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FOREWORD

BALTIC SURVEYING (ISSN 2255 – 999X) is international scientific journal. The periodicity of the journal is 1 or 2 volume per year.

Universities from Latvia and Lithuania joined their efforts to publish international scientific journal BALTIC SURVEYING. It is jointly issued by:

- Department of Land Management and Geodesy of Latvia University of Agriculture
- Institute of Land Use Planning and Geomatics of Aleksandras Stulginskis University (Lithuania).

In the 6th volume of the journal are included 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 Easten Europe and elsewhere. The journal is the first one in the Baltic countries dealing with the issues mentioned above.

This scientific journal contains peer reviewed papers. For academic quality each paper has been reviewed by two independent anonymous academic reviewers having Doctors of science degree. Editorial Board has made the final decision on the acceptance for publication. Each author is responsible for high quality and correct information of his/ her article.

We believe that scientists from other foreign countries will become authors of research articles, and the topics of articles will range widely.

We believe that journal will disseminate the latest scientific findings, theoretical and experimental research and will be extremely useful for young scientists

Scientific journal BALTIC SURVEYING already is indexed in databases:

- Agris (http://agris.fao.org/), and
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APPLICATION OF GNSS TECHNOLOGY TO SOLVING METEOROLOGY PROBLEMS

Nataliya Kablak, Oleksandr Reity
Uzhhorod National University

Abstract
The remote monitoring of atmosphere is designed to obtain information about the state of atmosphere. The principle of the remote monitoring of atmosphere is based on registering and processing of GLONASS/GPS radio signals. Modern networks of active reference stations allow us to solve both practical problems of geodesy, navigation, and purely scientific problems that are important in all geosciences. We propose to explore the existing infrastructure of national networks of active reference GNSS stations for remote sensing of the atmosphere in order to determine the water vapour content in the atmosphere as one of the major factors affecting weather.
Key words: GNSS observations, tropospheric delay, water vapour.

Introduction

The Earth's atmosphere is mainly divided into two main shells – the/ ionosphere and troposphere because distributions of satellite signals in these two parts are quite different:

- troposphere (neutral atmosphere) is the lower part of the atmosphere extended from the Earth's surface up to the altitude of about 20 km. Signal propagation depends mainly on temperature, pressure and water vapour content in the atmospheric layers. For the microwave wavelength the neutral atmosphere is not dispersed,
- ionosphere is the upper part of the atmosphere located between about 70 and 1000 km over the Earth. Free charged particles delay mostly the signal propagation. Ionosphere is a dispersive medium for microwave signals. Therefore, it is possible to eliminate the influence of the ionosphere on radio propagation by means of conducting observation on two frequencies.

A signal delay in the troposphere arises due to the presence of tropospheric nitrogen molecules, oxygen, carbon dioxide and water vapour. Under the influence of external radio wave, these molecules are polarized and create additional electrical currents in the troposphere. As a result, total currents are different from currents in vacuum that leads to reducing the phase velocity of radio waves, which depends directly on the concentration of molecules. Consequently, measurements of additional delay of radio signal propagation in the troposphere give information about the integral properties of the atmosphere along the propagation path of a signal. When processing observational data from the spacecrafts one can derive an additional information in the form of files of zenith tropospheric delay (ZTD) of radio signals registered by GNSS receivers. Because of the strong correlation between water vapour in the atmosphere and tropospheric delay of GNSS signals propagation, Integrated Precipitable Water Vapour (IPWV) in the atmosphere can be evaluated from GNSS observations. As it is knows, this parameter is crucial for weather forecasters (meteorologists) because water vapour content in the atmosphere is a key parameter in weather model.
The main purpose of this paper is to analyze the possibilities of using the capacity of network of active reference GNSS stations to solve problems of meteorology.

Methodology of research and materials

Modern GNSS networks provide a significant supplement to other geophysical networks (e.g. seismic, geodynamic, gravimetrical) due to their high precision, sensitivity to the duration of the observation period, ease of deployment, and the ability to perform measurements of deviations in the range from local to global scales.
Currently, research of troposphere by means of GNSS observations is directed towards a deeper understanding weather and climate processes, and ultimately improving weather forecast [1-3, 6-8, 10].
This method was initially used for numerical weather prediction in five countries, namely Germany, Switzerland, Great Britain, Sweden and Denmark. Today, in Central Europe, E-GVAP is an active project aimed to determine near real-time ZTDs from the regional network of GNSS stations. Its major computer center is located at the Royal Observatory of Belgium (ROB). Currently, the network consists of about 1,700 stations, most of them belong to the European Permanent Network (EPN) of EUREF [http://egvap.dmi.dk] and to the International GNSS Service (IGS) [http://igscb.jpl.nasa.gov].

At the EGU General Assembly, held April 7-12, 2013 in Vienna (Austria) was noted that in January of 2013 the E-GVAP-III has been launched which will run until the end of 2017. The main objective of the E-GVAP project is collecting and distributing estimations of atmospheric delays derived from GNSS observations for use in weather forecasting. Operation of E-GVAP is based on close cooperation of geodesy and meteorology.

Severe meteorological events (heavy rains and snowfalls, squalls, river floods, sudden changes of weather, hail, avalanches, mudflows, etc.) cause significant damages for economic sectors and population of Ukraine. Rising economic exploitation of coastal and hazardous flood areas, irrational human economic activity lead to growing number of objects and people being under risk of negative impact of unfavorable meteorological phenomena.

According to experts of the World Meteorological Organization (WMO), in the period from 1991 to 2010 around the globe, over 70% of losses and 90% of events happened when people were affected by natural disasters caused by severe hydrological and meteorological events. Ukraine is a member of the WMO. Obligations on Ukraine's participation in international organizations and treaties are impossible without data of meteorological observations and forecasts, as well as observations of environmental pollution provided by the National Hydrometeorological Service.

A basic activity of the Hydrometeorological Service is operation of integral state system of observation and forecasting. This is a complex multi-level informational system intended to systematic instrumental observations of weather conditions, atmosphere status, and atmospheric pollution by natural and man-made factors.

Unfortunately, the level of technical and technological equipment of Hydrometeorological Service of Ukraine lags behind the needs of the present and is much inferior compared to hydrometeorological services of not only developed countries, but of such neighboring countries as Poland, Romania, Slovakia.

The vast majority of 25,000 measuring instruments used by the Ukrainian meteorological service was developed 30-40 years ago, are obsolete and do not meet modern international standards, including the requirements of WMO and the International Civil Aviation Organization. More than 90% of measuring devices operate with extended service life, and about 50% are in urgent need of replacement (www.mns.gov.ua/laws/regulations/pub.../conception_gidromet.doc).

Such state of technical and technological equipment of Hydrometeorological Service causes particular concern due to increasing repetition and intensity of natural hydrometeorological phenomena in Ukraine, such as catastrophic floods on the rivers of Transcarpathia.

However, modern satellite information technology is not used in the meteorological service. Theoretical and applied aspects of hydrometeorological forecasting based on modern numerical models using computer and information technology require significant development.

The network of active reference stations, which is based on the modern RTK technology and is the most centralized, automated and high-tech infrastructure, helps to solve not only the practical problems of providing coordinate basis but also purely scientific problems being important in all geosciences.

Thus, in order to study atmospheric conditions and to forecast weather, it is necessary to carry out simultaneously and systematically different observation in many points on large areas. In the United States every hour and in Ukraine every three hours, the weather monitoring is carried out. The cloudiness (its density, altitude and type) is characterized; indicators of barometers are observed and supplemented by corrections intended to bring derived values to sea level; direction and wind speed are observed; amount of liquid or solid precipitation, humidity, temperature of air and soil are measured; visibility conditions and other atmospheric phenomena (e.g. storms, fog, etc.) are carefully recorded.

Atmospheric processes develop chaotically. This means that different approaches are required for the prediction of various phenomena in a various space-time scale, particularly for forecasting behavior of large cyclones in temperate latitudes and local heavy rains as well as for long-term forecasts.

Operative forecast is usually based on observations of relative humidity along with pressure and temperature, determined by means of radiosondes and surface meteorological instruments. Radiosondes are launched twice a day and determine the profile changes of atmospheric pressure, air temperature and relative humidity in the atmosphere. One of the main disadvantages of a radiosonde is the relatively low accuracy of its sensors due to contamination during startup.

On the other hand, the amount of water vapour can be determined by radiometers. Radiometers usually provide very accurate data, but the measurements are unreliable during rain, and this

instrument is too expensive. In addition, radiosondes and ground-based or space water vapour radiometers are separated by considerable distances and measurement discreteness is low. Thus, the spatial and temporal distribution of existing measurement methods is of low density and depends on weather conditions.
Thus, there is a need for further development of methods and means of remote sensing of the atmosphere, which on the one hand, would provide high-accuracy measurements of humidity, and on the other hand, would be accessible, reliable, simple and inexpensive in operation.
An advantage of the method of remote sensing of the atmosphere is a possibility of its implementation on the existing GNSS infrastructure (network of active reference stations with single control center), and the fact that these measurements do not depend on rainfall and the presence of clouds. The developed infrastructure of reference stations in Ukraine allows identifying and predicting changes in the dynamics of the water vapour in the atmosphere and thus rainfall in real time to be used at timely forecasting of natural disasters, environmental and climate monitoring.
Use of operative information on the content of water vapour in the atmosphere in numerical weather prediction models will allow to improve data detailization and accuracy of regional short-term weather forecasts, because one can assume that at GPS observations the radio signal passes through Earth's atmosphere immediately. That is the real state of unstable atmosphere is taken into account. Owing to continuous GPS measurements occuring every second, we can expect high measurement accuracy of precipitable water vapour.

Discussions and results
The Transcarpathian Positioning Service ZAKPOS is a local initiative and project of installation of uniform basic infrastructure of differential GNSS (DGNSS) in the Zakarpatska Region with computing center in Mukachevo. Regular GNSS observations at reference stations of ZAKPOS network were started on February 4, 2009 [5].
In geodesic sense, network of active reference stations is a densification networks of permanent stations network. These networks differ in their tasks, accuracy, infrastructure, etc. A network of permanent stations is actually as a basic fundamental network designed to solve scientific and technical problems of the highest accuracy. A network of active reference stations based on RTK technology is able to obtain objective data having object-positioning accuracy of a few centimeters in a single coordinate system and to solve complex issues, primarily of qualitative geodetic providing land-cadastre works.
In mid-2010, ZAKPOS network consisted of 17 stations, by the end of 2010 - 28 stations, and eventually it has became a nationwide network under a new name UA-EUPOS/ZAKPOS [www.zakpos.zakgeo.com.ua]. Today, the network of active reference stations UA-EUPOS/ZAKPOS process data from nearly 90 GNSS stations located on the territory of Ukraine, Poland, Slovakia, Hungary, Romania and Moldova. The use of unknown tropospheric parameters when processing satellite observations allows getting values of tropospheric delay for each reference station of the network. In many countries, similar networks operate, closest of which are SKPOS (Slovakia), CZEPOS (Czech Republic), APOS (Austria), SAPOS (Germany), ASG-EUPOS (Poland) and others networks of active reference stations.
After initial processing of GNSS measurements, distances from observation site to GNSS satellite are determined. A secondary processing of GNSS measurements is to solve navigation problem and provides information on the station location. In order to derive meteorological information it is necessary to develop special methods of secondary data processing, based on the solution of inverse problems.
Only problems of tropospheric delays estimation from permanent GNSS stations have led to creation of a new scientific direction – GNSS meteorology. One of the objectives of GNSS meteorology is the use of ZTDs from regional network of permanent GNSS stations for numerical weather prediction (NWP) [6].
Evaluation of troposphere parameters can be done in two ways [4]:
- by processing of "raw" data of GNSS observation obtained from network of active reference stations;
- by means of ready tropospheric delays obtained from a network software which manages such networks.

The determination of ZTD was traditionally based on the analysis of data in mode of packet network solution using the least squares method and the method of observation that is based on the formation

of double differences (DD) [11]. However, in recent years GNSS meteorology exploitates intensively the method of Precise Point Positioning (PPP) [9], the implementation of which requires access to accurate satellite clock corrections together with predicted orbits.
A result of the joint work of Uzhhorod National University (Lead Partner) and its partners – University of Miskolc (Miskolc, Hungary), Vihorlat Observatory (Humenne, Slovakia), Association Center for Research, Innovation and Technology Transfer "NORDTech" (Baia Mare, Romania), and International Association of Regional Development Institution "IARDI" (Uzhhorod, Ukraine) was the project HUSKROUA/1101/252 [www.gnssnet.hu]. The system of remote monitoring of atmosphere on the cross-border area is processing observations from 38 active reference stations networks of neighboring countries. During the construction and operation of the system of remote monitoring of atmosphere is assumed that the satellite data from networks of active reference stations UA-EUPOS/ZAKPOS and meteorological data from weather stations collected on the cross-border area are processed by the Alberding GNSS Status Software. The Alberding GNSS Status Software package uses streams of input data from reference GNSS stations in real time and PPP processing approach for determination of ZTD for each station separately (https://www.alberding.eu/en/GNSSStatus.html). This package is based on the ALBERDING EURONET software module and uses additional external software real-time components of orbit and clock corrections: RTCM3EPH, IGS01, CLK11. From point of view of strategy of GNSS data processing, the PPP method is popular due to that International GNSS Service (IGS) and other organizations create products such as the precise satellite orbit and clock corrections in real-time (RT).
Currently, data from 38 active reference GNSS stations and meteorological data are processed in three analysis centers: one for monitoring the parameters of the troposphere in real time (Uzhhorod National University), one for the analysis of parameters of the atmosphere in near real-time (University of Miskolc), and one in post-processing mode (National University "Lviv Polytechnic").
The analysis center of University of Miskolc uses the Bernese GNSS Software v. 5.2 package. ZTD determination in this software is based on the analysis of data in mode of packet network solution. At its application the following values: station coordinates, phase ambiguities, values of ZTD, ZWD, IPWV and horizontal gradients of the troposphere are unknown. Since coordinates of stations of GNSS networks are closely correlated with the values of ZTD, derived coordinates are corrected later through taking into account ZTD (second step) in near real-time.
The computer center of UA-EUPOS/ZAKPOS network uses network software of the Trimble Inc. (USA), one of the world leaders in the field of GNSS technologies.
Currently, GNSS infrastructure of Trimble Inc. has two new software applications:

- Trimble VRS³Net™ App,
- Trimble Atmosphere App.

