or other factors within the corridor that can prevent migration and species placement; they must contain well-preserved vegetation and have a great biological diversity; they may contain areas where there are rare, relic or endemic species of flora and fauna or rare plant groups that are not present in ecological nuclei for some reason (Deodatus F., Protsenko L. and others, 2010). It is rather complicated to adhere to the above-mentioned criteria in designing connecting territories in Ukrainian realities taking into account the fact that economic activity has led to the insularization of natural ecosystems (forests, natural reservoirs, swamps).

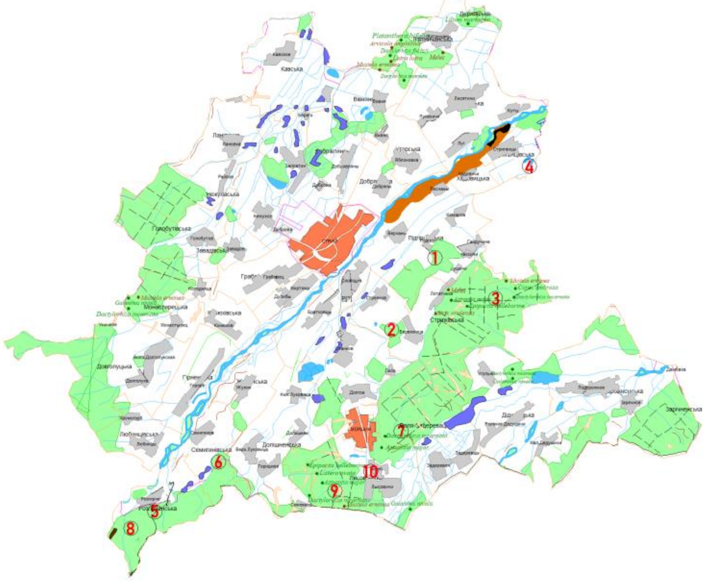


Fig. 1. Location of reserved objects and valuable species of flora and fauna within Stryi district: 1 – Monument of landscape art "Pidhirtsi park"; 2 – Park-monument of landscape art "Park of the 19th century"; 3 – Natural landmark "Birch wood"; 4 – Natural landmark "Yosypovychi"; 5 – Natural landmark "Rozhirche"; 6 – Natural landmark "Semyhyniv"; 7 – Landscape reserved area "Morshyn reserved area"; 8 – Complex natural monument "Baring of Vyhorodskyi sandstone"; 9 – Botanical natural monument "Franz Joseph's Oak"; 10 – Hydrological natural monument "Well №6"
(developed by authors)

Most of the projected migration routes consist of semi-natural lands (hayfields and pastures), and in some places from unnatural lands (mainly arable lands).

The criteria for establishing buffer zones are determined by the peculiarity of the crucial and connecting territories, and buffer territory is formed for their protection. The buffer zones in the ecological network are designed around crucial territories in those places where the risk of negative impact of anthropogenic activity on adjacent spaces (settlements, lack of natural lands, etc.) predominates. Arable lands are partially included in the buffer zones. One should conduct safe farming (organic) on these lands.

Renewable territories include territories the natural state of which has been disturbed due to human activity and territories with active expressions of negative geodynamic processes for which it is necessary and possible to recreate the natural vegetation and repatriate the species of flora and fauna (the transfer of artificially propagated plants to natural conditions). The area of the renewable territory can be attached to or become part of the crucial ecological networks, after taking appropriate measures for re-naturalization. One has recommended creating renewable territories within the region on agricultural land plots, including arable lands with medium-eroded soils (320 hectares) and waterlogged flood plain soils (1166 hectares).

The design ecological network of the district includes 5 crucial territories with a total area of 9335.97 hectares; 9 connecting territories with the total area of 2945.0 hectares; renewable territories with a total area of 4626.87 hectares; buffer zones with a total area of 1503.44 hectares. The total area of the structural elements of the ecological network is 18411.27 hectares (Fig. 2).

An estimation of the degree of connectivity of crucial territories of the design ecological network indicates the following: $\alpha = 1$ – indicates the sufficient number of alternative ways of migration of individuals from some crucial territories to others, that is, the ecological network ensures the fulfilment of the bio-migration function; $\beta = 2$ – points to several cycles, that is, most of the crucial territories are interconnected by connecting territories into a single whole; $\gamma = 1$ – indicates that each crucial area is bound by the connecting territory.

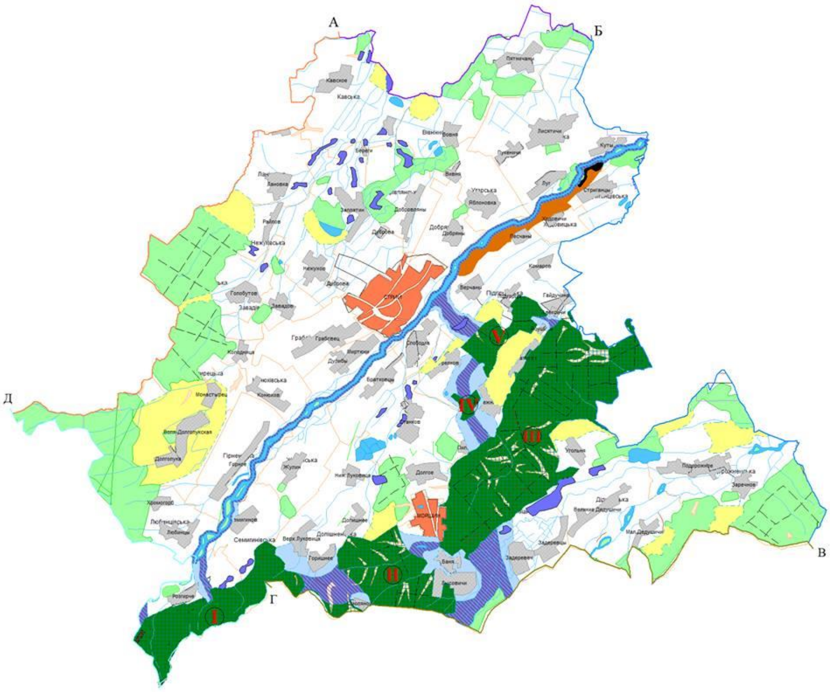


Fig. 2. The scheme of promising structural elements of the ecological network of Stryi district:
– crucial territories; – connecting territories; buffer zones,
– renewable territories (developed by the authors)

In general, the structural and functional system of the design ecological network includes: 1) reserved territories, which have a special regime of protection and use for the purpose of their conservation; 2) territories that were in economic (agricultural, forestry, and water industry) use but they should be transferred to the category of nature protection territories; 3) territories which will be in further economic use with some restrictions.

Therefore, one should consider the ecological network in two conceptual directions – strict nature protection and nature protection with controlled use of natural resources (Bennett G., 2004). That is, the concept of ecological networks is interconnected with the concept of ecosystem services. One explains ecosystem services as the potential of natural processes and components for the provision of goods and services used directly or indirectly to meet human needs. Moreover, these services perform regulatory functions, habitat functions, production functions, information functions. Habitat function lies in the fact that natural ecosystems provide living space for flora and fauna species. In turn, these species are of vital importance for the maintenance of most ecosystem functions, so support of habitat is an extremely principal prerequisite for the direct or indirect acquisition of goods and services for ecosystems (De Groot R. S., Wilson M. A., Boumans R. M. J., 2002). In this context, the biological and landscape diversity of the territories is a natural capital that provides people with air, water, soil, recreation areas, etc. In our opinion, this position should be placed in the strategy of social and economic development and planning of territories at the state, regional and local levels.

We believe that the formation of ecological networks of local importance is the basis for the establishment and maintenance of proper functioning of biosphere reserves, which perform three interrelated functions: the function of conservation of genetic resources, species, ecosystems and landscapes, the function of sustainable social and economic development, and inventory and logistics function to support demonstration projects, environmental education and training, as well as research and monitoring in the context of implementing local, national and global problems of preserving environment and sustainable development (Zahorodnii A., Cherinko P., Poltoratska T., 2014). The development of biosphere reserves is a regional task, but activities in this direction take place in obligatory and close cooperation with local governments and the local population. Despite the fact that Ukraine has a legal basis for the formation of ecological networks, the process is complex, lasting and has a number of problems. At the local level, it requires solving a set of tasks, among which we have identified the most relevant ones: an arrangement of the scheme of the ecological network with all landowners and land users; development and establishment of land use regimes for structural elements of the ecological network; development and implementation of measures for land re-naturalization. The fulfillment of these tasks requires the improvement of institutional and managerial mechanisms in the sphere of nature protection land use. First of all, it is necessary to develop an effective mechanism for encouraging landowners and land users to use resources; to increase investment in regulation and management of environmental activities; to ensure the appropriate level of environmental education and environmental public awareness campaign; to provide consulting services to local self-government bodies when developing ecological network development programs at the local level.

Conclusions and proposals

1. Ukraine supports the idea of conservation and renovation of biological diversity of territories due to the implementation of the concept of ecological networks, considering the existing legislation and drafts of design ecological network schemes at the regional level. However, the principle of the integrity of ecosystem functions, as well as the location of the objects of Nature Reserve Fund and valuable species of flora and fauna are not fully taken into account when designing structural elements of ecological networks of the regional level. In our opinion, one should resolve these issues at the local level, which will allow more detailed and objective analysis of the natural potential of the territories and the actual state of land use.
2. One has carried out the study on the development of an ecological network at the local level on the example of Stryi district of Lviv region, within which there are 10 objects of the Nature Reserve Fund, as well as 9 species of flora and 5 species of fauna which are listed in the Red Data Book of Ukraine. Natural vegetation is mainly preserved in forests, which perform mainly ecological functions, but forest lands are located fragmentarily. Expediency of developing an ecological network is obvious. It will allow forming a whole framework of protected areas in order to preserve the places of settlement and growth of valuable species of animal and plant life, ways of migration of animals due to a combination of objects of the Nature Reserve Fund.
3. An estimation of the degree of connectivity of the design crucial territories indicates the high efficiency of the migration function of the ecological network of the district. However, most of the migration routes (green corridors) are formed from semi-natural and unnatural lands (hayfields, pastures, arable lands), which complicates the practical side of the implementation of this project. It is necessary to improve administrative and institutional mechanisms in the sphere of nature protection land use, in particular: to develop tools for encouraging landowners and land users to carry out environmental activities; to increase investments in re-naturalization of lands; to carry out environmental public awareness campaign among the population; to provide consulting services on environmental protection.