Trimble VRS³Net™ App is the latest version of Trimble VRS³Net. The VRS³Net™ App software provides operators of active network of basic GNSS stations with highly integrated set of tools needed to manage the network.
Trimble Atmosphere App is a new infrastructure performing calculation and analysis of integrated precipitable water vapour (IPWV) and total electron content (TEC) in the ionosphere. This module is able to calculate atmospheric conditions basing on GNSS observations and meteorological data from weather stations, radiosondes etc. Trimble Atmosphere App is completely supported by current Trimble infrastructure strategy and is based on VRS³Net technology.
A peculiarity of Trimble Atmosphere App is the module allows one to calculate both IPWV and TEC not from separated GNSS stations but from a network of permanent stations. Here IPWV is calculated using ground-based meteorological data such as temperature and pressure, as well as radiosonde data.
In order to derive independent estimation data, analysis center located at the National University "Lviv Polytechnic" carries out comparison of two different approaches to the study of GNSS observations, namely DD and PPP in their software implementations: Bernese GNSS Software and Alberding GNSS Status Software, respectively, and two additional software products based on the formation of double difference (DD): Atmosphere App software module of Trimble Pivot Platform and GAMIT/GLOBK software package [4].
Mean monthly results of the comparison of these four software products for 10 GNSS stations have showed that the average differences are less than 1 cm, and their mean-square deviations are in the range 0.6-2.3 cm [4].
Consequently, according to the comparison results, the authors have concluded that the use of different strategies of GNSS data processing does not make a significant impact on accuracy of zenith

tropospheric delay. The derived estimations of 1-2 cm meet the requirements of numerical weather prediction (NWP) to evaluate the accuracy of ZTD for the current weather forecast. It is because it is theoretically believed that in GNSS meteorology, the precision of ZTD is in the range from 3 to 10 mm, and NWP requirements to evaluate the accuracy of ZTD for the current weather forecast are ranged from 6 to 30 mm [12].
Currently, there is the possibility of estimation of ZTD and cosequently the tropospheric water vapour content in real time of 1-minute increments in the active network reference stations (see Figs. 1 and 2). After processing these data, the dynamic map of changes of atmospheric delay and precipitable water vapour in the area are obtained in real time (4D measurements of PW (IWV) field).

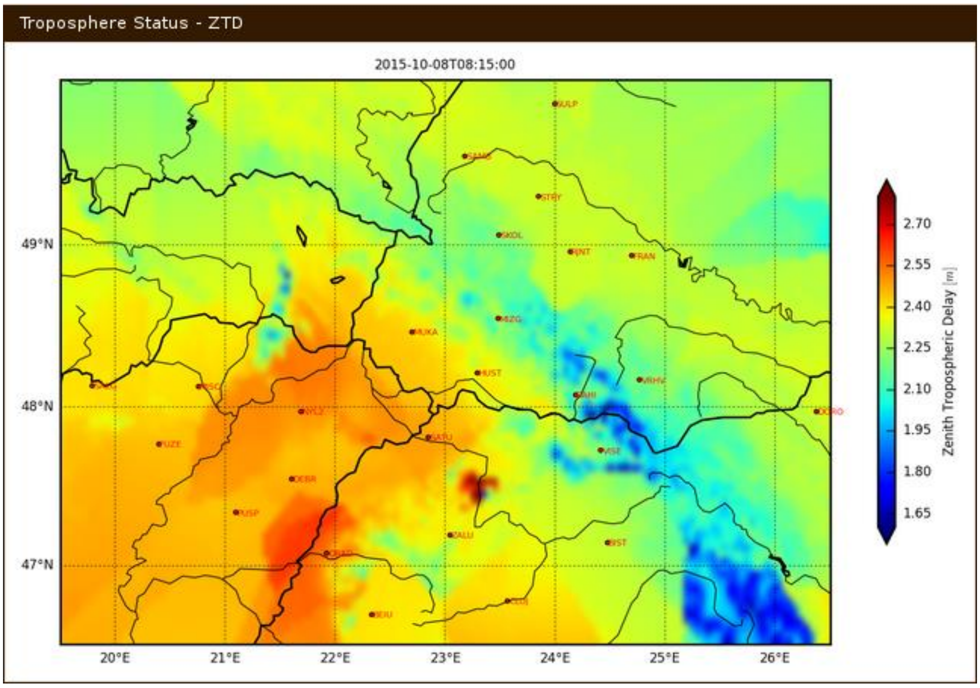

Fig. 1. Spatial (latitude - longitude) distribution of zenith tropospheric delays (ZTD) on 2015-10-08, 15.00 UTC from the Alberding GNSS Status Software

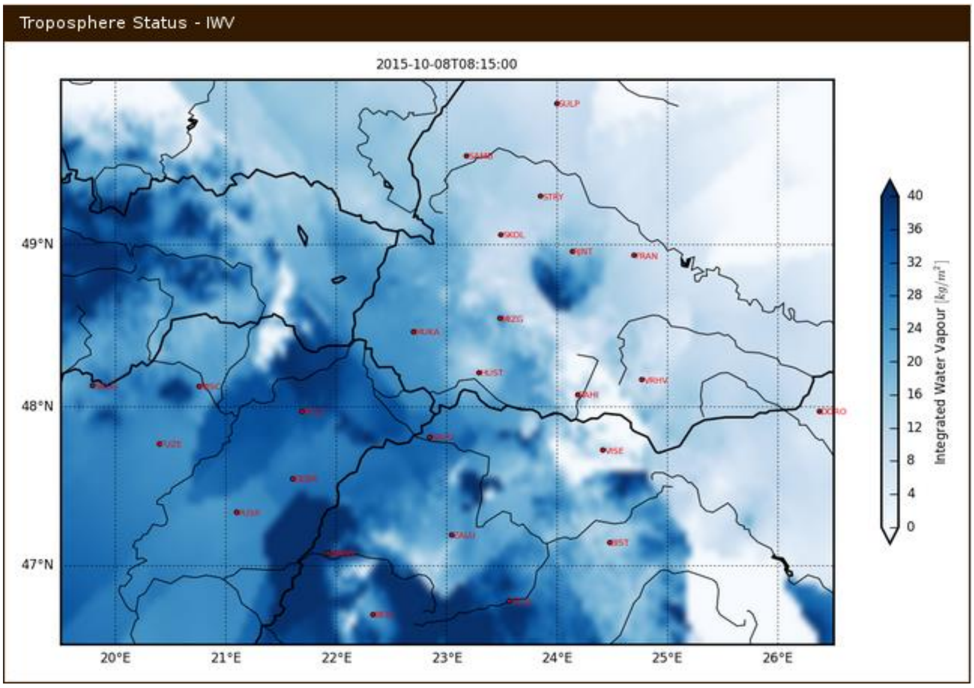

Fig. 2. Spatial (latitude - longitude) distribution of integrated water vapour (IWV) on 2015-10-08, 15.00 UTC from the Alberding GNSS Status Software

The spatial and temporal distributions of ZTD and IWV content in the troposphere obtained from the network of active reference stations in real time can be valuable information in the field of operational numerical weather prediction.

Conclusions and proposals

Operational efficiency of this approach, complete automation and the lack of supplies when carrying out remote sensing open possibilities to wide implementation in practice of continuous and operational monitoring of atmosphere status in order to improve data detalization and enhance accuracy of regional short-term weather forecasts.

GNSS observations in ZAKPOS / UA-EUPOS network and use of cross-border cooperation between European countries allow us to have a precise, dense and frequent sample of IWV values in large areas as well as to identify and predict the dynamics of water vapour change in real time.

The remote monitoring of the atmosphere creates a powerful system and basis for cross-border cooperation in the direction of increasing accuracy of forecast of severe meteorological events in the cross-border territory (heavy rains and snowfalls, hail, icing, heavy squalls, etc.), prediction of dangerous natural phenomena (floods, mudslides, landslides, avalanches in the mountains) and related environmental disasters (ingress of sewage into the river, sources of drinking water, the threat of dangerous infections, pollution, etc.). Therefore, the larger area of study, the forecast will be more accurate.

It should be also noted that the monitoring of water vapour in space and time using GNSS (i.e. GNSS meteorology) could have the following applications:

1. The identification of the current weather and short-term weather forecasting.

Combining GNSS measurements of water vapour (IWV fields derived from GNSS and their time series), upper-air sounding of atmosphere and radar meteorological data can improve the understanding of processes occurring in the atmosphere.

2. Numerical weather prediction (NWP).

Comparing GNSS time series of water vapour and numerical data of weather forecast determined by other methods, one can detect errors in NWP models to be useful for calibration of these models and control of their operation. In addition, GNSS data fill in a gap in observations of humidity due to the presence of some problems in determining the current meteorological data.

3. Climate applications.

GNSS observations are a unique, consistent, reliable and long-term data source being able to improve the monitoring of changes in global climate.

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ASSESSMENT OF RURAL DEVELOPMENT LAND USE PROJECTS FOR FARMSTEAD SITE SELECTION (ELEKTRĖNAI MUNICIPALITY AS EXAMPLE)

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Abstract
Lately, especially near major cities or by naturally attractive areas, the intensified development of urban areas has been observed. Such tendencies has been observed both in the land used for other purposes and agricultural land. It is possible that the rural development land use projects have special significance in the agrucultaral land for the farmstead site selection. The purpose of this article is to analyze the rural development land use projects for farmstead site selection prepared in the municipality of Elektrėnai during the period between the years of 2012 and 2016, and to determine their potential impact on the growth of built-up areas and the rational use of land. According to the survey data, it can be stated that drafting rates of rural development land use projects for farmstead site selection tend to grow especially in those municipalities that are close to Vilnius and which have a good geographical position as well as a special landscape and national cultural heritage values (Vilnius district, Trakai district and Elektrėnai district municipalities). Having carried out the agricultural land change analysis, it is noted that during the analysis period (2012 - 2016) in Elektrėnai municipality, similarly to the whole Vilnius county, land utilities structure is dominated by agricultural land, mostly arable land, but the significant trend of agricultural land reduction at the expense of the growth of built-up areas was noticed. During the analyzed period the built-up areas in the municipality of Elektrėnai increased even by 6 times, and the area of agricultural land declined on average, by almost 2 percent every year. A detailed analysis of specific projects and information gathered during qualitative research suggest that the prepared rural development land use projects for farmstead site selection are not prepared for the improvement of the actual farming activity conditions in constructing farm and other buildings. It is clear that the drafting of these projects ensure the possibility for alleged farmers to simply build a dwelling house on agricultural land. This flawed practice affects the chaotic development of built-up areas and does not achieve the objective of the implementation of sustainable development of residential areas based on the balance and coherence of social needs, economic activity and environmental relations.
Key words: rural development land use projects, agricultural land, farmer‘s farms, built-up areas.

Introduction

The countryside is an integral part of our country’s social and cultural life, ethnic cultural centre and space for recreation. The sustainable territorial planning with special emphasis on the rational land management has a significant impact on the planning, management and development of rural areas.

Essential rational land management works in rural areas are implemented through spatial planning documents, some of them are rural development land use projects. According to V.Gurskienė and G.Ivavičiūtė, both land use schemes and rural development projects may be important for the state regulation of rural areas management and agricultural development (Gurskienė et al., 2012).

Rural development land use projects are an area level special territorial planning land use documents prepared for the planning of the change of land use structure, forest planting, other agriculture-related activities in non-urbanized and not-to-be-urbanized rural residential areas, to develop agricultural activities and alternative activities operator’s holdings. Their preparation, coordination, inspection, approval and registration procedure is governed by the drafting rules of rural development land use projects (Lietuvos Respublikos žemės..., 2004).

Recently it has been noticed that the demand for the urbanization of yet not-urbanized new territories is growing (Andrews, 1986; Berger, 2006; Adell, 2016). It is possible through rural development land use projects for farmstead site selection in not-urbanized and in non-urbanized rural residential areas to plan the change of land utilities composition in areas, where the general plan does not provide for such actions. It is therefore important (when carrying out specific reseach) to find out how such practice contributes to sustainable development of urban areas as well as the influence upon the rational use of land. It is likely that the problem patterns of the detailed studies should help find solutions for the coordination of sustainable development in urban areas and planning in the future.

The aim of the research is to analyse rural development land use projects for farmstead site selection prepared in the municipality of Elektrėnai during the period between 2012 and 2016 and to determine their potential impact on the growth of built-up areas and the rational use of land.

The object of the research is rural development land use projects for farmstead site selection in Elektrėnai municipality.

The following tasks have been set to achieve the aim:

1. To carry out land utilities change analysis in Vilnius county and Elektrėnai municipality.
2. To analyze rural development land use projects for farmstead site selection prepared during the period between 2012 and 2016.
3. Having carried out the analysis of selected specific rural development land use projects for farmstead site selection, to determine their potential impact on the rational use of land.

Methodology of research and materials

During the research, the mixed methods, i.e. empirical and theoretical, were chosen according to the specificity of the research theme. The theoretical method – the secondary data analysis, including analysis and synthesis of legislation, prepared projects and scientific articles as well as comparison and logical abstraction. The data on the rural development land use projects for farmstead site selection prepared during the period between 2012 and 2016 were obtained from the Elektrėnai department archive of the National Land Service under the Ministry of Agriculture.