References

1. Bennett G., Wit P. (2001) The Development and Application of Ecological Networks: a Review of Proposals, Plans and Programmes. Amsterdam: AIDEnvironment. 136 p.
2. Bennett G., Mulongoy K. J. (2006) Review of Experience with Ecological Networks, Corridors and Buffer Zones. Secretariat of the Convention on Biological Diversity, Montreal, Technical Series No. 23. 100 p.
3. Jongman R.H.G, Külvik M., Kristiansen I. (2004) European Ecological Networks and Greenways. Landscape and Urban Planning, No 68, pp. 305-319.
4. Opdam P., Steingröver E., Van Rooij S. (2006) Ecological networks: A spatial concept for multi-actor planning of sustainable landscapes. Landscape and Urban Planning, No 75, pp. 322-332.
5. Boitani L., Falcucci A. Maiorano L, Rondinini C. (2007) Ecological networks as conceptual framework or operational tools in conservation. Conservation Biology, No 21 (6), pp. 1414-1422.
6. Statistical Yearbook of Ukraine for the year 2017. Edited by Verner I. 540 p. (In Ukrainian)
7. On Ecological network (Law of Ukraine). June 24, 2004. № 1864-IV. URL: https://zakon.rada.gov.ua/laws/show/1864-15/conv (Accessed 2 March, 2019) (In Ukrainian)

8. Kahalo O. (2009) Building an Ecological network in Ukraine: Principles, Problems, Perspectives. L.: Institute of the Carpathian Ecology of the National Academy of Sciences of Ukraine. pp. 10–13. (In Ukrainian)
9. Kostiushyn V., Vasyliuk O., Kolomytsev H. An Indicative Scheme of the Ecological network of the Pivdennyi Bug River Basin and Methodical Approaches to the Creation of the National Ecological network of Ukraine. Kyiv: Institute of Zoology named after. I. Shmalhauzen of National Academy of Sciences, National Ecological Center of Ukraine, 2011. 28 p. (In Ukrainian)
10. Hrodzynskyi D. (1993) Foundations of Landscape Ecology: Manual. K.: Lybid. 224 p. (In Ukrainian)
11. State Enterprise "Stryi Forestry Enterprise». Official site. URL: http://stryi-lisgosp.com.ua/) (Accessed 6 February, 2019)
12. Nature and Reserve Fund of Ukraine: Official site. URL: http://pzf.menr.gov.ua/ (Accessed 12 February, 2019)
13. Deodatus F., Protsenko L. and others (2010) The Creation of Green Corridors in Ukraine. К.: "Printing House "BusinessPolygraph". 160 p. (In Ukrainian)
14. Bennett G. (2004) Integrating Biodiversity Conservation and Sustainable Use: Lessons Learned From Ecological Networks. IUCN, Gland, Switzerland, and Cambridge, UK. 55 p.
15. De Groot R. S., Wilson M. A., Boumans R. M. J. (2002) A Typology for the Classification, Description and Valuation of Ecosystem Functions, Goods and Services. Ecological Economics, No 41, pp. 393–408.
16. Zahorodnii A., Cherinko P., Poltoratska T. (2014) National Network of Biosphere Reserves of UNESCO in Ukraine (to the 40th anniversary of the National Committee of Ukraine on the UNESCO program "Human and Biosphere). Bulletin of the National Academy of Sciences of Ukraine, № 2, pp. 55-66. (In Ukrainian)

Information about authors:
Nataliia Stoiko, Ph.D, Associate Professor of Department of Land Organization of Lviv National Agrarian University. Address: Lviv-Dublyany, Ukraine, 80381, phone: +38 067 132 76 16, e-mail: n_stoiko@ukr.net
Fields of interest: land management, land use planning, environment protection.
Oksana Cherechon, Ph.D, Associate Professor of Department of Land Organization of Lviv National Agrarian University. Address: Lviv-Dublyany, Ukraine, 80381, phone: +38 097 530 09 33, e-mail: okcherechon@gmail.com
Fields of interest: environmental economics, organization of the territory, land protection.

DOI: 10.22616/j.balticsurveying.2019.008

ABANDONED LAND CLASSIFICATION USING CLASSICAL THEORY METHOD

Sužiedelyte Visockiene Jūrate[1], Tumeliene Egle[1, 2]
[1]*Vilnius Gediminas Technical University, Lithuania*
[2] *Vytautas Magnus University, Agriculture Academy, Lithuania*

Abstract
According to the official statistics the areas of abandoned agricultural land in Lithuania are gradually decreasing, but very slightly. The aim of this study is to research spatial determination and abandoned land classification in the territory of Vilnius District Municipality. Vilnius District Municipality was chosen for the research because it, although located near the capital of the country and has a high population density, it is still the district having the largest percent of abandoned land plots. A fast, cost-effective and sufficiently accurate method for determination of abandoned land plots would allow to constantly monitor, to fix changes and foresee the abandoned land plots reduction possibilities. In the study there was used the multispectral RGB and NIR colour Sentinel-2 satellite images, the layer of the administrative boundary of Vilnius County and layer of abandoned agriculture land, which is available in Lithuanian Spatial Information Portal (www.geoportal.lt). The data was processed by Geographic Information System (GIS) techniques using classical classification Region Growing Algorithm. The research shows that NIR image classification result is more reliable than the result from RGB images.
Key words: abandoned land, RGB, NIR, spatial resolution, Remote Sensing.

Introduction
Many countries, including Lithuania, analyze the problems of abandoned agricultural lands that are no longer used for their intended purpose. Robust data on agricultural abandonment is important to obtain though, because abandonment has strong environmental implications, affecting, for example, soil stability, carbon sequestration, water quality and nutrient cycling (MacDonald et. al., 2000; Moreira, Russo, 2007; Ramankutty et. al., 2007; Stoate et. al., 2001; Alcantara et. al., 2012). Therefore, better monitoring of agricultural land abandonment is essential to understanding the trajectories and determinants of agricultural land-use change and guiding land-use policies (Prishchepov et. al., 2012).
Properly defining abandoned agriculture is not easy. Because abandoned agricultural areas are in transition, the land-use change is without fixed patterns, and often non-linear (Lambin, Meyfroidt, 2011; Alcantara et. al., 2012). Abandoned agriculture is the result of a land owner's decision to reduce the intensity of use of land for agriculture (including grazing) for an undetermined period of time; based on either natural, socioeconomic, or personal constrains. The decision to abandon an agricultural area can precede the actual abandonment by months or even years, depending on the type of agricultural use, and even more time can expire before abandoned agriculture can be detected via remote sensing (Alcantara et. al., 2012). Vice versa, fallow periods are part of the typical crop rotation cycle, making it difficult to ascertain if a field has been truly abandoned or is just awaiting future use. However, as more time expires, it becomes more obvious that a field is abandoned, especially if shrubs and trees start to grow on former fields, since woody plants make it increasingly costly to start agricultural use again, and farmers will typically avoid woody growth on their fields (Alcantara et. al., 2012).
Due to high emigration of working age people Lithuania can be attributed to the regions with higher risk of farmland abandonment, therefore, it can be predicted that areas of abandoned land, especially in sparsely populated areas in Lithuania, may grow in the future.
In Lithuania abandoned land is identified using remote sensing methods, but only in the stage, when they are overgrown with woody plants. For and effective way to solve the problems of abandoned lands and to update the data it is important to choose modern, inexpensive but relatively accurate ways to determine abandoned lands and their size.
Information about land-cover could be derived from Remote Sensed data at various spectral bands images. The principle from of deriving land-cover information from remotely sensed images is

classification (Prasad, Thenkabail, 2016). Color has been a great help in identifying objects for many years. It is the by-product of the spectrum of light, as it is reflected or absorbed, as received by the human eye and processed by the human brain (Azmi et. al., 2010).
Authors using classical object classification method did research tests with RGB and NIR colour images.

Study area

The territory of Lithuania is divided into 10 counties. Vilnius District Municipality (Fig. 1), which is the part of Vilnius County, is selected for this research, because the majority of abandoned agricultural land evaluating the total area of each Municipality are situated in Vilnius District Municipality (Suziedelyte et. al., 2019). Abandoned agricultural areas are being identified by the state owned enterprise The National Land Fund (Order of the Minister, 2002).

Fig. 1. Study region - Vilnius district municipality (source: www.regia.lt)

Method of research and materials

The research data were collected from Lithuanian Spatial Information Portal (LSIP) www.geoportal.lt Data time: autumn 2018. Data sources (Fig. 2):

1. Sentenel-2 Red Green Blue (RGB) and Near-infrared (NIR) colour images in Lithuanian coordinate system (LKS94) (2018-09-07);
2. The layer of administrative boundary of Vilnius County in LKS94;
3. The layer of abandoned land in LKS94.

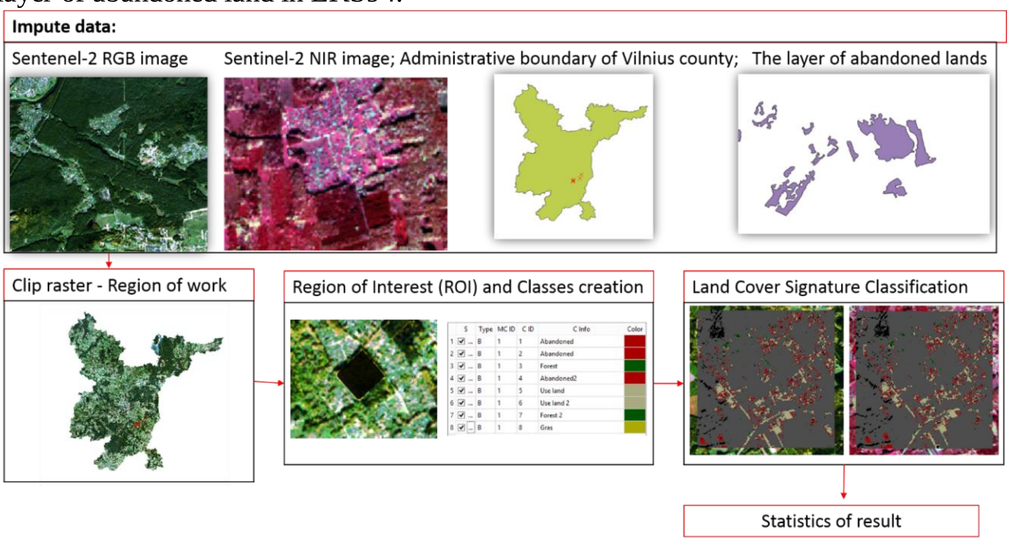


Fig. 2. Data and technological process of land classification

The principle and categories of deriving land-cover (vegetation species map) result from remotely sensed images is supervised (human-guided) or unsupervised (calculated by software) classification (or segmentation). The supervised classification could be performed by manual interpretation or automated. In the manual method operator digitalizing of the land-cover boundaries using GIS system, but this data is expensive and involving many work hours. The traditionally in classification used the clustering classification algorithms K-mean and ISODATA (Iterative Self-Organizing Data Analysis Technique A) involved iterative procedures by Distance Functions *Di(x)*. The Distance between pixels in feature space is the measure of similarity and scaled in pixels, radiance or reflectance. The relative distances may change when data are calibrated (digital counts ==> radiance) or atmospherically corrected or rescaled in ways that treat different spectral bands differently (CEE, 2018). Therefore, it is important to use for classification calibrated image. The K-mean is to reduce the variability within the cluster. Many variations of the K-means algorithm have been developed (CEE, 2018; Abbas et. al., 2016).