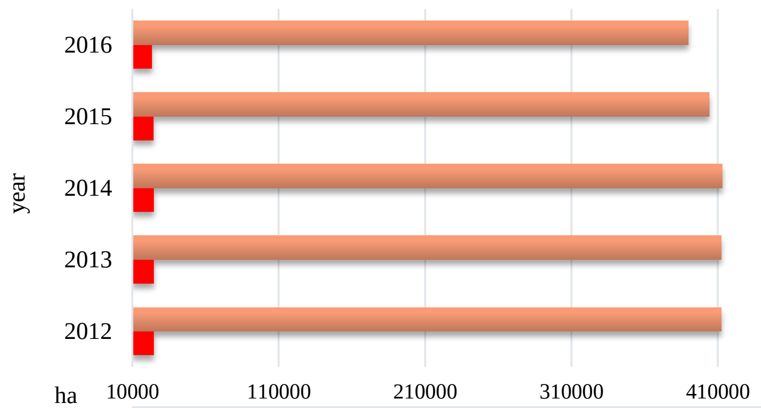
The empirical method was applied in a qualitative study, in which the semi-structured interview was carried out. During the interview the questions were pre-prepared as well as there were additional questions. Selection of the participants for the interview was carried out on the basis of the paper's authors practical experience and choosing the most informative experts. The latter are competent in the analysed field and can provide relevant information about the analysed problem thanks to their professional activities, existing qualifications and experience. Interview participants became: the senior specialist (informant A) from the Elektrėnai department of the National Land Service under the Ministry of Agriculture, the surveyor preparing rural development land use projects (informant B) and the specialist from the Department of agriculture and land reclamation in Elektrėnai municipality (informant C).

Carrying out the assessment of the rural development land use projects for farmstead site selection one of the eight municipalities of Vilnius county, i.e. Elektrėnai municipality has been chosen for the detailed research. This municipality is distinguished by its special geographical position, because it is almost halfway between the two largest Lithuanian cities Vilnius and Kaunas, and thus it is becoming quite attractive living area where you can live in, while working in both largest cities. Also, the analysis of rural development land use projects scope revealed that of the eight Vilnius district municipalities (the town of Elektrėnai, the city of Vilnius, Šalčininkai district, Širvintos district, Švenčionys district, Trakai district, Ukmergė district and Vilnius district), it prepared the majority of this type of projects, apart from Vilnius district, which has already been analyzed in previous works (Filipavičienė, 2016.).

Discussions and results

In Elektrėnai municipality, the area of agricultural land makes up 33.57 percent, in comparison with the national average (52.74 percent), however, its use extensity is much higher. It shows almost five times (70 percent) higher the amount of undeclared farmlands than the average in Lithuania (11.89 percent). Agricultural extensity depends on soil fertility, its condition. A large part of the municipal area makes up agricultural land of low efficiency (up to 32 scores) as well as areas susceptible to deflation, erosion and anthropogenic load. Due to the low demand and unfavorable terrain conditions only one fifth of the cultivated lands were drained in the municipality (Elektrėnai, 2016.).

The analysis of the details of the composition of agricultural land as well as its change shows that during the period between 2012 and 2016, in the municipality of Elektrėnai, as throughout the Vilnius county, agricultural land areas continues to decline (Fig. 1).



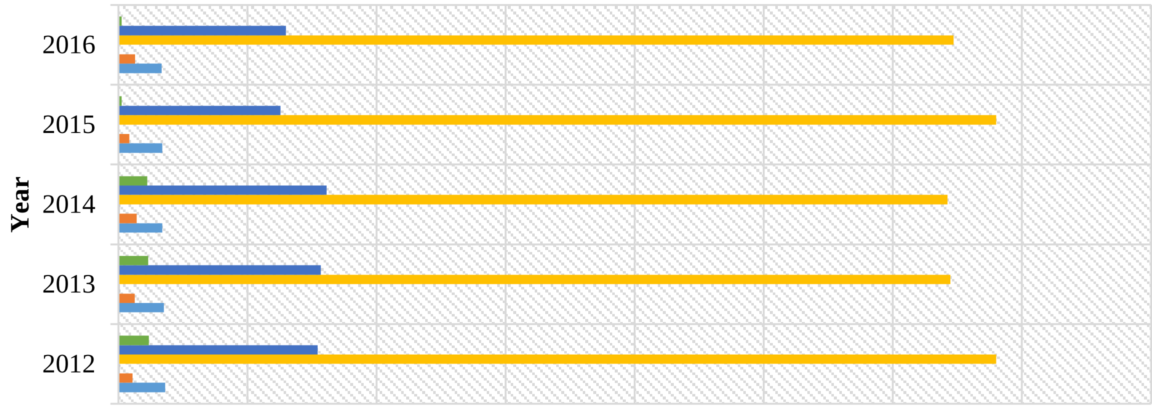
	2012	2013	2014	2015	2016
In Vilnius county	412408,87	412293,71	413090,25	404242,71	389802,02
In Elektrėnai municipality	24543,01	24517,82	24517,39	24292,69	23310,27

Fig. 1. Agricultural land area change in Vilnius county and Elektrėnai municipality during the years 2012 - 2016

In Vilnius county, agricultural area declined on average, by 1.91 percent every year, and in the municipality of Elektrėnai – by 1.68 percent.

As it can be seen from the data, the largest areas of agricultural lands were in 2014 both in Vilnius county and in Elektrėnai municipality, respectively, they accounted for 4.25 percent (41 390.25 hectares) and 48.19 percent (24 517.39 hectares) of land use. The minimum area of agricultural land was observed in 2016 – 3.99 percent (38 902.02 hectares) and 45.82 percent (23 310.27 hectares) of the total agricultural land.

When analyzing trends of agricultural land components in details, it can be noted that significant changes have occurred in the arable land. During the analysed period, arable land in the municipality of Elektrėnai continued to decline, an average by 1.67 percent every year, whereas in Vilnius county in 2015 the opposite phenomenon than in previous years happened, i.e. occupied arable land areas increased significantly (over 16 546.75 hectares), but in 2016, these areas decreased again (Fig. 2). This could have been influenced by direct payments for crops.



	2012	2013	2014	2015	2016
Orchards in Vilnius county	11788,3	11607,79	11271,9	1285,75	1291,29
Meadows and natural pastures in Vilnius county	77235,75	78401,5	80690,11	62867,91	64968,43
Arable land in Vilnius county	340089,05	322284,52	321128,34	340089,05	323542,3
Orchards in Elektrėnai municipality	516,6	516,6	516,6	50,24	49,4
Meadows and natural pastures in Elektrėnai municipality	5494,23	6378,92	7183,89	4302,6	6499,57
Arable land in Eektrėnai municipality	18188,12	17622,3	17083,9	17073,9	16761,3

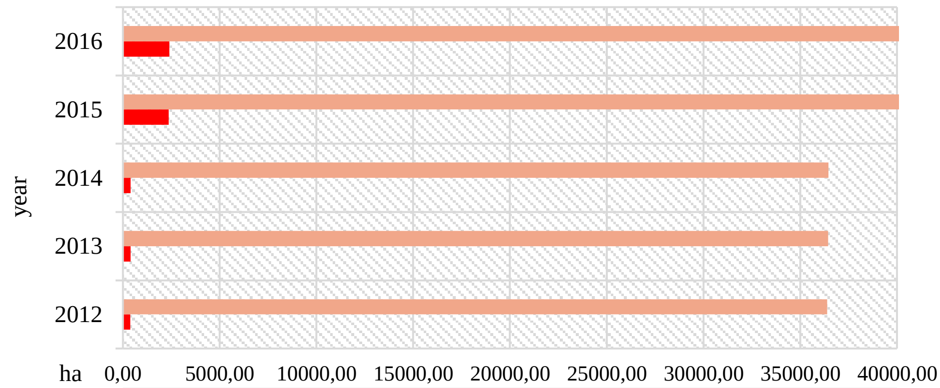
Fig. 2. The change of agricultural land components in Vilnius county and Elektrėnai municipality during the period between the years 2012 and 2016

In Vilnius county and Elektrėnai municipality, meadows and natural pastures varied inconsistently, in the municipality of Elektrėnai, in 2014 these land utilities formed the largest part, i.e. 7183.89 ha, in Vilnius county in 2014 – 80 690.11 ha, and the smallest part of these land utilities were formed in 2015 in the municipality of Elektrėnai – 4302.6 ha, in Vilnius county in 2012 –78 401.5 ha.

In Vilnius county, orchard area changed only slightly, however, in the municipality of Elektrėnai, this land has decreased 10 times in 2015.

In practice, a steady loss of arable land has been affected by some adjusted legal acts, which came into force on January, 2014, and they are as follows: "The main purpose of land use and method for determining and replacement procedure and conditions description" approved by the Government of the Republic of Lithuania (Lietuvos Respublikos Vyriausybės…, 2014) and the Republic of Lithuania Law on Territorial Planning, June 27, 2013, No. XII-407 (Lietuvos Respublikos teritorijų…, 2013), which regulate the essential and simple procedure of the change of the conditions and the way of the main land use, when (while desiring or when solutions of master plan are allowing) land use purpose is changed from agricultural to other by writing only an application to the municipality administration without preparing certain territorial planning documents. Such facilitated conditions, and not only they, in fact, had quite an impact on the development of urban areas.

As can be seen from the presented data, during the period of nearly five years, the area of built-up territories in Vilnius county increased by 1.2 times, while in the municipality of Elektrėnai – 6 times (Fig. 3). The largest change of these areas was noticed in 2015.



	2012	2013	2014	2015	2016
In Vilnius county	36386	36441,27	36456,7	45607,35	45632,87
In Elektrėnai municipality	389,00	396,14	403,45	2370,96	2397,03

Fig. 3. The change of built-up territories in Vilnius county and Elektrėnai municipality during the period between the years 2012 and 2016

On the basis of the results of the earlier analyzed agricultural land areas change and evaluation of some earlier described legislation changes, it can be said that quite a significant increase of built-up areas (on the account of the decrease of agricultural land areas, particularly arable land) was influenced by a change in a simplified land use change procedures, when urbanization of the part of former agricultural land by making it residential land was a relatively simple issue on the basis of general plan solutions, i.e. in the case when the planned to urbanize area falls within the priority areas for the development of residential areas. Another way in which conversions of land utilities are carried out, which result in an increase in area of built-up territories of agricultural land, is rural development land use projects for farmstead site selection.

On the other hand, an incentive to extremely high growth of built-up area in the municipality of Elektrėnai is a convenient location of this area. The geographic location of Elektrėnai municipality in terms of transportation is particularly advantageous because it is halfway between the major Lithuanian cities, Vilnius and Kaunas, therefore the demand to urbanize the most beautiful places of the municipality (located not far from these towns) is increasing.

Analysis of rural development land use projects for farmstead site selection in Vilnius county and Elektrėnai municipality. 1132 rural development land use projects for farmstead site selection were prepared in Vilnius county during the period between the years 2012 and 2016 (Table 1).

Table 1

The prepared rural development land use projects for farmstead site selection in Vilnius county during the years 2012 – 2016

Years of project preparation	2012	2013	2014	2015	2016
Number of prepared projects, in psc.	41	103	312	332	337

As can be seen from the data presented, the scope of projects prepared in Vilnius county has a tendency to increase. In 2012, 41 projects have been prepared, while in 2013 – 103, in 2014 – 312, in 2015 – 332, in 2016 –337 projects, i.e. the number of projects prepared since the beginning of the analysis period has increased 8 times.

Most of the projects were prepared in Vilnius district – 610, in Trakai district – 155 and in the municipality of Elektrėnai – 156. The least number of the projects were prepared in Šalčininkai and Ukmergė districts – 14 and 23, respectively (Fig. 4).

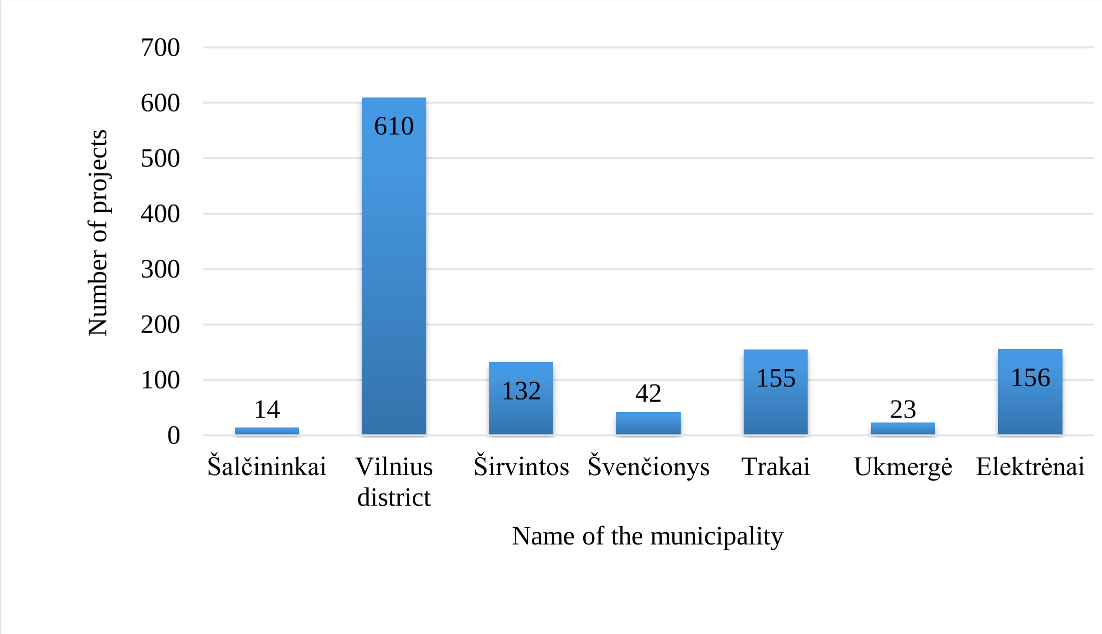


Fig. 4. Number of prepared rural development land use projects in Vilnius County during the years 2012 - 2016

It can be said that the largest scope of rural development land use projects for farmstead site selection are in special interest areas, i.e., Vilnius district is an area closest to the capital city Vilnius, which concentrates the largest number of inhabitants, the largest supply of jobs and where other socially, culturally and economically important things are abundant. Trakai district is located not far away from the capital Vilnius and it is particularly characterized by its beautiful landscape and the existing national cultural heritage values. Peculiarities of Elektrėnai municipality were discussed earlier.
When analyzing the distribution of projects in different subdistricts of Elektrėnai municipality, it was noted that the largest scope of projects prepared are in Vievis subdistrict, which is the largest subdistrict in terms of area in the municipality of Elektrėnai. This subdistrict covers an area of 152 square km and it is about 30 percent of the total area of Elektrėnai municipality (Table 2).