The ISODATA algorithm is essentially a refinement of the K-Means algorithm. The specific refinements are (CEE, 2018): clusters that have too few members are discarded; clusters that have too many members are split into two new cluster groups; Clusters that are too large (too disperse) are split into two new cluster groups; If two cluster centres are too close together they are merged. In the study authors are used the Region Growing Algorithm allows to select pixels similar to a seed (image) one, considering the spectral similarity (spectral distance) of adjacent pixels (Region Growing Algorithm, 2018). Land cover are identified to the classes and macro classes with an arbitrary ID codes. In this study we distinguished the vegetation Macro class (ID 1) and class names – abandoned land (ID1), forest land (ID2), land-user (ID3) and unclassified land. The spectral characteristics of reference land cover classes are calculated considering the values of pixels under each Regions of Interest (ROI) having the same Class ID (or Macro class ID). Therefore, the classification algorithm classifies the whole image by comparing the spectral characteristics of each pixel to the spectral characteristics of reference land cover classes. In case of pixels falling inside overlapping regions or outside any spectral region, it is possible to use additional classification algorithms (Minimum Distance, Maximum Likelihood, Spectral Angle Mapping) considering the spectral characteristics of the original input signature. All algorithms could be find in the references (Region Growing Algorithm, 2018; Richards & Jia, 2006). Minimum Distance algorithm calculates the Euclidean distance *d*(*x*,*y*) between spectral signatures of image pixels and training spectral signatures, according to the following equation (Region Growing Algorithm, 2018):

$$d(x,y) = \sqrt{\sum_{i=1}^{n}(x\_i - y\_i)^2} \qquad (1)$$

where: *x* – spectral signature vector of an image pixel; y– spectral signature vector of a training area; *n* – number of image bands.

The Euclidean Distance is 0 when signatures are identical and tends to increase according to the spectral distance of signatures. Therefore, the distance is calculated for every pixel in the image, assigning the class of the spectral signature that is closer, according to the following discriminant function (Richards and Jia, 2006). Maximum Likelihood algorithm calculates the probability distributions for the classes, related to Bayes' theorem, estimating if a pixel belongs to a land cover class. In particular, the probability distributions for the classes are assumed the form of multivariate normal models (Richards and Jia, 2006). In order to use this algorithm, a sufficient number of pixels is required for each training area allowing for the calculation of the covariance matrix. The discriminant function, described by Richards and Jia (2006), is calculated for every pixel as:

$$g_{k(x)} = \ln p(C_k) - \frac{1}{2} ln|\Sigma k| - \frac{1}{2}(x - y_k)^t \Sigma_k^{-1}(x - y_k) \qquad (2)$$

where: C_k – land cover class k; x– spectral signature vector of a image pixel; $p(C_k)$ – probability that the correct class is C_k; $|\Sigma k|$ - determinant of the covariance matrix of the data in class C_k; Σk−1 – inverse of the covariance matrix; y_k – spectral signature vector of class k.

The Spectral Angle Mapping calculates the spectral angle between spectral signatures of image pixels and training spectral signatures. The spectral angle θ is defined as (Kruse et. al., 1993):

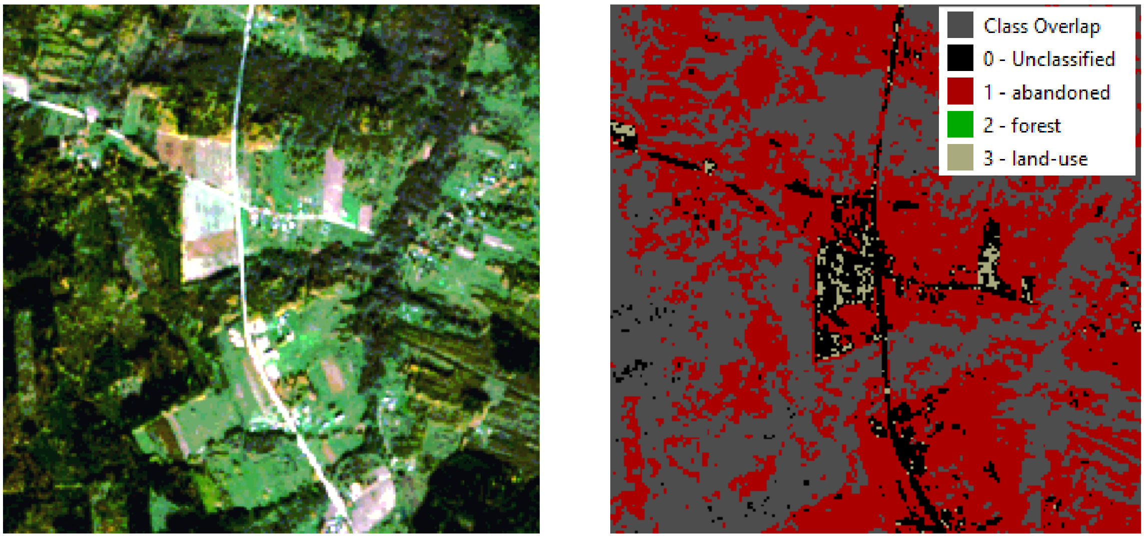
$$\theta(x,y) = \cos^{-1}\left(\frac{\sum_{i=1}^{n} x_i y_i}{\left(\sum_{i=1}^{n} x_i^2\right)^{1/2} * \left(\sum_{i=1}^{n} y_i^2\right)^{1/2}}\right) \qquad (3)$$

The spectral angle goes from 0, when signatures are identical, to 90 when signatures are completely different.

Discussions and Results

1.Results from RGB colour images.

RGB color images 10×10 m spatial resolution was obtained from LSIP. Land classification mode (abandoned, forest and land-user) in ROI 200×200-pixel square area and layer of abandoned agriculture land from LSIP was used for analysis. Digitalizing segment matching the abandoned land area in RGB colour images were separated. Forest and land-used area segments were also introduced. These objects are easily identifiable in the images. Classification according to the colour spectrum of entered objects was performed to use GIS technology. General result of created classes Fig. 3.



1) 2)

Fig. 3. RGB image classification result: 1) RGB image; 2) classification result

Besides the selected objects classes there is also unclassified objects (black colour) and class overlap objects (grey colour) visible in Fig. 3, part 2). The color spectrum of forest objects is identical to the color spectrum of abandoned land, so in the results the forest is an overlapping class. For more accurate assessment of classification characteristics between classes are presented (Table 1), they describe the compatibility of colour spectrum between classes.

Table 1

Characteristics between classes

Between Classes name-Class name	Spectral angle, θ ^{0}	Euclidean distance $d(x,y)$	Bray-Curtis similarity*, %
Abandoned – Forest	0,27	311,99	99,65
Abandoned – Land-use	1,02	1175,69	98,53
Forest – Land-use	1,28	1466,27	98,19

*The Bray-Curtis similarity is calculated as percentage and ranges from 0 when signatures are completely different to 100 when spectral signatures are identical.

Spectral angle θ close to zero between Abandoned and Forest classes shows that the classification between these classes overlaps. This is also evidenced by the high degree of similarity of color spectrum 99,65%. Better situation is when you compare Abandoned – Land-user and Forest – Land-user classes. Similarity of color spectrum is 98,53 % and 98,19 %. Results of classification of separate classes is showed in Fig. 4.

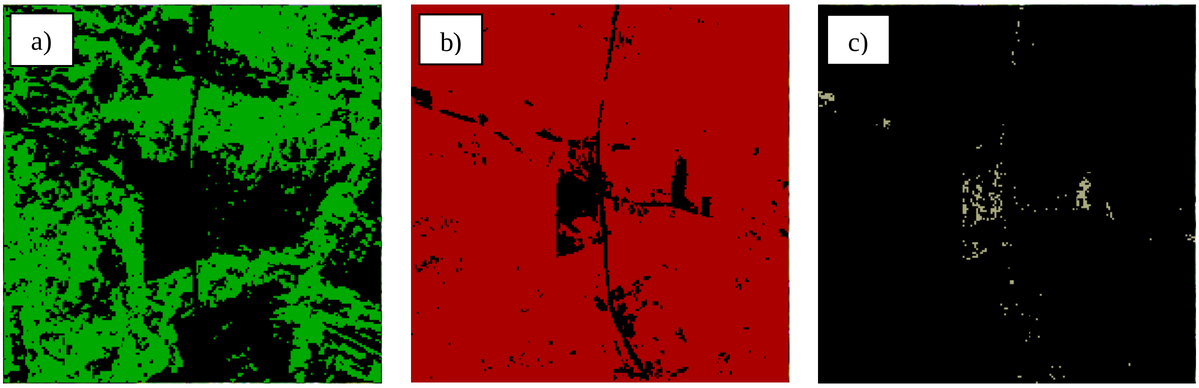


Fig. 4. Results of classification: a) forest land; b) abandoned land; c) land-use

From Fig. 4 it is clear that the biggest part of abandoned land consists from forest areas, small part from land-user class objects. In Fig. 5 presented a general view of forests and abandoned land classification images.