Table 2

Distribution of the rural development land use projects for farmstead site selection in the municipality of Elektrėnai, prepared in 2012 - 2016

Name of subdistrict	Subdistrict area, km^2	Number of projects	Average area of the land plot projected, ha
Elektrėnai	40	20	0.6785
Vievis	152	60	1.8567
Semeliškės	67	10	1.9534
Kietaviškės	56	15	1.5678
Kazokiškės	62	7	1.4500
Pastrėvys	58.60	19	1.0250
Beižionys	51	14	1.8596
Gilučiai	25	11	1.4536

It is likely that the largest number (60) of prepared projects in Vievis subdistrict was determined by excellent connection with the municipal centre, as well as the short distance to the main city of the country – the capital city of Vilnius. The smallest number of projects were developed in Kazokiškės subdistrict, i.e. only 7, one of the reasons why there are not many projects prepared in this area is that there is a number of protected areas where farming is restricted.
Having analyzed 10 randomly selected rural development land use projects in the municipality of Elektrėnai, it was noted that the projected plot area ranges from 0.55 up to more than 7 hectares, and usually land utility changes are being designed taking into account agricultural land. However, it is also interesting that farmers preparing in these land plots rural development land use projects for

farmstead site selection, in general, do not declare their cultivated land. This raises the question of whether they actually do any business? (Table 3).

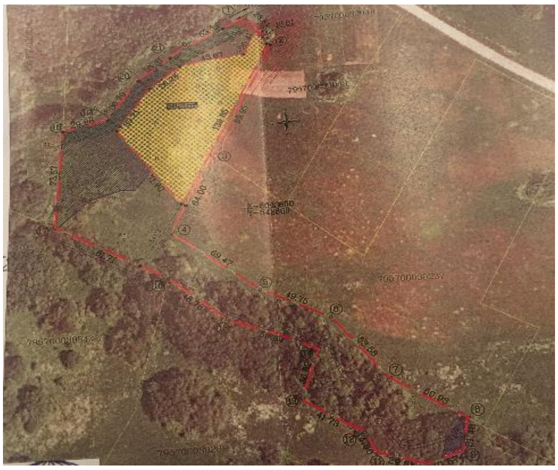
Table 3

Characteristics of selected rural development land use projects for farmstead site selection in Elektrėnai municipality

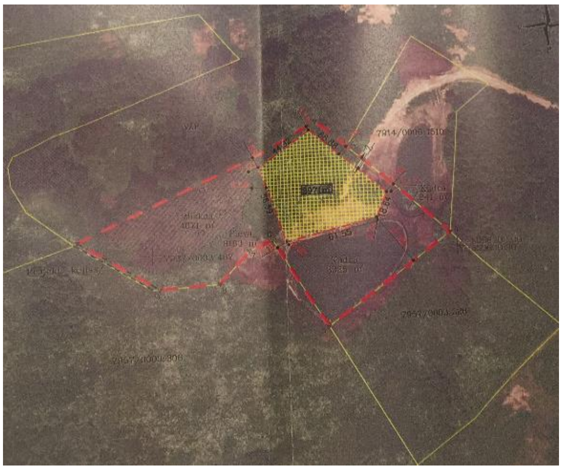
Number	Subdistrict	Village	Area of the land plot designed, ha	The builtuo area, ha	Expected specific land use and forest conditions	Protected areas	Expected changes of land utilities	Expected approach	Owned land tenure, ha	Farmer's declared land	Farmer's leased land	Efficiency score
1.	Vievis	Ausieniškiai	0,7566	0,494	XIX, XXIX	The former territory of Ausieniškiai manor	Meadows and natural pastures	From the projected 4m wide road	5,7566	-	-	50
2.	Pastrėvys	Belezos	1,7804	0,5944	XXIX, VI, II	-	Arable land	Existing 4 meter wide road	2,7804	-	-	31,7
3.	Pastrėvys	Strėvininkai	2,1224	0,5621	VI, XXVI, XXIX, XXVIII	-	Meadows and natural pastures	From the existing 6 meter wide road	2,4224	-	-	29
4.	Elektrėnai	Migūčionys	0,6546	0,4891	II, VI	-	Meadows and natural pastures	From the existing12 meter wide road	0,7546	-	-	28,3
5.	Vievis	Rusakalnis	1,58	0,3971	XXVI	-	Meadows and natural pastures	By servitute road	1,58	-	-	39
6.	Semeliškės	Klevinė	7,1951	4,3508	II, VI, XXVI, XXIX	-	Meadows and natural pastures	From the exzisting 8 meter wide road	7,1951	-	-	25,7
7.	Pastrėvys	Mackūniškiai	2,1359	1,0679	XXIX	-	Arable land	From then existing 4 meter wide road	2,1359	-	-	35,8
8.	Pastrėvys	Mustniai	3	0,3796	II, XXI	-	Arable land	From the existing 10 meter wide road	3	-	-	28
9.	Vievis	Viliškiai	3,1092	2,461	-	-	Meadows and natural pastures	From the existing 10 meter wide road	3,1092	-	-	32,9
10.	Semeliškės	Daugirdiškiai	0,5525	0,316	-	-	Arable land	From the existing 4 meter wide road	0,5525	-	-	34,6

Having analyzed in detail solutions provided in the projects, e.g., the designed built-up areas, it is noted that there are very small possibilities of developing an effective agricultural activities due to the complex plots configuration and overall small size almost in all land plots (Fig. 4).

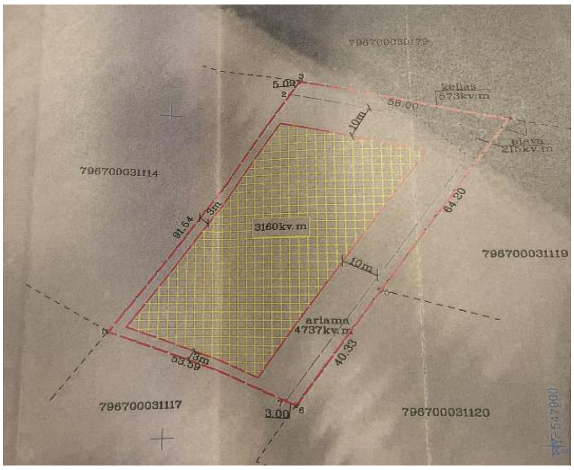
a) Pastrėvys subdistrict, Strėvininkai village



b) Semeliškės subdistrict, Klevinė village



c) Vievis subdistrict, Rusakalnis village



d) Semeliškės subdistrict, Daugirdiškės village

Fig. 4. Examples of the designed built-up areas of rural development land use projects for farmstead site selection

As can be seen from the presented specific visual examples, in all the analyzed projects the most part of the territory is occupied by built-up area, and the rest of the agricultural lands remain uncomfortably situated, i.e. narrow strips of irregular shape. Such residual land plot boundaries limit the possibility to cultivate land with agricultural machinery, and the area is too small for stockbreeding.

In order to more accurately ground the results of the research, a qualitative study was carried out, during which three qualified experts, who in their daily activities often come into contact with the farmers and their preparation of the rural development land use projects, were interviewed via direct interview. Informant A (the senior specialist from the National Land Service under the Ministry of Agriculture), informant B (surveyor), informant C (the specialist from the Department of Agriculture and Land Reclamation in Elektrėnai municipality).

According to all experts, almost in all cases persons preparing the rural development land use projects for farmstead site selection, are not true farmers: informant A <...> *from the service order in the information system of Land Management design documentation it can be noted that most farmers have registered farm not long ago and in projects provide only dwelling houses, without farm buildings;* informant B <....> *In 10 years there was only one customer, the purpose of which was to farm. The aim of all others was to build a dwelling house*; Informant C <...> *not all people are real farmers, as people mention that they need only a certificate for house construction. The big farmers who actually farm already tend to have farmsteads".*

All interviewed experts agree that rural development land use project for farmstead site selection is an opportunity to build a dwelling house on agricultural land: informant A <...> *"In my opinion, this is definitely one of the trends, why rural development land use project for farmstead site selection is being prepared*. *As far as we deal with the developers of these projects, they hide nothing while* *declaring that they prepare the project only to construct a dwelling house";* Informant B <...> *"the majority are not real farmers"*, the informant C <...> *"Well, since the law allows it and does not control the further actual economic activity, this trend is real."*

So to summarize the research results, it can be said that the prepared rural development land use projects for farmstead site selection are not being prepared for the improvement of actual farming activity conditions or other things. Unfortunately, this is the most common means of enabling to build a dwelling house on agricultural land. The uncontrolled development of such "farmers" homesteads especially influence the chaotic development of built-up areas, resulting in encountered various problems, such as infrastructure costs increase. Finally, these costs are covered by each municipality resident funds. Also, such non-coordinated development does not help the municipality to implement the development of sustainable residential areas based on the balance and coherence of social needs, economic activity and environmental relations.

Conclusions and proposals

1. Agricultural land still dominates in the land utility structure of Elektrėnai municipaly, as in the whole Vilnius county, but in recent years the agricultural land area tends to decline, while the built-up areas are increasing. During the analyzed period the built-up areas in the municipality of Elektrenai increased 6 times, and the area of agricultural land declined on average by almost 2 percent every year.
2. The volume of the preparation of the rural development land use projects for farmstead site selection during the analysed period tends to increase not only in the municipality of Elektrėnai, but also throughout the county of Vilnius. 1,132 projects were prepared during the period between the years 2012 and 2016. Most of the projects were developed in the special significance – the characteristic areas of the county, i.e., in those municipalities that are closest to the city of Vilnius and which have good geographical position and special landscape and national cultural heritage values (Vilnius district, Trakai district and Elektrėnai district municipalities).
3. The analysis of the projects and the information collected during the qualitative research suggest that rural development land use projects for farmstead site selection are not being prepared for the improvement of actual farming activity conditions in constructing farm and other buildings. It is clear that the drafting of these projects for alleged farmers ensure the possibility to simply build a dwelling house on agricultural land. This flawed practice affects the development of chaotically built-up areas and do not achieve sustainable development of residential areas based on the balance and coherence of social needs, economic activity and environmental relations.

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CHANGES OF DAMAGED LAND IN KAUNAS COUNTY, LITHUANIA

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Abstract
The article presents the analysis of the current situation of the damaged land in Kaunas County. The methods of comparative, analytical as well as statistical and logical analysis were used for the investigation. The aim of the investigation is to carry out the analysis of the damaged land area in Kaunas County during the period between 2005 and 2017. The object of the investigation is Kaunas County damaged land. The study found that the number of affected areas in the county is 409. Because the damaged areas consist of mineral quarries and territories occupied by dumps, the article contains the description and condition of these areas. By 2009, there were 98 landfills in Kaunas County. Kaunas municipal waste management region comprises 6 municipalities; 58 old landfills and dumps were shut down, at present two regional non-hazardous waste landfills have been arranged. In 2017, the damaged land occupied 3,447.36 hectares and amounted to 14.15 percent of all Lithuanian damaged land and accounted for 0.43 percent of the county's area. During the period between 2005 and 2017 the damaged land area in Kaunas County increased by 236.48 hectares or 6.86 percent. The analysis of the damaged land area of the municipalities situated in the Kaunas County showed that the largest of these areas during the period between 2005 and 2017 was in Kaunas district municipality.
Key words: damaged land, landfills, mineral quarries.

Introduction

Article relevance. Survey of the current situation and change determination of damaged lands as well as their recultivation and ecological restoration is the global challenge of the twenty-first century: to unite science and practical achievements in order to improve ecological status of the planet, individual regions or local areas and ensure the landscape's ecological balance, natural resources, sustainable use and restoration.

In the Journal of the National Land Service ”Land Fund of the Republic of Lithuania by January 1, 2017” the damaged land is described in the following way: operating and depleted mineral quarries, peat bogs and landfill areas (Nacionaline…, 2005-2017).

According to the type of use, damaged land parcels are divided into (Aleknavičius, 2012):

- mineral areas, the usage natures of which are the following: mineral mining open workings (pits) (land parcels used for minerals, stratifying close to the ground surface, mining waste facilities); mineral extraction underground workings (shaft) and the wells (land parcels, in which are actual or intended to be equipped facilities for the manufacturing process maintenance and storage of minerals, stratifying in deeper soil layers);
- waste storage, sorting and disposal (landfills) areas subject to perpetual waste (hazardous, non-hazardous or inert) accumulation, storage indefinitely in the special device or territory, in order to use them, remove or sort waste collected by materials for recycling or further use.

Minerals are natural materials existing in the earth's crust that can be used for substantive production or other uses (Lietuvos…, 2001). The landfill is assigned to a group of sources of pollution that pose a potential threat to groundwater users and other environmental objects. The use of subsoil resources is an important element when meeting the needs of society, but this activity has a negative impact on the environment because during the open mining of the extraction of useful subsoil resources (solid minerals, including peat) in industrial and small quarries, peatland areas are usually damaged. These damaged but not recultivated areas spoil the landscape and pose a threat to humans (Lietuvos..., 2012).

The Waste Management Law of the Republic of Lithuania (Lietuvos, 2002) provides that *the landfill* is a waste disposal facility for the deposit of the waste onto or into land (i.e. underground). It is the object, due to economic activities of which directly or indirectly materials and chemical compounds fall in the underground hydrosphere, therefore the change in the chemical composition of the groundwater occurs. The main factor affecting the underground hydrosphere is the likely access of various pollutants into the environment during the degradation of collected garbage (Tinkamai..., 2016).

15 waste disposal methods are foreseen in the European Parliament and Council Directive 2008/98/EC (The European…, 2008) and the above-mentioned Lithuanian Republic Waste Management Law. Waste placement in a landfill is the least desirable option, but still the dominant method of Lithuania. Rational, innovative models should be selected in planning, managing and rehabilitating damaged land

areas that ensure the sustainable use of natural resources and ecosystem conservation and management.

The object of the investigation is damaged land of Kaunas County.

The aim of the investigation is to carry out the analysis of the Kaunas County damaged land area during the period between 2005 and 2017.

Tasks of the investigation:

1. To describe the status quo of the damaged land in Kaunas County.
2. To analyze and compare the damaged land change in Kaunas County during the period between 2005 and 2017.

Methodology of research and materials

Comparative, analytical as well as statistical and logical analysis methods were used for the investigation. The land fund statistics of the Republic of Lithuania (Nacionaline zemes..., 2005-2017), graphically depicted in figures were used for the fulfilment of the research of the damaged land change in Kaunas County for the years 2005 - 2017.

The article analyzed and assessed the current state of the damaged land in the County of Kaunas, i.e., the current state of the mineral deposits and dumps was analyzed, the statistics were presented and systemized to structure and present graphs. The study provides the damaged land change analysis in Kaunas County. The ten-year period, i.e., the period between 2005 and 2017 was selected for the determination of the change. For the fulfilment of the analysis, statistics of the land fund and other sources of the Republic of Lithuania (Geological Survey of Lithuania, the Ministry of Environment, county and regional waste management centres) were used. They were systematized, analyzed and expression of the percentage was calculated during the preparation of the research.

Discussion and results

Characterization of Kaunas County. Kaunas County is located in the geographical center of Lithuania. It is an industrial and agricultural region. Kaunas County occupies 808 624.92 ha or 12.5 percent of the whole territory of the country. Kaunas County has a definite structure of population concentration centre with a top-level centre of Kaunas City and 5 lower-level centres, which coincide with the municipal administrative centres. Kaunas County is an industrial, agricultural and tourist region. More than a half of the county's territory is occupied by agricultural lands. These lands are one of the most productive ones in Lithuania – only 5.8 percent of lands consist of low productivity ones (Kauno regiono…, 2014). Kaunas County landscape is constantly changing due to human activities and natural processes, but at present the direction and magnitude of these changes are not exactly known. Therefore, it is more and more difficult to implement the principles of sustainable development (Lietuvos Respublikos…, 2009).

The system of protected areas in Kaunas County consists of protected areas category foreseen in the statutory of all protected areas of the Republic of Lithuania. Protected areas cover about 13 percent of the county's territory. In the Republic of Lithuania, protected areas account for 15.71 percent of the country's area (Saugomų teritorijų…, 2016). Kaunas County is rich in mineral resources used in the construction industry with enough reserves for the long time period. Many products from peatlands are suitable for fuel.

The current situation of damage land in Kaunas County. In Lithuania, the areas damaged by quarries, peat bogs and landfills are several times larger than they should be according to the solid mineral mining open workings scale and the used mining technology. The largest parts of damaged areas of Kaunas County are located in the municipalities of Kėdainiai district (21.27 percent), Prienai district (21.03 percent) and Kaunas district (19.56 percent), while the smallest parts – in Kaunas and Birštonas municipalities (Fig. 1). 409 damaged areas were determined in Kaunas County. This is the third county in Lithuania by the amount of damaged areas.

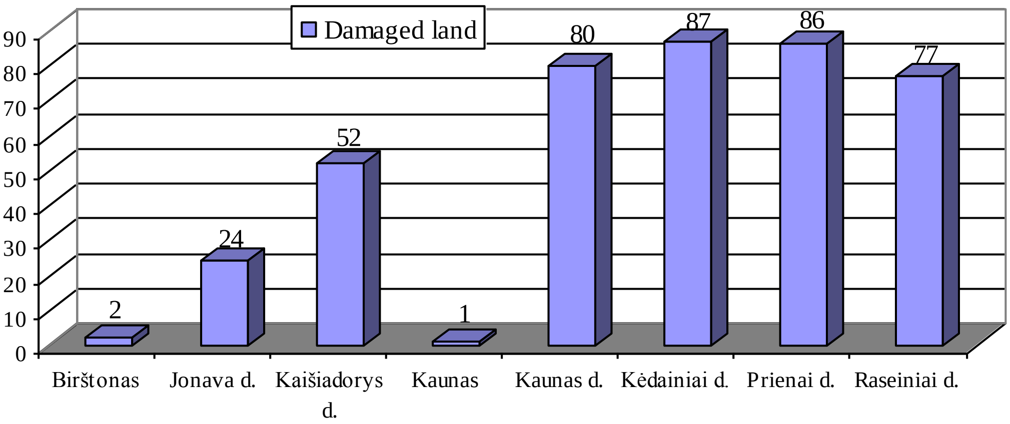

Fig. 1. The number of damaged areas in Kaunas County, in pieces

Mineral deposits occupy 4.3 percent of Lithuanian territory. Lithuania has 17 species of minerals used in the world and investigated at various detail levels (Lietuvos…, 2017). Currently, there are 9 types of exploited mineral deposits (limestone, dolomite, sand, gravel, clay, chalk marl, peat, sapropel and oil). The only explored anhydrite reservoir is situated in Kaunas district. Gypsum resources can be found in the above-mentioned anhydrite reservoir in Kaunas district. Limestone and clay can be found in Kaunas County as well. The most widely spread ones are gravel and sand resources; they are the most explored ones in Kaunas County.

By 2009, there were 98 landfills in Kaunas County. Lapes municipal waste landfill and 12 other municipal waste landfills operate in Kaunas district territory: Gaižėnėliai – 1.7 hectares, Miškiniai (active) – 5.5 hectares, Butkūnai – 2.5 hectares, Dirviniai – 3.2 hectares, Piliuona – 3 hectares, Ilgakiemis – 0.5 hectares, Besmerčiai – 2 hectares, Pagiriai – 2 hectares Muniškiai – 2 hectares, Berlainiai – 1.5 hectares, Ežerėlis – 1.8 hectare, Digriai – 3 hectares.

There were 18 landfills in Kėdainiai district – a total of 53.86 hectares: Babėnai – 17.23 hectares, Čiukiškiai (active) – 8.12 hectares, Šalčmiriai – 1.74 hectares, Čystapolis – 1 hectare, Rekšiai – 0.42 hectares, Milžemiai – 2.44 hectares, Gudžiūnai – 0.46 hectares, Vikaičiai – 2.24 hectares, Pajiesis – 3.97 hectares, Špitolpievis – 0.54 hectares, Labūnava –3.41 hectares, Jovaišos – 2.91 hectares, Graužiai – 3.4 hectares, Šeteniai – 1.32 hectares, Aristavėlė – 0.6 hectares, Žiogaičiai – 0.66 hectares, Pavermenys – 0.7 hectares, Dotnuva – 2.7 ha.

Currently, one waste landfill site (in Būdiškės) is still operating in Kaišiadorys district. 11 landfills have been rehabilitated in this district, i.e., Graužai, Morkūnai, Klėriškiai, Kalviai, Kruonis, Rumšiškės, Antakalnis, Tarpumiškis, Pakalniškiai, Mikalaučiškės ir Živintos.

10 municipal waste landfills were exploited in Jonava district: the town of Jonava – 11.55 hectares, Biržuliškis – 0.69 hectares, Varpiai – 1.2 hectares, Naraunínkiškiai – 2.31 hectares, Paskutiškiai – 0.47 hectares, Kuliškiai – 2.2 hectares , Palokė – 0.5 hectares, Kuigaliai – 1.33 hectares, Čičinai – 2.25 hectares, Akliai –5.65 hectares.

19 landfills were operating in Raseiniai region: Andriušaičiai – 3.6 hectares, Numgaliai (Viduklė) – 6.12 hectares, Gėluva – 4.7 hectares, Žvirgždė – 4 hectares, Papelkiai – 0.4 hectares, Jukainiai – 1.2 hectares, Steponkaimis – 0.6 hectares, Girkalnis – 0.4 hectares, Zbaras – 0.6 hectares, Meiliškiai – 1.16 hectares, Tarosai – 1 hectare, Paliepiai – 1 hectare, Paskystūnis – 0.5 hectares, Dautartai – 1.5 hectares, Poškaičiai – 0.6 hectares, Rinkšeliai – 0.6 hectares, Ugionys – 1 hectare, Diržonys – 0.4 hectares, Ančakiai (recultivated).

One legal landfill (located in Prienlaukis village, Šilavotas subdistrict) was registered in Prienai district, which, after installing the container waste management system, has not been exploited since the second half of 2001. Other landfills are considered as arbitrary ones. The main ones are: near Jieznas, Beržynai village (1.5 hectares) and Pagirmuonis village, Pakuonis subdistrict (0.2 ha).

Prienai and Birštonas municipal waste was transported to the landfill belonging to Alytus district, since Prienai and Birštonas landfill meet neither landfill installation rules nor the European Union requirements.

Currently, there are two Kaunas regional landfills (Lietuvos Respublikos…, 2009). Kaunas municipal waste management region covers 6 municipalities. The region closed 58 old landfills, dumps. 2 regional non-hazardous waste landfills were arranged: Lapes regional landfill (in Leipšiškiai village of

Kaunas district) and Zabieliškis regional landfill (in Zabieliškis village of Kėdainiai district), 3 waste transfer stations were arranged (in Raseiniai, Kaišiadorys and Jonava regions), 11 bulky waste collection sites, 3 green waste composting sites, mechanical and biological waste treatment plants were built in Kaunas City and Zabieliškis village of Kėdainiai district, 30,000 individual composting containers were purchased.

The damaged land change in Kaunas County. In 2017, the damaged land area in Kaunas County covered 3,447.36 hectares, or 14.15 percent of all Lithuanian damaged lands and 0.43 percent of the county's total area. Meanwhile, in 2005 it accounted for 12.99 percent of the country's damaged lands and 0.59 percent of the total county area. During the period between 2005 and 2011, the area decreased by 75.92 hectares, or an average by 12.65 hectares per year. In 2012, the area has decreased additionally by 1,257.05 ha, but in 2014 the area increased and in 2017 it reached 3,447.36 ha (Fig. 2). During the analysed period the damaged land area in the county increased by 236.48 ha, or 6.86 percent.

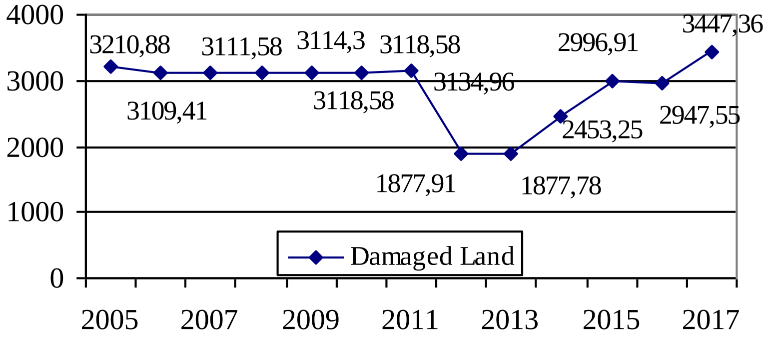

Fig. 2. The damaged land change in Kaunas County in ha from 2005 to 2017

Once the analysis of the damaged land area of the municipalities situated in the Kaunas county had been carried out, it was found that the largest area of these lands during the period between 2005 and 2017 was in Kaunas district municipality: in 2005 the amount was 915.50 ha and in 2017 the amount was 1,090.49 ha or 31.63 percent of the county's damaged land area. During the period of ten years the area in the municipality increased by 174.99 ha, or 16.5 percent. The area increased due to the development of the use of anhydrite and gypsum resources in Kaunas district.

The smallest damaged land area by 2017 was in Kaunas City Municipality and it occupied 11.00 ha, in 2005 the number was 4.52 hectares. During the period between 2005 and 2017, the analyzed area of the municipality increased by 6.48 hectares, or 58.91 percent.During the period between 2005 and 2017, in four counties out of ten (Klaipėda, Šiauliai, Vilnius and Kaunas) of the Republic of Lithuania the area of damaged land increased. Damaged land areas can be located both in private property land and on the state land.

Analysis of the damaged land of Kaunas region in planning documents. In Kaunas County General Plan (Kauno..., 2009) it was foreseen to shut down the old, non-compliant landfills and to leave the two municipal waste landfills in the region – the Lapes landfill site near the city of Kaunas and landfill in Zabieliškis, Kėdainiai district. Upon completion of the operation of the Lapes landfill (2020), the entire region is planning to transport the waste to the landfill in Zabieliškis (Kauno..., 2014). Once the management plans was carried out, the accumulated municipal waste are disposed in the regional landfill in Takniškiai village of Alytus district. Another large waste collection site was arranged in Prienai district.

Regional Waste Management Plan (Kauno..., 2010) provides for composting facilities, development of secondary raw materials and other waste collection suitable for the processing in municipalities, Zabieliškis landfill extension (17 ha), or construction and operation of a new landfill in Kaunas region. In order to optimize the management and development of municipal waste management and to use the means from the EU Cohesion Fund efficiently, the regional municipal waste treatment system was established in Kaunas region. Implementing the investment project of the waste framework, the closing and recultivation technical projects of large and small landfills with a total area of 18.5 hectares were established.

Rapidly increasing urbanization level will lead to more intensive use of mineral resources and waste generation, which will increase the impact on the environment. Challenges require sustainable use of mineral resources and avoidance of waste generation, the guidance of high environmental standards, the introduction of new, advanced technologies covering the entire chain of raw materials extraction and processing stages as well as rehabilitation methods.