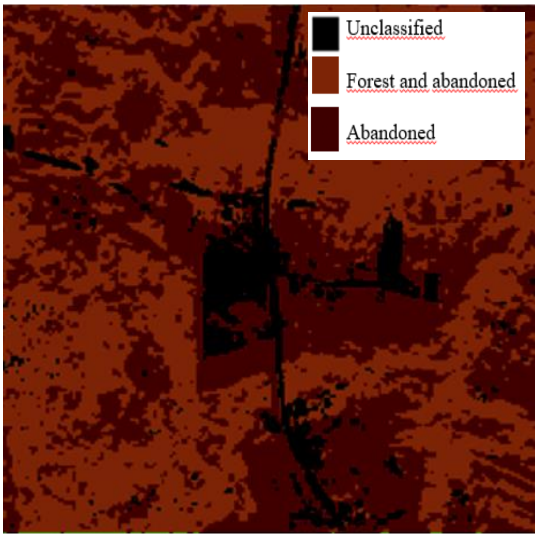
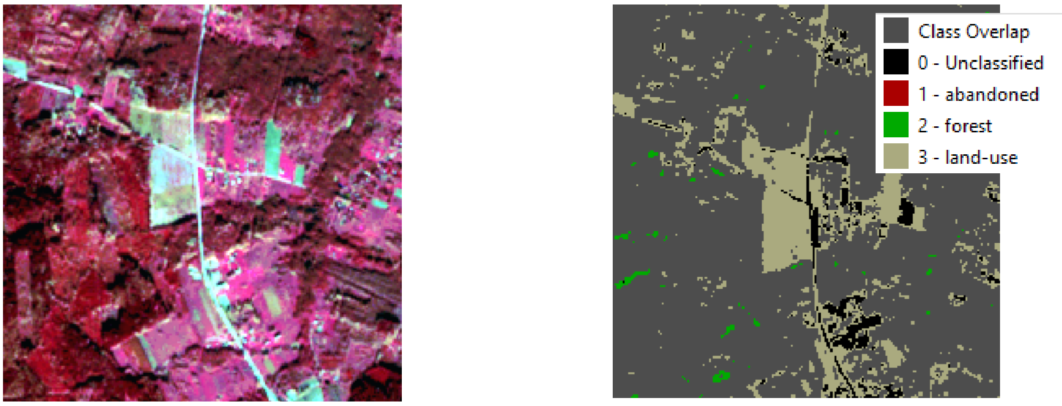


Fig. 5. A general view of forest and abandoned land classification

The dark brown colour in the Fig. 5 is an unclassified object in the forest classification result and abandoned land class object. Light brown colour – forest and an abandoned class together. Black colour – an unclassified land in the forest and an abandoned class. The dark brown layer has abandoned land segments, but the result must be checked and field measurements need to be performed.
2. Results from NIR colour images.
Land-cover classification result used Sentinel-2 NIR colour image data presented in Fig. 6.



1) 2)

Fig. 6. NIR image classification result: 1) NIR image; 2) classification results

To evaluate classification accuracy of NIR colour images characteristics between classes are presented in Table 2.

Table 2

Characteristics between classes

Between Classes name-Class name	**Spectral angle, θ ^{0}**	**Euclidean distance $d(x,y)$**	**Bray-Curtis similarity*, %**
Abandoned – Forest	4,63	335,29	89,82
Abandoned – Land-use	26,98	1311,14	76,24
Forest – Land-use	31,06	1522,89	68,73

Obtained classification results in this method are much better. Spectral angle between abandoned and forest classes is 4,63^0. Which means that colour spectrum results overlap between these classes but less than when the Sentinel-2 RGB colour data was used. Similarity of colour spectrum is 89,82 %. This result is also better than RGB. Compared results from other layers are also significantly better when Sentinel-2 NIR data used. The results from separate classes and merged layers of forest and abandoned lands are shown in Fig.7 and Fig. 8.

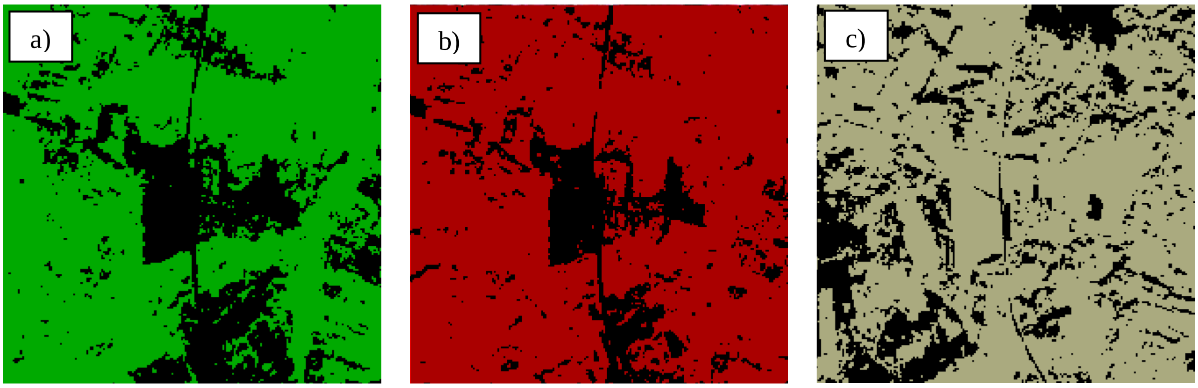


Fig. 7. Results of separate classes: a) forest; b) abandoned land; c) land-user

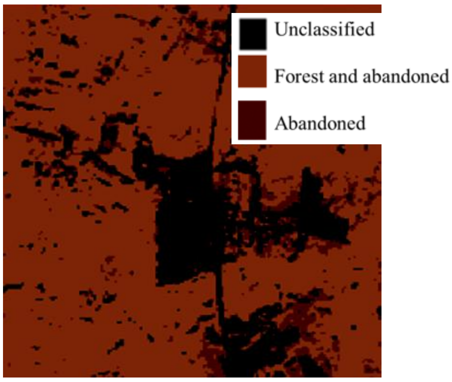


Fig. 8. Merged layers of forest and abandoned land

In the general drawing of forests and abandoned land the data of the dark brown layer is significantly less than what it was in Fig. 5. The inspected areas decreased, because the number of abandoned lands was reduced (Fig.8). A general drawing of classification results and abandoned land from LSIP is presented in figure 9.

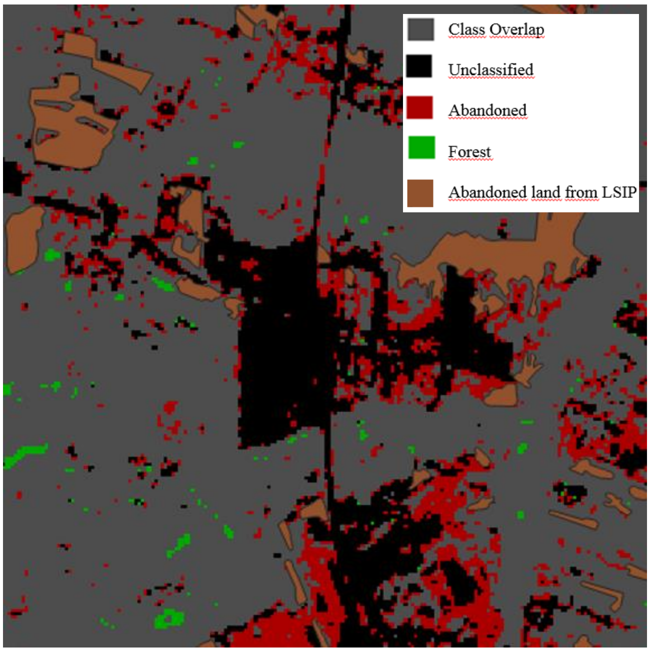


Fig. 9. A general view of the classification and the layer of abandoned land

Figure 9 shows that the abandoned land layer (from LSIP) not cover the abandoned land layer, identified by the classification method, everywhere. The classification results need to be checked locally. The discrepancy may also be due to the fact that the abandoned land from the LSIP layer has a fixed area of a smallest spatial object – 0,10 ha (Order of the Minister, 2013). When classification method was used the abandoned land of all sizes was identified. For more accurate result the higher image resolution should be used.

Conclusions and proposals

Region Growing Algorithm can be used to classify Sentinel-2 RGB and NIR data and be used to deduct the similarity of view pixels' colour spectrum of excluded classes. Research with 10×10 m spatial resolution RGB colour images shows that after the classification of forests, abandoned and used land, the colour spectrum similarity between the forest and abandoned land is 99%. The number of abandoned areas after the classification is high. To check the result field measurements, which are costly and require considerable time, should be carried out. The results from the NIR classification photos are about 10% better than the results of the RGB classification. The similarity of the colour spectrum of this data between forest and abandoned land classes is 89%. In a general view of forests and abandoned lands, areas of abandoned land are distinguished. Abandoned land areas in NIR photos are far smaller than in the RGB. Part of the abandoned land identified in the RGB image merges into the forest areas in NIR data.

The study shows that it is difficult to precisely distinguish abandoned lands because of the overlapping spectrum of abandoned land and forest classes. To solve this problem it would be appropriate to distinguish the classes of other lands: roads, waters, built-up areas, etc.

Image resolution also influences the result. The higher image resolution (0.25 - 1.0 m) – the more reliable classification result. However, this should be based on research. It would also be useful to perform the research with data from different seasons when the pixels colour spectrum of objects is different.

Clearly, the classification results need to be checked locally.

References

1. Abbas A. W.; Abid S. A. R.; Ahmad N.; Ali Khan M. A. (2016) K-Means and ISODATA Clustering Algorithms for Landcover Classification Using Remote Sensing. Sindh Univ., Res. Journal, 48(2):315-318.
2. Alcantara C., Kuemmerle T., Prishchepov A.V., Radeloff V.C. (2012) Mapping abandoned agriculture with multi-temporal MODIS satellite data. Remote Sensing of Environment, 124 (2012) 334–347.
3. Azmi M. A. S. B., Mazli N. B., Yusof Y., Hassan M. F. H. A. (2010) Study of RGB Color Classification Using Fuzzy Logic. ETERD’10 Proceeding 2010.
4. CEE 6150 (2018) Digital Image Processing. Unsupervised Classification. In the internet site: http://ceeserver.cee.cornell.edu/wdp2/cee6150/lectures/dip11_clustering_sp11.pdf
5. Kruse F. A., Lefkoff A. B., Boardman J. W., Heidebrecht K. B., Shapiro A. T., Barloon P. J., Goetz A. F. H. (1993) The spectral image processing system (SIPS)—interactive visualization and analysis of imaging spectrometer data. Remote Sensing of Environment, 44, 2–3: 145-163.
6. Lambin E. F., Meyfroidt P. (2011) Global land use change, economic globalization, and the looming land scarcity. Proceedings of the National Academy of Sciences of the United States of America, 108, 3465–3472.
7. MacDonald D., Crabtree J. R., Wiesinger G., Dax T., Stamou N., Fleury P., et al. (2000) Agricultural abandonment in mountain areas of Europe: Environmental consequences and policy response. Journal of Environmental Management, 59, 47–69.
8. Moreira F., & Russo, D. (2007) Modeling the impact of agricultural abandonment and wildfires on vertebrate diversity in Mediterranean Europe. Landscape Ecology, 22, 1461–1476.
9. Lietuvos Respublikos Žemės ūkio ministro įsakymas :Dėl žemės fondo apskaitos taisyklių patvirtinimo, 2002.(Order of the Minister of Agriculture of the Republic of Lithuania „On Approval of Land Fund accounting rules“). “, 2002, 7th of August, No. 302, Vilnius. (in Lithuanian)
10. Lietuvos Respublikos Žemės Ūkio Ministro Įsakymas „Dėl Apleistų Žemės Ūkio Naudmenų Plotų Nustatymo Tvarkos Aprašo Patvirtinimo. 2013 (Order of the Minister of Agriculture of the Republic of Lithuania, 2013. On Approval of the Description of the Procedure for the Determination of Abandoned Farmland Land Areas"),., 21th of Marth, No. 3D-212, Vilnius. (in Lithuanian).
11. Prasad S., Thenkabail. (2016) Remotely Sensed data characterization, classification, and accuracies. Taylor @ Francis Group, LLC.
12. Prishchepov A. V., Radeloff V. C., Baumann M., Kuemmerle T., Müller D. (2012) Effects of institutional changes on land use: Agricultural land abandonment during the transition from state-command to market-driven economies in post-Soviet Eastern Europe. Environmental Research Letters, 7, 024021 (13 pp.).
13. Ramankutty N., Gibbs H. K., Achard F., DeFries R. S., Foley J. A., & Houghton R. A. (2007) Challenges to estimating carbon emissions from tropical deforestation. Global Change Biology, 13, 51–66.
14. Region Growing Algorithm. In the internet site: https://fromgistors.blogspot.com/p/user-manual.html?spref=scp
15. Richards J. A., Jia X. (2006) Remote Sensing Digital Image Analysis: An Introduction. Berlin, Germany: Springer.
16. Stoate C., Boatman N. D., Borralho R. J., Carvalho C. R., Snoo G. R. D., Eden P. (2001) Ecological impacts of arable intensification in Europe. Journal of Environmental Management, 63, 337–365.
17. Suziedelyte Visockiene J., Tumeliene E., Maliene V. (2019) Analysis and identification of abandoned agricultural land using remote sensing methodology. Land Use Policy, 82 (2019) 709–715.

Information about authors:
Eglė Tumelienė, PhD student at the Institute of Land Management and Geomatics, Vytautas Magnus University Agricultural Academy. Address: Universiteto str. 10, LT-53361 Akademija, Kauno r., Lithuania. Lecturer at Department of Geodesy and Cadastre, Vilnius Gediminas Technical University, Sauletekio av. 11, Vilnius, LT-10223, Lithuania e-mail: egle.tumeliene@vgtu.lt

Jūratė Sužiedelytė Visockienė, prof. at Department of Geodesy and Cadastre, Vilnius Gediminas Technical University, Sauletekio av. 11, Vilnius, LT-10223, Lithuania, e-mail: jurate.visockiene@vgtu.lt

DOI: 10.22616/j.balticsurveying.2019.009

PUBLIC ADMINISTRATION OF AGRICULTURAL LAND: CASE OF SAMARA REGION

Alexandr Vlasov[1], **Darya Vasilieva**[1], **Velta Parsova**[2]
[1]Samara State University of Economics, [2]Latvia University of Life Sciences and Technology

Abstract
As result of land reform in Russian Federation the public administration of agricultural land has been totally transformed. Land reform was carried out in order to solve problems in the sphere of agriculture, housing construction, ecology, creating a plurality of land ownership forms, introducing land use payments, etc. The decision to cancel monopoly of state ownership in land and to create institution of private property was made. The land redistribution projects for each farm were made, where stock of shares, stock of land redistribution and stock of land administered by previous soviet village councils was represented.
The example of the Samara region was used to develop mechanisms for transfer of public land to private ownership. Currently, the situation with use of the land in many agricultural enterprises can be considered as unsatisfactory due to unsystematic economic activity - there are no or are not implemented scientifically based crop rotations, natural soil fertility is not taken into account, there is no modern cartographic material indicating the size of the fields, degree of slope and degree of erosion. Significant deterioration of the agro-ecological situation and the spread of negative processes on arable land require changes in national land policy and development of comprehensive measures to organize rational use of land. In the near future, a significant modernization of national and federal land legislation is planned, which will affect all subjects of the Russian Federation in terms of the management and use of agricultural land.
Key words: crop rotation, erosion, private property, public administration, soil fertility.

Introduction

Agricultural land has high importance for national food security. As result of land reform the total transformation of state administration over agricultural land was implemented. Land reform was carried out in order to solve problems in the sphere of agriculture, housing construction, ecology, creating a plurality of land ownership forms, introducing land use payments, etc. A large number of scientific publications are devoted to discussing the results of land reform in the field of state land management, especially about agricultural land category (Волков, Хлыстун, 2018; Volkov, Cherkashina, 2018; Khasaev, et.al., 2018; Кресникова, 2015; Дмитриева, et.al., 2015).
Since start of land reform the law "On land reform" and "On peasant (farmer) holdings" has been entered into force. Land Code and the Law on Land Payments, adopted in 1991, allowed the emergence of various forms of land ownership. As exception the right to private property referred to the land used for farming, because land was excluded from civilian circulation and moratorium on the purchase - sale of land for 10 years was introduced. Moratorium was canceled in 1992 in relation to land for gardening, individual housing construction and personal subsidiary farming. Further development of land reform was given by Decree of President of the Russian Federation No. 323 (27.12.1991) "On urgent measures for implementing land reform in the Russia", which provided the process of reorganization of larges agricultural enterprises and allotment of land shares to the employees of these enterprises. In accordance with the Decree of the President of the Russian Federation No. 1767 (10.27.1993) "On regulation of land relations and development of agrarian reform in Russia", the decision to abolish the monopoly of state ownership to land and emergence of the institution of private property was made. After that land redistribution projects for all farms were developed, in which were allocated:

- stock of shares in land (shares were given to employees of state and collective farms, as well as to employees of service holdings;
- stock of land redistribution (for internally displaced persons, military personnel, students, etc.);
- stock of land administered by previously existing village councils (land was used to expand the area of settlements, as well as for grazing livestock by settlements residents, etc.).

The aim of the article is to study current condition of management problems of agricultural land at the regional level on the example of the Samara region. To achieve this goal, the following tasks were solved:

- analysis of current land stock condition in the region in general and, particulary, agricultural land;
- dynamics over last 10 years based on statistical reports on condition and use of land in Samara region and Russian Federation in general;
- identification of management of land stock mechanisms, of most acute problems;
- proposals for solutions of problems at regional and federal level.

In the process of implementing the reform on territory of Russia, the example of Samara region was used to develop mechanisms to transfer the land from state ownership to private ownership. One of the first regional law "On the land of the Samara Region" was adopted in studied region, which was tested at scientific and practical meetings in Germany and Austria. Significant part of this regional law was used in the development of the Land Code of the Russian Federation adopted in 2001. In 2000, under governance of the President of the Russian Federation in the Samara took place the meeting on agrarian issues. The government of Russia included the Samara region in the pilot projects of *Laris* and *Tacis*, which provided support for progress of land reform on land transfer to private ownership.

Methodology of research and materials

Annual reports on the situation and use of the land stock and agricultural land both of Russian Federation and Samara region over past 10 years have been analysed. There have been used an information given by Ministry of Agriculture of the Russian Federation and other authorities of national and regional level as well. Based on this analysis the dynamics of agricultural land category areas, as well as changes in the areas of some types of land use, e.g., arable land, fallow land, etc. have been showed. In the paper an authority of various ministries and departments on land management issues have been examined, current situation in the regulatory framework and directions of its modernization after approval of planned federal laws in field of agricultural land management have been analysed.

Discussions and results

Samara region is part of the Volga Federal District. Agricultural land category dominates (76%) in the composition of the land stock of the region. This makes Samara region different from the land stock of the Russian Federation, where forest land category dominates (66%) (Папцов, 2009; Власов, et.al., 2013).

Agricultural land generally is located outside of boundaries of settlements, it is allocated and intended for agricultural purposes. Agricultural land generally is used by agricultural enterprises, organizations for production of agricultural products, research and training purposes, by citizens – for peasant farming, personal subsidiary farms, horticulture, livestock farming, haymaking and cattle grazing. Agricultural land also includes:

- land of land redistribution stock which is created for the purpose of land redistribution for agricultural production, creation and expansion of peasant farms, personal subsidiary farms, gardening and other agricultural purposes;
- agricultural land plots located outside of settlements boundaries and assigned to rural administrations.

On 01.01.2018 agricultural land in Samara region occupied an area of 4.1 million hectares. To compare with 2016, area of this land category has decreased by 0.2 thousand hectares due to their transfer to enlargement of settlements. Total area of agricultural land in frame of agricultural land category is 3.8 million hectares or 93%. Breakdown of total area of agricultural land is: arable land - 70%, fallow land - 3%, orchards - 1%, meadows - 1% and pastures - 19 % (Воронин, et.al., 2014). Investigation of quantitative and qualitative dynamics of agricultural land area in the Samara region is given in the table 1.

Land Code of the Russian Federation defines that agricultural land has priority in use and is the subject to special protection. So, over the past 10 years the following dynamics can be traced - area of agricultural land has been gradually decreased both generally in the Russian Federation and in Samara region.

Table 1

Dynamics of changes of the area of agricultural land

Indicators	2008	2010	2013	2016	2017
in Russian Federation, million hectares					
Area of agricultural land	402	393	386	384	383
Arable land in composition agricultural land	115	115	115	116	X
Area of fallow land in composition of agricultural land	4	4	4	4	X
in Samara region, thousand hectares					
Area of agricultural land	4106	4089	4070	4067	4067
Arable land in composition of agricultural land	2915	2871	2858	2858	2858
Area of fallow land in composition of agricultural land	57	95	105	104	103

Source: own elaboration, using statistical data of annual reports

At the same time at federal level area of arable and fallow land has not been changed. Whereas in Samara region area of arable land decreased by 56 thousand hectares. Since 2008 the area of fallow land has noticeably increased, however since 2013 the area of arable land has slightly increased due to ploughing of small areas of fallow land (Fig. 1) (Воронин et.al., 2014).