Conclusions

1. Kaunas County is located in the geographical center of Lithuania. It is industrial and agricultural region. Kaunas County occupies 808,624.92 ha or 12.5 percent of the whole territory of the country. The largest parts of the damaged areas of Kaunas County are located in the municipalities of Kėdainiai district (21.27 percent), Prienai district (21.03 percent) and Kaunas district (19.56 percent), while the smallest parts are located in Kaunas and Birštonas municipalities. 409 damaged areas were determined in Kaunas County. This is the third county in Lithuania by the amount of damaged areas.
2. Kaunas municipal waste management region covers 6 municipalities. The region closed 58 old landfills, dumps. 2 regional non-hazardous waste landfills were arranged: Lapes regional landfill (in Leipšiškiai village of Kaunas district) and Zabieliškis regional landfill (in Zabieliškis village of Kėdainiai district), 3 waste transfer stations were arranged (in Raseiniai, Kaišiadorys and Jonava regions), 11 bulky waste collection sites, 3 green waste composting sites, mechanical and biological waste treatment plants were built in Kaunas City and Zabieliškis village of Kėdainiai district, 30.000 individual composting containers were purchased.
3. In 2017, the damaged land area in Kaunas County covered 3,447.36 hectares, or 14.15 percent of all Lithuanian damaged lands and 0.43 percent of the county's total area. Meanwhile, in 2005 it accounted for 12.99 percent of the country's damaged lands and 0.59 percent of the total county area.
4. During the analysed period the damaged land area in the county increased by 236.48 ha, or 6.86 percent. Once the analysis of the damaged land area of the municipalities situated in the Kaunas county had been carried out, it was found that the largest area of these lands during the period between 2005 and 2017 was in Kaunas district municipality: in 2005 the amount was 915.50 ha and in 2017 the amount was 1,090.49 ha, or 31.63 percent of the county's damaged land area. During the period of ten years the area in the municipality increased by 174.99 ha, or 16.5 percent. The area increased due to the development of the use of anhydrite and gypsum resources in Kaunas district.

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DENSIFICATION ITRF08 INTO UKRAINE AREA

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Abstract
According to the fast development and distribution of GNSS technologies all over the world, the large numbers of reference GNSS stations have appeared in Ukraine. These stations are included in the state and several private networks. The permanent GNSS observations gathered within these networks are processed and analysed by the Centre of Lviv Polytechnic National University. A cumulative solution (coordinates expressed at the specified epoch and velocities of all stations) was estimated by using the GAMIT-GLOBK software. The authors made several numerous tests using certain configuration of fiducial stations which belong to the EPN A class to transfer ITRF08 frame into Ukraine area and choose the best strategy of alignment of the Ukrainian national GNSS network to the EPN. Three different solutions with cretin tolerance set for Ukrainian GNSS network were estimated and each time the different set of coordinates was obtained. The differences reached several millimetres. Also for verification, our solution was compared with EPN solution. Received coordinates and velocities could have a geophysical interpretation and provide very useful information for local geodesy tasks.
Key words: reference GNSS station, cumulative solution, GAMIT-GLOBK software, national densification

Introduction
The realization of ITRF is based on five techniques: Very Long Baseline Interferometry (VLBI), Lunar and Satellite Laser Ranging (LLR and SLR), Global Navigation Satellite System (GNSS) and Doppler Orbitography Radio - positioning Integrated by Satellite (DORIS). ITRF coordinates were obtained by combination of individual solutions computed by analysis centres using the observations from networks of stations located on sites covering the whole Earth. For regional and local research station density of global network is not sufficient. For densification the network and improvement of the availability of ITRF regional networks were organized. From the geodetic point of view, densification of the ITRF is meant for the expression of station positions (and velocities) of a regional or local network in the ITRF. The GNSS, compared to other techniques, has the advantage of being the most efficient one for the ITRF densification purpose, given its easy use, low cost and the availability of the IGS products for all users (Altamimi, 2003). An example of such densification of the ITRF is EUREF Permanent GNSS Network (EPN) (http://www.epncb.oma.be). Also almost all countries have their national GNSS networks: Romania - ROMPOS (http://www.rompos.ro), Poland - ASG-EUPOS (http://www.asgeupos.pl), Finland - FinnRef (http://euref-fin.fgi.fi), Italy – RDN (Barbarella et al. 2009) etc. All these networks also have their own Analysis Centres, which estimate cumulative solutions (coordinates expressed at the specified epoch and velocities of all stations) using three different GNSS analysis packages (GIPSY, Bernese, GAMIT-GLOBK) (Dach et al. 2015; Herring et al. 2016; Lichten et al. 1995). For example, the Italian network RDN (100 permanent stations) was processed by Military Geographical Institute (IGMI) and computed with Bernese software (Caldera, 2010). Poland network ASG-EUPOS (130 permanent stations) was processed by the Centre of Applied Geomatics of Military University of Technology, which is one of the EPN Local Analysis Centres (Araszkiewicz et al. 2011) with Bernese software. Strategy of processing was very similar to EPN test reprocessing strategy (Kenyeres et al. 2008). Designated solution is expressed in the reference frame implemented by given reference stations. Reference frame is transferred by introducing a minimum number of constraints (Szafranek, Bogusz, Figurski, 2014). ASG - EUPOS fulfils the role of the main national geodetic frame and enable conservation of ETRF (European Terrestrial Reference Frame) in Poland. Also daily and weekly solutions will help to monitor and control whole system activity (Szafranek et al. 2009).
In Ukraine we also have large numbers of reference GNSS stations (~150), which observations are processed and analysed in Lviv Polytechnic National University, Department of Geodesy and Astronomy. The aim of this research is the estimation of a cumulative solution and selection of the optimal alignment strategy of Ukraine GNSS network to EPN.

Methodology of research and materials

The primary aim of this research was to align the Ukrainian national GNSS network to the EPN, the Guidelines for EUREF Densifications (Bruyninx et al. 2013) were followed. In particular, we used final IGS orbits and Earth Rotation Parameters, the same antenna calibration values as the EPN analysis centres, also GNSS observations collected by the Ukrainian GNSS network (Fig. 1) since 2013 (including 1721-1929 GPS weeks) have been processed in GAMIT - GLOBK software which are based on a classical double-difference approach.

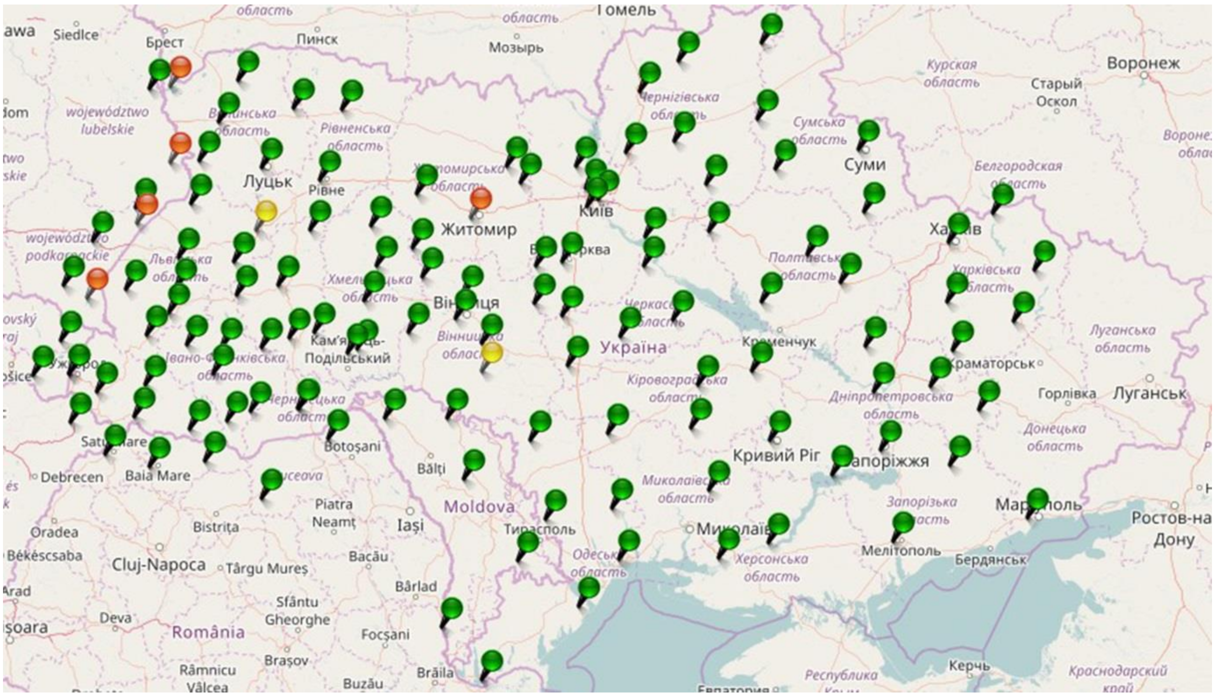

Fig. 1. Ukrainian GNSS network

To ensure a reliable alignment, data from 24 EPN stations class A (Kenyeres, 2009) (Fig.2): BBYS (Slovakia), TUBO (Czech Republic), BAIA, BUCU (Romania), BYDG, JOZ2, LAMA, USDL (Poland), GRAZ (Austria), IGEO (Republic of Moldova), MATE (Italy), MDVJ, ZECK (Russian Federation), POTS, WTZR (Germany), RIGA (Latvia), SOFI (Bulgaria), VLNS (Lithuania) i CNIV, GLSV, MIKL, POLV, SULP, UZHL (Ukraine) distributed around the processed network was used. This configuration of fiducial stations was chosen as optimal from the previous research (Doskich, 2016).

The relation between a regional solution (X_R) and ITRF (X_1), over selected stations could be written as (Altamimi, 2003):

$$X_1 = X_R + A1 \tag{1}$$

where A and 1 are respectively the design matrix of partial derivatives and the vector of 7 transformation parameters:

$$A = \begin{pmatrix} . & . & . & . & & . & . & . \\ 1 & 0 & 0 & x_a^i & 0 & z_a^i & -y_a^i \\ 0 & 1 & 0 & y_a^i & -z_a^i & 0 & x_a^i \\ 0 & 0 & 1 & z_a^i & y_a^i & -x_a^i & 0 \end{pmatrix} \tag{2}$$

$$1 = \left(T_x, T_y, T_z, D, R_x, R_y, R_z\right)^T$$

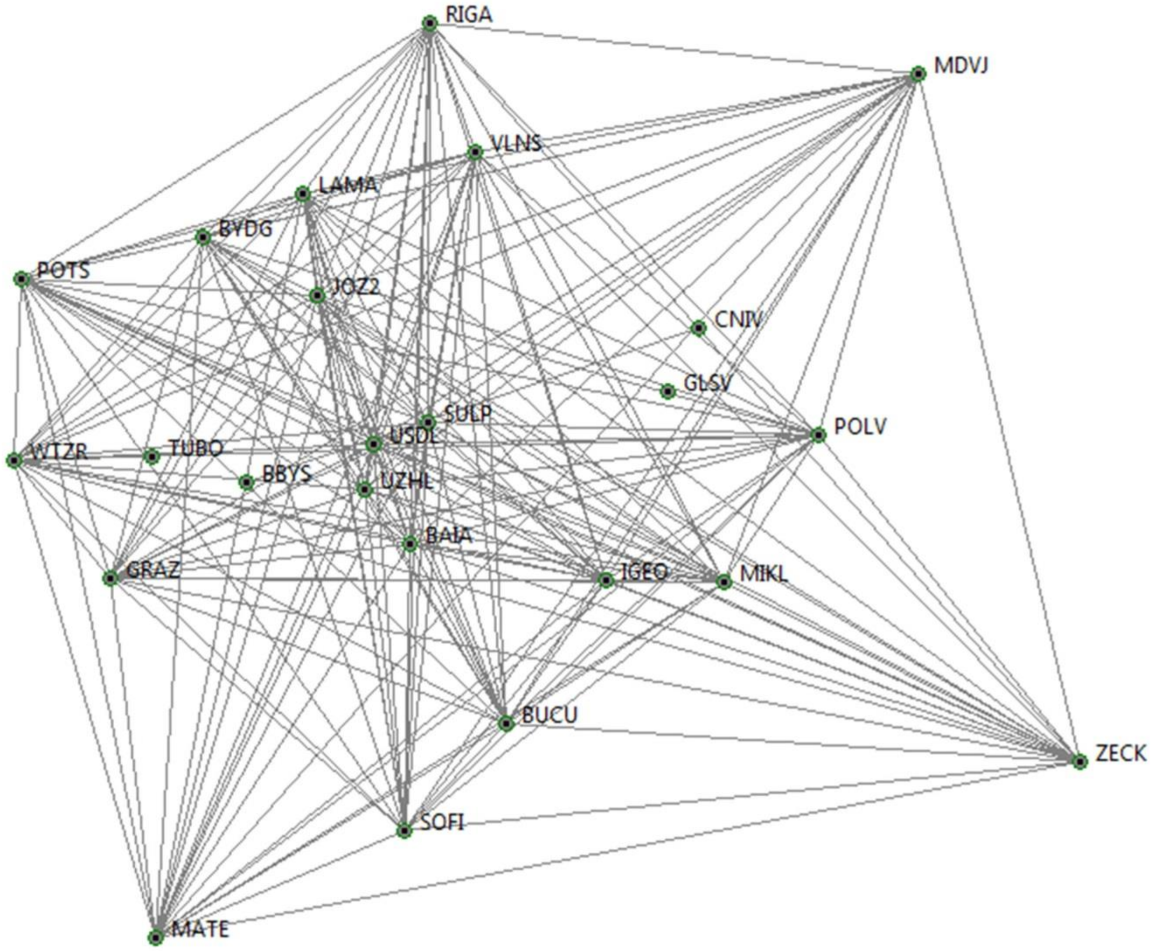

Fig. 2. Scheme of the fiducial stations network

During the alignment GAMIT-GLOBK also compared the estimated values of the parameters to the a priori. If they differ, it is more than the tolerance set (max_chii), ”bad” data are automatically excluded. Max chii has three arguments to specify the maximum chi-square increment, the maximum prefit residual (m) and the maximum rotation (mas). To choose the best tolerance set for our network, we made several numerous tests using certain max_chii: max_chii1=13 3 100; max_chii2=100 5 20000; max_chii3=20 10000 10000.