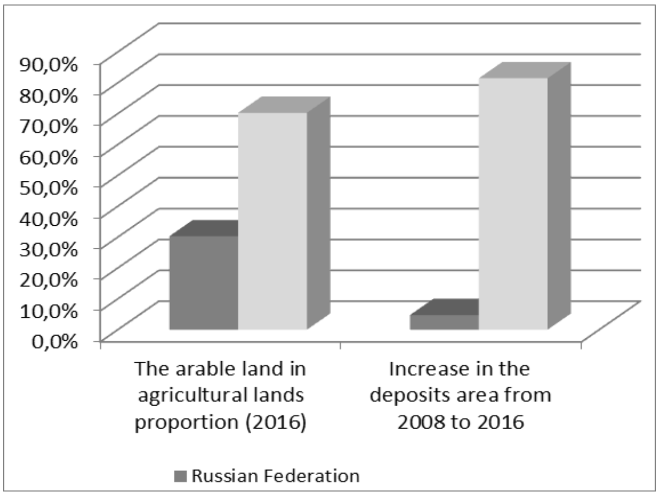


Fig.1. Comparison of breakdown of arable land and fallow land in Russian Federation and Samara region

On the territory of Russian Federation the agrochemical and ecological toxicological indicators in the soil, as well as changes in the structure of soil cover and the development of negative processes are monitored. These activities are carried out by federal state institution “Center and stations of the agrochemical service” and “Centers of agricultural radiology”, which are subordinate to Ministry of Agriculture of the Russian Federation. Monitoring of soil cover and soil fertility indicators is carried out at intervals of 5 - 12 years, annually covering only 8-10% of agricultural land of the Russian Federation (Государственный (национальный) доклад …, 2018). Results do not fully reflect the real situation (Доклад о состоянии ..., 2018). There is going on development of negative processes on agricultural land: wind and water erosion, salinization, rise of groundwater level, etc.

Wind erosion (deflation) is the most susceptible to arable land soil in Volga Federal District. Results of the survey in 2016 showed that 469 thousand hectares or 33% of the total area in Russian Federation were identified as exposed to wind erosion. Water erosion is widespread in all regions of the Russian Federation, but the largest areas are identified in Volga Federal District. According to the monitoring data in 2016 was identified salinization of soil on the territory of 3% of total arable land surveyed in Russian Federation. The largest area of saline land was identified in North Caucasus Federal District. Areas of wetland soils were identified on territory of 4% of total arable land surveyed in 2016, mainly such land is located in North-West Federal District. It should be noted that the cultivated area in Russian Federation has decreased from 118 million hectares in 1990 to 80 million hectares in 2016. At the same time yield of main crops, for example, grain and leguminous crops, increased from 19 (in 1990) to 26 (in 2016) cent./ hectare (Государственный (национальный) доклад …, 2018).

On the territory of the Samara region last soil survey of fertility indicators of agricultural land was carried out in 2002 - 2004 for the purpose of statistics, and so far data from this survey are available, although they are undoubtedly outdated. For the period between survey in 1991 - 1992 and survey in 2002 - 2003 on agricultural land were identified negative processes as follows – content of humus on average decreased by 0.2%, annual loss of humus was 0.4 t/ ha. Area of moderate humus soils decreased by 2% and area of low-humus and weakly humus soils increased accordingly by 0.3% and 1.4%. Area of agricultural land exposed to water erosion and wind erosion has not changed. Area of wetland and swampy agricultural land increased by 0.3% due to flooding and rise in the level of groundwater. The area of re-saline soils decreased due to reduction in the area of irrigated land (Воронин et.al., 2014).

Problems of state management of the land stock, including the category of agricultural land, currently are related to the fact that in the Russian Federation there is no single authority for managing the land resources. Authorities are distributed between following authorities:

- Federal State Service of registration, cadastre and cartography (*Rosreestr*);
- Federal Service for Supervision of Natural Resources Management (*Rosprirodnadzor*);
- Federal Service for Veterinary and Phytosanitary Surveillance (*Rosselkhoznadzor*);
- Federal Agency for Use of Entrails of the Earth (*Rosnedra*).

Rosreestr performs the functions of state registration of rights to real estate and transactions with it, state cadastral real estate registration, land management, state land monitoring, geodesy and cartography, navigation support for the transport complex, state cadastral valuation, etc. By 2017 Cadastral Chamber fulfilled duties in the field of cadastral registration, formation and storage of State Real Estate Cadastre documents, registration of real estate ownership rights and transactions with them, as well as issues of cadastral valuation and inventory of all real estate objects - structures, buildings, premises, etc. Since2017 functions of cadastral registration and registration of rights are concentrated in the Rosreestr. An important issue now is the execution of work on the preparation of documents describing location of the boundaries of zones with:

- special conditions for use of territories;
- territories of cultural heritage objects;
- territories of advanced socio-economic development;
- zones of territorial development;
- gambling zones;
- forest areas and forest parks;
- especially protected natural territories;
- special economic zones;
- hunting grounds, etc.

Since 2017 in state cadastral evaluation should be involved specially created state budgetary institutions, which also should be responsible for disputing of cadastral value of real estate objects. In Samara region such an institution was established in end of 2018.

Rosprirodnadzor is subordinate to Ministry of Natural Resources and Ecology and performs the functions:

- control of land recultivation after completion of mining of mineral deposits;
- implementation of measures to improve land quality and protect the soil from wind and water erosion.

Rosselkhoznadzor is subordinate to Ministry of Agriculture. On agricultural land it carries out control over implementation of measures on:

- conservation and reproduction of fertility of agricultural land soil, including reclaimed land;
- fulfillment of requirements for prevention of unauthorized removal, movement and destruction of fertile soil layer;
- damage to land as a result of violation of the rules for handling pesticides, agrochemicals or other substances hazardous to human health and the environment, as well as production and consumption of waste.

Rosnedra is subordinate to the Ministry of Natural Resources and Ecology, it performs the functions on:

- issue and registration of licenses for use of the entrails of the earth;
- issue of conclusions about absence of entrails of the earth under building sites of the upcoming construction;
- issue of permissions for construction of buildings on building sites with entrails of the earth under them.

So, in Russian Federation rights in land management are dispersed across different authorities - ministries and departments, which lead to reduced responsibility for effectiveness of land use and protection.

Currently, the state of land in greatest part of agricultural enterprises of Samara region can be considered as not quite satisfactory due to unsystematic economic activity. They do not apply scientifically based crop rotations, placing crops in an agrolandscape is carried out without taking into account the natural fertility of the soil, there is no modern cartographic material indicating the size of the fields, slope steepness and level of eroded areas. Dominance of grain crops and sunflowers in cornfields with an insignificant application of mineral fertilizers reduces the nutrient reserves in the soil. Therefore significant deterioration of agro-ecological state and the spread of negative processes on arable land require the changes in national land policy and the development of comprehensive measures to organize the rational use of land by agricultural enterprises.

It is planned that in 201 - 2020 in Russian Federation significant modernization of federal legislation relating to land issues will be implemented. These changes will affect all subjects of the Russian Federation in terms of the management and use of agricultural land. Because this category of land prevails in Samara region, changes in federal legislation will have significant consequences. One of the most significant purposes is the abolition of land categories. Taking into account the presence of great number of natural monopolies - gas and oil production companies, oil refining companies, main pipelines, etc., abolition of land categories will affect the region to a large extent, especially in terms of agricultural land the protection and rational use of agricultural land.

Conclusions and proposals

In 2018 in the Russian Federation has been adopted the legislative act “On approval of the plan of measures to improve the legal regulation of land relations”. Author’s consideration is that most important it is to adopt on the federal level legislative acts, providing:

- protection against unwarranted and/ or unreasonable changes of permitted use of the land plot;
- transition from land categories to territorial zoning;
- allocation of especially valuable agricultural land to the separate territorial zone, as well as establishment of criteria for assignment to such land;
- restriction of placement on agricultural land of objects not related to agricultural production;
- improvement of the system of inventory of agricultural land;
- adjustment of requirements of land management activities.

On the regional level it is necessary to carry out:

- reclamation, including cultural engineering activities associated with involvement of degraded and disturbed land in use;
- organization of full inventory of land and sustainable monitoring of land use;
- monitoring of law enforcement practice of federal laws in the field of land relations.

References

7. Khasaev G., Vlasov A., Vasilieva D., Parsova V. (2018) Trends of development of agrolandscapes in Samara region as result of land reform. Proceedings of 17th International Scientific Conference ”Engineering for Rural Development”. pp. 630-634.
8. Volkov C.H., Cherkashina E.V. (2018) Transfer into use of unused agricultural lands: significance, challenges, solutions. International Agricultural Journal. Volume 61. № 4. p. 4.
9. Власов А.Г., Воронин В.В., Васильева Д.И. (2013) Структура и оценка качества земель Самарской области (Structure and assessment of the quality of lands in the Samara region). Проблемы региональной экологии, №4. 2013. с. 109-116. (in Russian)
10. Волков С.Н., Хлыстун В.Н. (2018) Актуализация системы управления земельными ресурсами агропромышленного комплекса (Updating the land management system of the agro-industrial complex. Международный сельскохозяйственный журнал № 6 (366). с. 5-7 (in Russian)
11. Государственный (национальный) доклад о состоянии и использовании земель в Российской Федерации в 2017 году (2018) (State (national) report on the state and use of land in the Russian Federation in 2017), Федеральная служба государственной регистрации, кадастра и картографии. Москва, 197 с. (in Russian)
12. Дмитриева О.А., Кайдалова О.С., Кармолицкая Л.А. (2015) Практика управления и распоряжения государственными землями сельскохозяйственного назначения в Белгородской области (Practice of management and disposal of state agricultural lands in the Belgorod region). Труды Международной научно-практической конференции „Аграрная политика России в условиях международной и региональной интеграции”, с. 124-129 (in Russian)
13. Доклад о состоянии и использовании земель в Самарской области в 2017 г. (2018) (Report on the state and use of land in the Samara region in 2017). Управление Федеральной службы государственной регистрации, кадастра и картографии по Самарской области, Самара (in Russian)
14. Доклад о состоянии и использовании земель сельскохозяйственного назначения Российской Федерации в 2016 году (2018) (Report on the status and use of agricultural land in 2016) – Москва, ФГБНУ “Росинфорагротех”. 240 с. (in Russian)
15. Воронин В.В., Власов А.Г., Васильева Д.И. Мост Е.С. (2014) Опорный каркас развития территории (The basic framework of territorial development). Экология урбанизированных территорий №2, с. 41-49.
16. Кресникова Н.И. (2015) Государственное управление в сфере использования земель сельскохозяйственного назначения России (State administration in the use of agricultural land in Russia) Управленческие науки № 4. с. 42-51 (in Russian)
17. Кресникова Н. И. (2014) Разработка регламентов сельскохозяйственного землепользования (Development of regulations for agricultural land use). АПК: экономика, управление № 7. с. 28–34 (in Russian)
18. Папцов А. (2009) Правовое обеспечение землепользования в сельском хозяйстве развитых стран (Legal support of land use in agriculture of developed countries) АПК: экономика, управление № 9. с. 85-88 (in Russian)
19. Пашута А.О., Солодовникова М.П. (2015) Мониторинг земель сельскохозяйственного назначения как метод государственного управления земельными ресурсами (Monitoring of agricultural land as a method of state land management). Вестник Воронежского государственного аграрного университета № 3 (46). с. 245-252 (in Russian)

Information about authors:
Alexander Vlasov. PhD, Head of the Department of Land management and cadastre of Samara State University of Economics. Address: Russia, 443090, Samara, Soviet Army street 141, phone +7(937)799-08-86, e-mail: kaf-zik@yandex.ru
Darya Vasilieva. PhD, Associate Professor of the Department of Land management and cadastre of Samara State University of Economics. Address: Russia, 443090, Samara, Soviet Army street 141, phone +7(927)200-30-78, e-mail: vasilievadi@mail.ru
Velta Parsova. Dr.oec., professor, Department of Land Management and Geodesy of Latvia University of Life Sciences and Technologies. Address: 19, Akademijas str., Jelgava, LV-3001, phone: +371 29118285, e-mail: velta@parsova.lv

DOI: 10.22616/j.balticsurveying.2019.010

ENVIRONMENTAL PROBLEMS OF AGRICULTURAL LAND USE IN THE SAMARA REGION

Zudilin Sergey, Konakova Alyona
Samara State Agricultural Academy, Russia

Abstract
The zones of ecological trouble cover about 15% of the territory of Russia, where the main production capacities and the most productive agricultural lands are concentrated. The Samara region is characterized by a distinct natural zonality from a typical forest-steppe in the North with a forest cover close to 30%, to an open dry steppe in the South with a natural forest cover of only 0.1...0.2%. The article presents an analysis of land use in the Samara region on the example of the Borsky municipal district. Research methods include environmental analysis and statistical data analysis.The article presents an analysis of the land use of the Borskiy municipal district. During zoning, the territory of the district is divided into the northern, central and southern parts. Assessment of environmental and economic parameters showed heterogeneity of the territory and the need for detailed consideration of climatic, soil, economic conditions in the design of landscape optimization systems, even in the municipal area. In general, the district's land fund experiences an average anthropogenic load, the ecological stability of the territory as a whole is characterized as unstable stable. In comparison with other areas of the Central MES, the municipal Borskiy district belongs to the category with an average ecological intensity with a stabilization index of 0.59 units due to the beneficial influence of the Buzuluksky area.
Key words: anthropogenic, influence, factor, ploughing of the territory; ecological stability of the territory

Introduction

The development of agriculture and agriculture in General puts the issues of improving the use of land resources at the forefront in the overall system of measures aimed at improving the efficiency of public production. Problem: rational use of land in a variety of forms of ownership and management of the land includes a set of measures to further intensify land use and improve soil fertility through the widespread introduction of science and best practices (Клюшин, Марин, 2011).

At present, up to 40 million hectares of arable land have been abandoned in the Russian Federation, 16 million hectares have been overgrown with bushes and trees, and 58 million have been eroded. In turn, most users want to "squeeze" the maximum profit without thinking about the consequences for the earth. The ecological trouble zones cover about 15% of the territory of Russia, where the main production facilities and the most productive agricultural land are concentrated, and most importantly, more than 60% of the population lives here (Мусаев, Шаповалов, 2016). The processes of land degradation and desertification are a serious social and environmental problem of society as a result of the irrational use of natural resources, complicated by the tension of natural factors and economic activities (Клюшин, Марин, 2011).

Rational organization of land use, soil fertility preservation and land degradation protection are impossible without proper consideration of climatic conditions of the area. For the agricultural sector, the issues of formation of the natural resource potential of the territory, their interrelation, interaction and efficiency of use are extremely important. An objective analysis of natural conditions and factors is necessary in the development of a set of measures to restore and stabilize agroecosystems.

Discussions and results

Samara region is located in the South-Eastern part of the European part of the Russian Federation in the middle reaches of Europe's largest Volga River and occupies 53.6 thousand km^2, which is 0.32% of Russia's area. The territory of the region stretches from North to South for 335 km and from West to East for 315 km.the region is characterized by a clearly pronounced natural zoning from the typical forest-steppe in the North with forest cover close to 30 %, to the open dry steppe in the South with natural forest cover of only 0.1...0.2%. Three natural-economic zones are distinguished in the region:

Northern – forest-steppe, Central-transitional, southern – steppe. The Northern zone includes 8 municipal districts of the region, the Central - 12 and the southern – 7.

The territory of the Central natural and economic zone of the Samara region, which includes the Bor municipal district, is 25.6 thousand km2. The agricultural turnover includes 17.02 thousand km^2, their arable land occupies 12.88 thousand km^2, hayfields and pastures – 3.75 thousand km^2, perennial plantations – 0.39 thousand km^2.

The territory of the municipal district Borsky occupies the South-Eastern part of the Samara region and has an area of 2102.9 km^2, of which agricultural land -72.6 %, forests -18.5 %, under water and swamps 1.6% of the total area of the district. The land is suitable for the cultivation of grain, fodder and vegetable crops.

Geomorphologically, the Borsky municipal district is located on the watershed of the Maly Kinel-Chapayevka Rivers and is represented by two watersheds of the Kutuluk – Maly Kinel, Kutuluk – Samara rivers, as well as floodplains and floodplains.

The territory of the region is located in the zone of moderate continental climate and belongs to the III agro-climatic region of the Samara region with low moisture. The average long-term amount of precipitation in the area is 413 mm. the Hydrothermal coefficient of the area is 0.7-0.8 (Климат Самарской области … 2006).

According to the natural and agricultural zoning of the Russian Federation, the Northern part of the district, located North of the Samara river, belongs to the pre - Ural province of the forest-steppe zone, the southern part of the district-to the Zavolzhsky province of the steppe zone.

The relief of the territory of Borsky municipal district is of the hilly ridge. A wide undulating plateau watersheds transform them into flat and sloping slopes. The southern slopes to the rivers Samara and Kutuluk are sloping, sometimes steep, rugged ravines and beams. The Northern slopes are flat, long, gradually passing into the floodplain terraces and floodplains. In General, the relief of the district is relatively leveled.

In the soil cover of the district, located North of the Kutuluk River, is dominated by typical chernozems, less common leached chernozems, typical carbonate and typical residual carbonate.

The Central part of the region, represented by the water divide of the rivers Samara-Kutuluk, is characterized by the greatest variety of soil differences. On the elevated parts of the relief formed and leached Chernozem typical Chernozem, typical carbonate - on undulating slopes typical of residual-carbonaceous - on steep slopes, black soil of the ordinary - on the gentle Northern slopes.

In the southern part of the area is dominated by ordinary chernozems, have a small distribution of southern chernozems.

In soil terraces dominate the black residual-Lugovaya-typical and ordinary. A large area on the terrace above the floodplain of the Samara river Sands is loosely held.

In the structure of the land fund of the Borsky municipal district, the largest share is agricultural land – 72.2% and land of specially protected areas – 20.6%. The share of land settlements accounted for 4.9%, industrial land, transport and other special purpose – 1%, forest land – 0.8 %. The water Fund of the district includes surface water bodies, as well as land allocated for the drainage of hydraulic and other structures necessary for the use of water bodies and is 0.4%, there is no reserve land in the Bor municipal district (Отчеты о состоянии ..., 2017).

The total area of agricultural land of the district is 142274 hectares, including arable land - 107624 hectares, perennial plantations - 174 ha of the Plowed area is 52.2% of the land area, destabilizing the ecological situation, more than 70% of agricultural land (table 1).

The area of soil subject to water erosion in the area is 30673 hectares, which is 21.5% of the total area of agricultural land, of which poorly washed - 17%, average washed - 2.3% and heavily washed - 2.2%.

The average humus content in the arable soil layer of the district is 4.5 %. Fluctuations in the boundaries of the study area are quite significant: from 3.5% -4.0% (southern and South-Eastern part), to 5.2-6.6% (Northern part). The balance of humus on arable land in the district over the past decade is negative, so in 2015 it is equal to 0.07 t/ ha (Научно-производственный отчет ..., 2016).

Increased area of wetland soils that cause delay in the timely processing, 682 hectares are waterlogged, causing the impossibility of processing on 264 hectares identified again waterlogged soil (causing the inability to proceed).

Analysis of the quality of land in the Borsky district, showed the decline of fertility, large areas of land subject to degradation processes, the increase in the area of anthropogenically altered soils, indicates the need for certain land management activities to improve the condition and raise the level of land use.

Table 1

Composition and ratio of land of Borsky municipal district of Samara region

№ п.п.	The type of land and categories of land	Area, ha	as a percentage	
			total area	to the area of agricultural land
1	Arable	109712.0	52.2	71.9
2	Deposit	7970.0	3.8	5.2
3	Perennial plantings	174.0	0.1	0.1
4	Hayfields	1868.0	0.9	1.2
5	Pastures	32906.0	15.6	21.6
Total agricultural land		152630.0	72.6	100.0
6	In the stage of reclamation construction	30.0	0.0	-
7	Forest	45955.0	21.9	-
8	Under water	2379.0	1.1	-
9	Land settlements	562.0	0.3	-
10	Under roads	3741.0	1.8	-
11	Swamps	1047.0	0.5	-
12	Other land	3948.0	1.9	-
Total land within the district		210292.0	100.0	100.0

In accordance with the natural and economic conditions of the municipal district Borsky divided into three parts-the Northern (forest - steppe), Central (Buzuluk array of forest and floodplain terrace of the Samara River) and southern (steppe) (Fig. 1).