For verification of the achieved result, we compared our cumulative solution from GAMIT-GLOBK with EPN solution.

Discussions and results

When a cumulative solution (observation of 1721-1929 GPS weeks) from GAMIT-GLOBK software was estimated, several stations have “bad” values of coordinates and velocities. We have investigated that the reasons for this “bad” values have several factors:

1. Some stations had incorrectly indicated a receiver’s antenna. The reason for this is an error during transmission of data to our Centre. The server of private network automatically recorded the wrong antenna.
2. The length of the time interval of the station observations were small. Figure 3 illustrates diagrams of the time interval of the problematic station observation for 4 years (1461 days).
3. Some stations have incorrect input data.

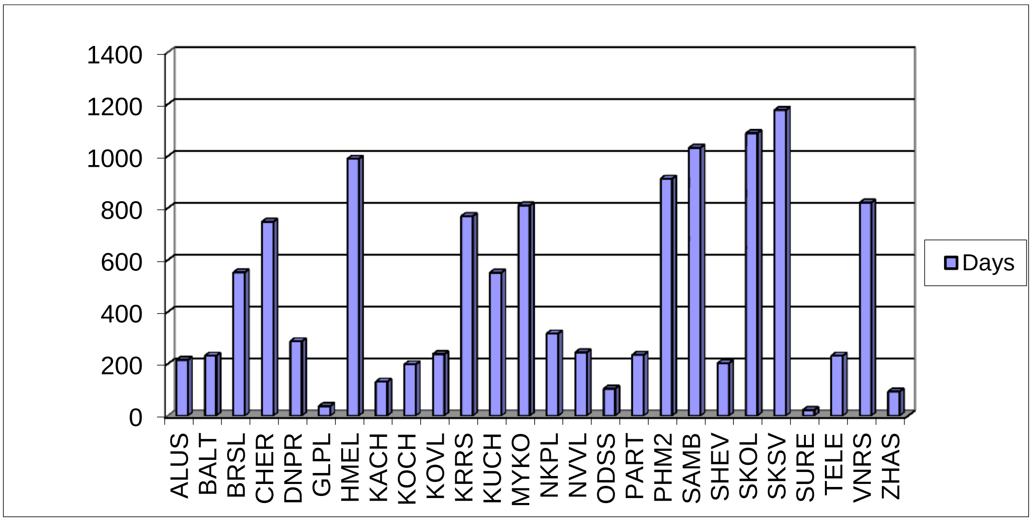

Fig. 3. The time interval of the stations observation

Table 1

The difference of coordinates between certain tolerance sets

Stations	max_chii1-max_chii2			max_chii1-max_chii3			max_chii2-max_chii3		
	ΔX, mm	ΔY, mm	ΔZ, mm	ΔX, mm	ΔY, mm	ΔZ, mm	ΔX, mm	ΔY, mm	ΔZ, mm
ALUS	0	0	0	0	0	0	0	0	0
BALT	0	0	0	-1	0	0	0	0	0
BRSL	0	-1	0	-1	0	0	0	0	0
CHER	0	0	0	1	0	2	1	0	2
DNPR	0	0	0	0	0	1	0	0	0
GLPL	-1	0	0	-2	-1	-1	-1	-2	-1
HMEL	0	0	0	0	0	1	0	0	0
KACH	0	0	0	1	-2	1	0	-1	1
KOCH	0	0	0	-1	0	0	0	0	0
KOVL	0	0	1	0	0	0	0	0	0
KRRS	-4	3	3	-4	3	3	0	0	0
KUCH	0	0	0	0	1	1	0	0	0
MYKO	1	0	1	1	-1	-1	0	-1	-2
NKPL	-1	0	0	-2	0	0	-1	1	0
NVVL	0	1	0	3	-4	-2	4	-6	-1
ODSS	-3	-2	-4	-9	-6	-13	-6	-4	-8
PART	-2	-1	-1	-8	1	-2	-6	1	-1
PHM2	0	0	0	0	0	0	0	0	0
SAMB	1	0	0	-2	0	-3	-2	0	-3
SKOL	1	0	1	-2	-2	-3	-2	-1	-4
SKSV	9	4	11	13	6	16	4	2	5
SHEV	-1	0	0	-1	0	0	0	0	0
SUDA	0	0	0	0	0	0	0	0	0
SURE	-1	-2	0	-1	-1	0	0	0	1
TELE	0	0	0	0	0	1	0	0	0
VNRS	0	0	0	-1	1	0	0	0	0
ZHAS	0	1	0	0	1	0	0	0	0

The next step of our research was to select the optimal tolerance set (max_chii) for our network. For this task we estimated 3 different cumulative solutions with a certain value max_chii (max_chii1=13 3 100; max_chii2=100 5 20000; max_chii3=20 10000 10000). From these solutions, we calculated the number of days for 4 years (1461 days). We received such results: max_chii1=1164 days, max_chii2=1177 days, max_chii3=1044 days and compared the coordinates obtained from all variants of tolerance set in Table 1.

The best result is shown by max_chii2 (1177 of 1461 days), so this tolerance set would be used to estimate a comulative solution in the future.

To investigate accuracy and correctness of our cumulative solutions, it was compared with EPN solutions by common station, and coordinates differences were determined (Fig.4). EPN solutions were taken from EPN_A_IGb08.SSC (http://www.epncb.oma.be/_productsservices/coordinates/). Coordinates have been calculated on the same epoch as in our solution.

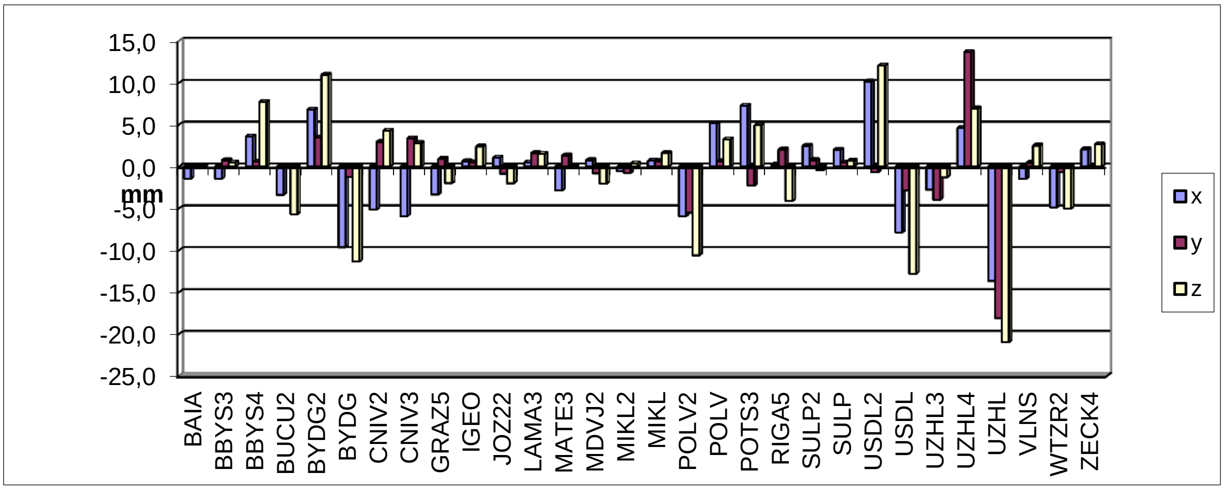

Fig. 4. Comparison of common sites coordinates from EPN and Ukraine solutions

Table 2 shows the statistical summary of the differences.

Table 2

Statistical result of the differences EPN-Ukraine solutions

St. dev	X	Y	Z
mm	5.2	4.6	6.9

The comparison made between solutions obtained in national processing and official EPN solution gave good results since differences do not exceed 1 cm.

Conclusions and proposals

1. The tests allowed to examine the impact of observation period on the reliability of the realization of the ITRF08 in Ukraine and select the optimal tolerance set (max_chii2=100 5 20000), which was used in software GAMIT-GLOBK to determine the reference coordinates and velocities.
2. For verification the achieved cumulative solution was compared with a cumulative solution from EPN. The comparison gave good results (differences do not exceed 1 cm), so it shows that procedures were done correctly.
3. The received cumulative solution (coordinates and velocities) may be further used for regional and local geodynamic studies, geophysical interpretation and for many practical applications in geodesy.

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ENVIRONMENTAL IMPACT OF LAND CONSOLIDATION

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Abstract
Land consolidation – an important stage of agricultural and rural development. This is a significant land use planning process, when private, municipal and state land parcels located in rural areas are redistributed in a complex way, their boundaries and location are changed by the prepared land consolidation project of a certain area. Recently, there has been a lot of talk about the benefits of land consolidation to farm structure and productivity, restructuring of rural areas and development, but there is not enough emphasis on the benefits of our environment, landscape and biodiversity. Experience of European countries shows that the land consolidation projects can be useful not only for farmers but also for our environment and its individual components. The article gives an overview of not only the positive aspects of environmental preservation. The fact that the land consolidation projects can bring negative results (i.e. that they are implemented without regard to the sustainable transformation of the territory) is noted as well.
Key words: land consolidation, environmental protection, land parcel, sustainable development

Introduction

Land consolidation is carried out in many countries of the world. In each country, it is different and unique, depending on many factors, in particular on the specific needs of the country, its traditions, specificity, culture, legal framework, and the country's economic, social and environmental considerations. However, despite different interests of the countries and the factors of land consolidation issues, the main goals remain the same: to improve the compactness of the scattered parcels of land and as well as to expand land holdings; to create the necessary rural infrastructure and implement other agricultural and rural development and environment protection policy objectives.
Most authors in their articles analyze the land consolidation benefits of economic aspects, forgetting that these projects can significantly contribute to the improvement of the environment. One can agree with the fact that at present in various scientific articles there are references to the land consolidation benefits to the environment and its components, but it is not an essential part of the discussion in the terms of the above-mentioned project analysis and execution.
The aim of this paper is to analyze how land consolidation and its measures affect the surrounding environment, landscape and biodiversity.

Methodology of research and materials

At present, the preservation of the environment is crucial for the world and therefore the autors pay the maximum attention to the implementation of environmental protection measures when preparing land consolidation projects. Foreign experience of land consolidation was analyzed using a variety of Lithuanian and foreign literature, scientific articles. Specific land consolidation projects performed in Poland, Slovakia, Cyprus and other countries were used in the paper. Literature and statistical data analysis, data abstraction and assessment methods were used in the paper.

Discussions and results

Land consolidation is being carried out to form farms' rational land holdings and to improve living conditions in rural areas. Many European countries have this practice: France for over than 200 years, Denmark, Holland, Belgium, Switzerland, Germany – almost for 100 years. This process is also widely implemented in other countries – the Czech Republic, Luxembourg, Slovenia, Poland, Spain, Portugal, Austria, Luxembourg. At present, the land consolidation projects are implemented and in the Scandinavian countries – Finland, Norway and Sweden. It is important to note the fact that these projects are carried out not only in Europe but also in China, India and Africa (Bennett et al., 2016; Wang et al., 2015; Oldenburg et al., 1990).
According to Derlich (2002), land consolidation projects addressed not only rearrangement of land parcels, but also the implementation of different rural development measures. This fact is confirmed by other authors as well, which claim that land consolidation projects promote local initiatives to develop the land consolidation mechanism as an essential tool for integrated rural development (Kavaliauskienė et al., 2011). According to Hartvigsen (2014), currently land consolidation is a multifunctional tool for the purpose of implementation of the tasks related to the protection of the environment. Dapkus (2008) states that land consolidation is not only for the forming of rational land

parcels but is an important factor in the balanced development of rural areas, increasing the competitiveness of both farms and the region, as well as improving social and economic infrastructure itself for the needs of local community. Meanwhile, Pašakarnis (2016) described how land consolidation could be useful in the transport sector.
It is important to note the fact that at the same time during the land consolidation it is possible to provide compensation to those people who have lost their once managed land due to the implementation of the public interest (in this case, due to the performance of corresponding land consolidation objectives).
The analysis of the literature showed that the land consolidation could be called not only a tool for improving the structure of landholdings, but also a tool to create a harmonious and sustainable rural development.
The detailed analysis of land consolidation measures (that are related to environmental conservation) was carried out. Denmark has many years of experience in this field. Environment protection and its policy are the matter of priority as land consolidation planning tool in this country (Hartvigsen 2014; Kovandova, 2006). However, in other countries the environmental protection is an important factor as well in the preparation of land consolidation projects (Table 1).