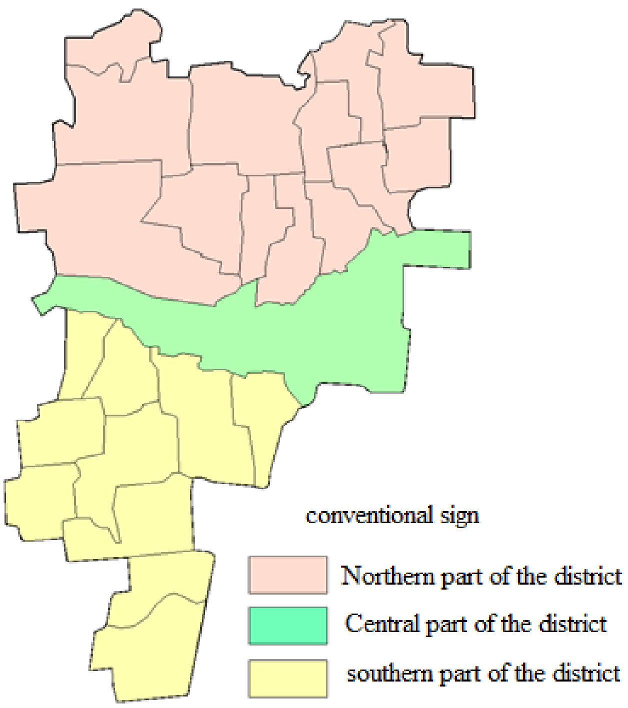


Fig. 1 Zoning of the Borsky municipal district by natural and climatic conditions

A large proportion of the Central part of the municipal district belongs to the specially protected areas as there is an array of the national Park Buzuluk Bor. The Northern and southern part is a territory that has an agricultural orientation and is more in need of rational use and increasing the efficiency of agricultural production. The structure of the land fund of parts of the district is presented in table 2.

Table 2

The structure of the land Fund of the municipal district of Borsky on 01.01.2017 year

Ground	Northern part		Central part		South part		Area	
	hectares	%	hectares	%	hectares	%	hectare	%
arable	65085.0	63.0	-	-	44627.0	68.6	109,712.0	52.2
deposit	2384.0	2.1	-	-	5586.0	8.6	7970.0	3.8
perennials	164.0	0.2	-	-	10.0	0.1	174.0	0.1
haymaking	497.0	0.5	1061.0	2.5	310.0	0.5	1868.0	0.9
pastures	14873.0	14.4	6738.0	16.0	11295.0	17.4	32906.0	15.6
total agricultural land	83003.0	80.6	7799.0	18.5	61828.0	95.1	152630.0	72.6
forests	13029.0	12.6	26487.0	62.7	180.0	0.3	39696.0	18.9
afforestation	1663.0	1.6	4024.0	9.5	572.0	0.9	6259.0	3.0
under the water	1071.6	1.0	1105.4	2.6	202.0	0.3	2379.0	1.1
land of industry	305.0	0.3	56.0	0.1	201.0	0.3	562.0	0.3
roads	1564.0	1.5	1236.0	2.9	941.0	1.45	3741.0	1.8
marshes	105.9	0.1	918.5	2.2	22.6	0.1	1047.0	0.5
other	2281.0	2.2	603.0	1.4	1094.0	1.7	3978.0	1.9
in total	103022.5	100	42228.9	100	65040.6	100	210292.0	100

The distribution of the land fund confirms the agricultural orientation of the Northern and southern parts of the region: the share of agricultural land is 80.57% and 95.07%, respectively.

Arable land in the Northern part and the southern part is 63.18 and 68.81%, the grassland, represented by pastures and hayfields, in the aggregate of 14.92 and was 17.85%.

The main reasons for the decrease in fertility should be called as natural factors (the presence of erosion-prone slopes, raising the level of groundwater), and the imbalance of nitrogen and other nutrients (mobile phosphorus and potassium exchange), the removal of which is not replenished by the fertilizers; reduction of crop cultivation in recent years; man-made soil pollution.

In order to organize the rational use of land in the municipal district, the formation of sustainable agricultural landscapes, the ecological and economic assessment of the district was carried out, the criteria of which are taken such indicators as ploughing of agricultural land, forest area, the coefficient of anthropogenic load, the coefficient of environmental stability, agricultural development (table.3).

The analysis of the land use structure in the municipal district of Borsky showed that the number of plowed lands per 1 km^2 is 0.7 km2, taking into account the area occupied by Buzuluk Forest, which is a specially protected area, the ploughing area is 0.56 km^2. The arable land in the Northern zone is 14% less than in the southern zone and is 0.63 and 0.77 km^2 respectively.

It is established that the area belongs to the category of unstable stable, ploughing exceeds 50%, forest cover reaches 22 %, anthropogenic load is average. Detailed consideration of the parameters of the Northern and southern part of the assessment shows strong fluctuations in the values: ploughing varies from 63 to 77%, agricultural development from 72 to 94%, forest area from 1 to 13%. Both the Northern and southern parts of the district are ecologically unstable territories, where the coefficient of ecological stability is 0.30 and 0.23 units, respectively.

Table 3

Parameters of ecological and economic assessment of the territory of the municipal district of Bor

Territory	Agricultural development,%	The share of tilled per 1 km^2	Wooded %	The coefficient of anthropogenic load units	The coefficient of ecological stability, ed.
North part	70.51	0.63	13,80	2.99	0.30
South part	93.91	0.77	1.35	3.37	0.23
Central part	18.47	0.00	72.25	1.73	0.82
Bor district	72.58	0.56	21.85	3.07	0.40

Thus, the assessment of ecological condition of the territory of the municipal district of Borsky showed that its land Fund experiences the average anthropogenous loading, ecological stability of the territory of the area as a whole is characterized as unstable stable.

The ecological stability of the whole territory of the region is generally higher than the ecological stability of the territory occupied by agricultural land, due to the influence of the forest area Buzuluk forest.

To compare the environmental situation, the land was assessed as a natural complex with a certain natural resource potential of the territory of twelve municipal districts of the Central natural and economic zone (PEZ) of the Samara region. Depending on the proportion of the stabilizing lands for each municipal area determined by the index of stabilization (tab. 4), the value of which is determined by the environmental stress of the territory: 0.61-0.90 - weak, 0.40-0.60 – average, 0.21 – 0.40 – strong, less than 0.2 – critical environmental stress (Агроэкологическая оценка земель ..., 2005).

Table 4

Status of environmental stress areas of municipal districts in Central FI Samara region

Municipal areas	Agricultural area, ha	Stabilization index	Category of environmental tension
Bezenchuksky	140.37	0.21	strong
Bogatovsky	64.66	0.74	poor
Bor	145.19	0.59	medium
Volzhsky	152.24	0.34	strong
Kinel	146.06	0.28	strong
Kinel-Cherkassy	189.31	0.59	medium
Krasnoyarsk	159.23	0.29	strong
Pohvistnevsky	139.77	0.42	medium
Volga	95.25	0.88	poor
Stavropol	173.12	0.99	poor
Syzranskiy	102.39	0.01	critical
Shigonsky	106.57	0.73	poor

In comparison with other areas of the Central PEZ, the Borsky municipal district belongs to the category with an average environmental stress - the stabilization index is 0.59 units. Large area occupied by the Buzuluk Forest has a positive impact on this criterion. That once again testifies to the beneficial effect of natural stabilizing landscapes on the ecological situation of the territory, and the destabilizing effect of intensively plowed agricultural landscapes.

On the basis of the results obtained, it can be stated that for the agricultural landscapes of the Borsky municipal district, and for the Central natural and economic zone of the Samara region, the existing organization of agricultural land does not contribute to the rational use of the natural bioenergy potential of the territory and it is necessary to optimize land use, changing the structure of lands and acreage in the direction of environmentally stable landscapes.

Conclusions and proposals

Large proportion of the Central part belongs to the specially protected areas. The northern and southern part is a territory that has an agricultural orientation and is more in need of rational use and increasing the efficiency of agricultural production.

The ecological stability of the whole territory of the region is generally higher than the ecological stability of the territory occupied by agricultural land, due to the influence of the forest area.

The main reasons for the decrease in fertility are natural factors - presence of erosion-prone slopes, raising level of groundwater, etc., imbalance of nitrogen and other nutrients, man-made soil pollution.

In order to organize the rational use of land formation of sustainable agricultural landscapes as result of calculations can be stated that existing organization of agricultural land does not contribute to the rational use of the natural bioenergy potential of the territory and it is necessary to optimize land use, changing the structure of land.

References

1. Агроэкологическая оценка земель, проектирование адаптивно-ландшафтных систем земледелия и агротехнологий (2005) (Agroecological assessment of the land, design of adaptive-landscape farming systems and agrotechnologies) Под редакцией В.Кирюшина и А.Иванова. Москва, Росинформагротех, 784 с. (in Russian)
2. Климат Самарской области и его характеристика для климатически чувствительных отраслей экономики (2006) (The climate of the Samara region and its characteristics for climate-sensitive sectors of the economy) Приволжское УГМС, Самара, 168 с. (in Russian)
3. Клюшин П.В., Марин А.Л. Антропогенная деградация Ставропольского края (2011) (Anthropogenic degradation of the Stavropol Territory) Юг России: экология и развитие. №3. с.101-107 (in Russian)
4. Мусаев М.Р., Шаповалов Д.А., Широков В.А., Клюшин П.В. и др. Экологические проблемы земель сельскохозяйственного назначения в Северо-Кавказском федеральном округе (2016) (Environmental problems of the agricultural land in the North Caucasian Federal District) Юг России: экология и развитие. №3. с.181-192 (in Russian)
5. Научно-производственный отчет за 2015 год (2016) (Research and Production Report for 2015) ФГБУ «Станция агроимической службы «Самара», 94 с. (in Russian)
6. Отчеты о состоянии и использовании земель муниципального района Бор за 2012-2016 годы (Reports on the state and use of land for the municipal district of Bor of 2012-2016) (in Russian)

Information about authors:

Zudilin Sergey Nikolaevich, Doctor of agricultural sciences, Professor, Head of Department of Land management, soil science and agricultural chemistry, FSBEI HE Samara state agricultural Academy. 446442, Russia, Samara region, Kinel, p. g. t. Ust-kinelsky, ul. Uchebnaya, 2, 89272622382. E-mail: zudilin_sn@mail.ru Land management, crop

Konakova Alyona Y. Senior of Department of Land management, soil science and agricultural chemistry, FSBEI HE Samara state agricultural Academy. 446442, Russia, Samara region, Kinel, p. g. t. Ust-kinelsky, ul. Uchebnaya, 2, georeg.mir@yandex.ru Land management, crop