Table 1

The main objectives of land consolidation in Finland, Germany, the Netherlands, Spain and Sweden (Vitikainen, 2004; Bergen..., 2014)

Objectives	**Finland**	**Germany**	**The Netherlands**	**Sweden**	**Spain**	**Norway**
Rearrangement of land parcels	XXX	XXX	XXX	(X)	XXX	XXX
Rearrangement of forest land parcels	XX	(X)	(X)	XXX	XXX	XXX
Property division improvement in villages	X	XXX	XXX	0	0	X
Changes in the field of lease	X	XXX	XXX	X	X	X
Farm size increase	XX	XXX	XXX	XX	XX	0
Municipal or State land acquisition	0	XX	XX	0	0	0
Rearrangement of homesteads	X	XX	XX	0	0	0
Road network improvement in consolidated territory	XX	XXX	XXX	X	XXX	XXX
Renovation of land reclamation systems	XXX	XXX	XXX	X	XX	XX
Implementation of environmental and conservation measures	X	XXX	XXX	X	X	0
Promotion of regional development projects	X	XXX	XXX	X	0	0

Note: XXX – the primary objective XX – the secondary objective
X – an objective of minor importance 0 – not mentioned in the objectives

It was found that one of the most important tasks almost in all of the countries concerned is the reorganization and increasing of land holdings as well as drainage and road network, however, the environment and nature conservation measures are also a priority factor, especially in Germany and the Netherlands.
As for the Lithuania's neighboring countries, Poland is worth mentioning, because in this country land consolidation projects and their environmental aspects are widely considered now (Leń et al., 2016; Leń et al., 2016; Przegon et al., 2016). Latvia and Estonia held only preparatory works in the field of land consolidation, specific projects are not carried out yet. These countries have only taken the first steps in the implementation of these projects. According to Platonova and Jankava (2013), in Latvia land consolidation is a new concept, but it is becoming more and more popular. According to the survey conducted, it was found out that both farmers and professionals from various institutions (34 and 45 percent, respectively) are interested and would like to participate in the implementation of land consolidation. This shows that the third of the farmers, and almost a half of the surveyed specialists

are ready for new challenges, so it makes sense to evaluate the need of land consolidation and to find the most appropriate and effective method for the implementation of these projects in Latvia.
The situation in Estonia is similar. Jürgenson (2016) argues that in this country land consolidation projects were implemented after the independence of 1919 and 1990. Unfortunately, these projects have not been further developed. Estonian politicians, the authorities, land owners also would like to see that land consolidation is one of the tools that enable the development of a comprehensive and sustainable management of territories.
As for the land consolidation impact on the environment, most of the analyzed authors agree with the fact that the analyzed projects can make a significant contribution to improving the environment. Hiironen and Niukkanen (2012) found that the implementation of the main land consolidation task – transforming the scattered land parcels, enables air pollution and greenhouse effect reduction, because the environment gets less carbon dioxide emissions. This is due to the fact that farmers no longer have to go to every managed land parcel scattered across the farming area (in this case, they are designed into larger land parcels, close to the farmstead), which results in reducing the cost of fuel used, and which leads to negative consequences for the environment.
Land consolidation can contribute to increasing the biomass. These studies were carried out in one of the Chinese provinces – Hubei. The survey analyzed by the authors showed that the implementation of certain measures of land consolidation increases biomass levels (Table 2).

Table 2

Biomass calculation before and after land consolidation project (Yu et al., 2014)

Type of plant	Total area hm^2		Average biomass t/hm^2		Total biomass t		(%)		Biomass change t
	Before LD	After LD	Before LD	After LD	Before LD	After LD	Before LD	After LD	
Open forest	3.140	3.14	19.870	19.870	62.392	62.392	6.79	4.16	0
Aspen forest	0.000	2.41	0.000	52.042	0.000	125.421	0	8.37	125.421
Waste grassplot	13.559	0.00	1.352	0.000	18.332	0.000	2	0	-18.332
Rice	70.170	124.78	6.010	7.210	421.722	899.664	45.92	60.04	477.942
Dry-land crop	130.035	104.07	3.200	3.950	416.112	411.077	45.30	27.43	-5.035
Total biomass					918.558	1498.554	100	100	579.996

The positive trend is that the biomass in the analyzed territory has increased by almost 580 tons. Mostly, the biomass of rice increased, the least – aspen forest, and there were such groups of plants which biomass unchanged or even decreased. Biomass increase can reduce soil erosion, greenhouse gas (carbon dioxide), and its changes contribute to the landscape structure change.
Measures of land consolidation, related to environmental protection and improvement of the environment in Europe, are already quite common. Measures taken during the land consolidation in Poland, for example, were as follows: arranged most of reclamation systems; afforested unproductive lands; submitted proposals to farmers on starting organic farming. These measures have already been implemented in one of villages located in Poland – Hucisko (Fig. 1).

a b

Fig. 1. Implementation of environmental measures during the land consolidation in Hucisko surroundings (Poland): a) – renovated reclamation system and designed culverts; d) the afforestation of unproductive lands (Leń et al., 2016)

The analyzed land consolidation project in Hucisko settlement lasted for three years (2011 - 2013). Not only reclamation systems were renovated and a certain area was afforested, but other important works related to the improvement of life and transformation of land parcels were carried out as well. The total result of the land consolidation – the number of land parcels decreased from 2,355 to 1,568. An example, where environmental protection measures are to be implemented through land consolidation projects, refers to Slovakia (Hudecová, 2015). One of the consolidation projects was selected in Prešovský settlement. In this project, one of the tasks focused on the reduction of soil erosion (Fig. 2).

a b

Fig. 2. The implemented land consolidation project in Slovakia, Prešovský territory: a) the situation before the land consolidation; b), the situation after the land consolidation (Muchová, 2016)

After the planting of an alley of trees along the road, fewer pollutants will fall into cultivated fields, at the same time it will prevent the wind erosion on nearby cultivated land.
In terms of a landscape, land consolidation projects can contribute to the improvement of its structure. In one of the settlements in Cyprus Vyzakia, Nikitari, effective results were achieved not only in the environmental field, but it was a complex transformation taking into account the economic and social aspects (Fig. 3).

Fig. 3. Complex redevelopment of the terrritory in one of the settlements in Cyprus (Land..., 2012)

The presented figure shows that it is possible to design and implement coherent and integrated rural development decisions during the preparation of land consolidation projects. In this case, surroundings were afforested with tree plantations, also local and farmers' roads were designed. This once again proves that the land consolidation can be an effective tool for implementing most of the problems existing in rural areas and connected with the environment and welfare.
Another relevant measure is the preservation of biodiversity, which may contribute to the consolidation of projects. Currently, biodiversity is constantly declining, which has an extremely negative impact on the environment. In order to preserve and enrich it, it is important to design such land parcels during the preparation of land consolidation projects that their size and shape should be more favorable to biodiversity.
The favorable landscaping issue is widely discussed by quite a lot of authors, one of them is Forman Richard T. T. (1995), who has precisely identified favorable and unfavorable landscaping cases. According to the above-mentioned author, specific biodiversity-friendly landscape mosaic development alternatives were designed (Fig. 4).

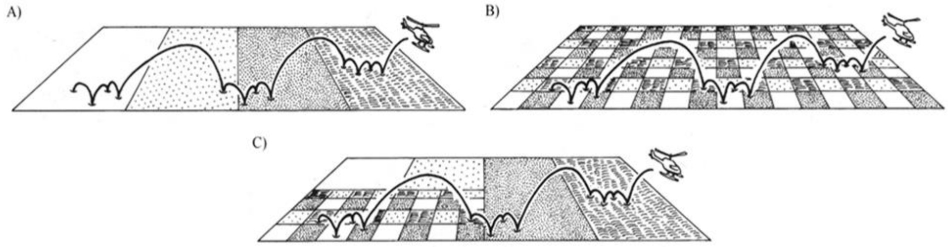

Fig. 4. Biodiversity favorable landscape structure development alternatives (by R. Forman (1995)). A) a large variety of landscape level, but small variety of area level (a very suitable habitat for internal types, specialized types, a wide range of environmental conditions); B) very suitable for peripheral species, for species, which are in need of habitat diversity, these are the most common species; C) landscape architecture suitable for most types

The analysis of the three options showed that alternative C is the most favorable for biodiversity, because it contains all the components of biodiversity conservation and restocking. Alternative C includes suitable habitat for both internal as well as peripheral species.
After the critical analysis of a wide range of scientific literature, it can be said that it is possible to achieve good results in the preservation of the environment in the area during the preparation of land consolidation projects by doing the following:

- reducing soil erosion;
- arranging reclamation facilities;
- preserving biodiversity;
- reducing air pollution;
- properly shaping the land;
- renovation of the landscape.

As for the negative impact of land consolidation on the environment, it is important to properly and competently implement these projects, so that they would bring the expected benefits. If only the improvement of economic conditions will be taken into account during the preparatory phase, also negative damage could be done to the environment. This is confirmed by several authors (Jun et al., 2015), who found that if only the arable land will be increased at the expense of natural meadows, wetlands and other useful natural areas, then the ecological stability of the territory will be reduced. In terms of biodiversity conservation, according to Osawa et al., 2016, if there is a consolidation of a large area and with endangered species in it, these projects are likely to reduce their emissions, and it will result in significant harm to the environment. Therefore, it is important that during the preparation and implementation of land consolidation projects environmental specialists should be involved, who would single out areas sensitive to human economic activities and provide appropriate environmental measures for the solving of these problems (Kupidura, 2010; Gilvickienė, 2009).
In summary it can be said that the land consolidation is a unique tool for the implementation of the tasks related to sustainable rural development. We are glad that in most countries environmental protection and improvement are taken into account in land consolidation. Six fields were identified, in which good results can be achieved in the field of environmental conservation during the preparation of analyzed projects. It is important to note the fact that the land consolidation process may bring negative consequences to the environment if it is focused only on the economic conditions, and without any regard to environmental aspects.

Conclusions and proposals

1. It was found that the land consolidation projects are an excellent means to ensure sustainable development of the territory. It is possible to create cost-effective and socially significant environmental areas during the development of these projects.
2. The analysis carried out in selected European countries found that land consolidation could contribute significantly to environmental protection, so other countries could benefit from this experience during the preparation of these projects.
3. The most important tasks during the consolidation of land parcels that could improve the environment include: reduction of soil erosion; arrangement of draining facilities; biodiversity conservation; reduction of air pollution; suitable land parcels formation and landscape renovation.

4. It is very important to assess the potential impact on the environment during the land consolidation through the development of these projects and provide for such reorganization measures without having negative consequences for the environment and its components. Therefore, it is proposed to consult with environmental specialists and other stakeholders on nature conservation issues.

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EVALUATION OF RESIDENTIAL URBAN AREAS IN LITHUANIA

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Abstract
The priority objective of the residential urban areas development – to improve the quality of life, sustainable development principles in order to form compact urban areas and polycentric functionally and socially integrated urban and suburban structure with the help of efforts of general public institutions as well as natural and legal persons. A living area today must comply with the needs of population from various social layers, so, when planning residential areas, it is necessary to assess the varied potential of the population needs and the quality of life expression. Therefore the article seeks to find out attitudes to residents' environment, development of social services network, infrastructure condition, functional and planned structure of the area. For the implementation of the objective, the programme in the research sites has been prepared. This programme allows multifaceted examination of existing residential areas, the assessment of their physical condition, public opinion, public needs, comments and suggestions of professionals. After analyzing the results of the research and drafting conceptual principles, it can be stated that the future of Lithuanian residential districts and cities depends on the territorial spatial planning system, which is affected by the free market and democratic society. Territorial spatial planning of residential microdistricts or blocks is the key to building sustainable and attractive cities.
Keywords: residential area of the city, the city, the urban environment.

Introduction

City (urban environment) should be understood as a complex system which consists of interrelated and mutually operating parts – urban society (community), the natural elements of nature and anthropogenic components. A modern city is not just residential and industrial areas, complex engineering communication, but also the environment in which individuals live, pursuing leisure and recreation, work, learn and, of course, communicate with each other. It is for these reasons the city should allow the development of society, a humane environment for modern community needs should be developed as well. It follows that the main aim of the development of the urban environment is to create a socially, economically and technically based, environmentally sound, aesthetic and effectively controlled environment, in line with the changing urban community and the needs of a single individual, encouraging them to participate in the environmental development and design solutions (Burinskienė, 2011; Jakovlevas – Mateckis, 2008).

The future of Lithuanian cities mostly depends on efficiency of the existing spatial planning framework and planning methodologies. Residential urban areas planning issues were examined by A. Miškinis (1991), K. Šešėlis (1996), M. Burinskienė (2003), P. Juškevičius (2003), J. Bučas (2008) and others. Also, considerable attention is paid to the historical development of cities and evolution of modern urban theory, taking into account population dynamics, their needs, urban aesthetics, its' expression in a common European context.

The entire today's spatial planning policy focuses on sustainable urban development. Sustainable urban development and spatial planning processes are defined by such strategic international and national instruments as "The Charter of European cities & towns towards sustainability" (1994), "The Long - term development strategy" (2002), "The European Urban Charter" (1993), "The Operational programme for the European Union funds' investments in 2014 - 2020" (2014), "The Guiding principles for sustainable spatial development of the European continent" (2000), "The Leipzig Charter on sustainable cities" (2007) and "The Rio Declaration on Environment and Development" (1992). The twenty first century urban challenges, according to I. Gražulevičiūtė – Vilenskienė, A. Ražauskaitė, L. Ažukaitė, V. Bartininkaitė, V. Kulbokaitė, J. Kameneckas (2011), include responsible use of energy resources, urban sustainable development, complex renovation of existing residential buildings and construction of new ones, social exclusion reduction, public transport development, pollution reduction – all of which should be carried out in real estate development. These issues and processes must excite real estate developers because of sustainable urban development being the backbone of the economy.

When examining cities, it is important to explore the urban residential areas forming factors in terms of sustainable urban development as well as to formulate principles of residential areas while assessing the modern aesthetic, economic and ecological aspects of urban development.

The priority objective of residential urban areas development is to improve the quality of life, to form compact urban areas and a polycentric functionally and socially integrated urban and suburban structure by sustainable development principles with the help of general public institutions as well as natural and legal persons' efforts.

The purpose of this article is to assess the structural features of Lithuanian urban residential areas. The following **objectives** were set in order to achieve the goal:

- to analyze Lithuanian urban residential areas, to assess spatial planning factors;
- to assess the population and professional approach towards the environment, development of social services network, condition of the infrastructure, functional planned structure of the territory;
- to provide basic urban residential areas development features (after having finished the research).

Methodology of research and materials

To reach the aim, the quantitative research method was selected: a program in research sites was prepared, which allows the multifaceted examination of existing residential areas, the assessment of their physical condition, public opinion, public needs, professionals' comments and suggestions. The research was carried out using a questionnaire.

Residential areas in different cities of Lithuania were selected as the research object: in Vilnius – Lazdynai and Perkūnkiemis districts, in Kaunas – Dainava, Vytėnai, Užliedžiai, Vaišvydava districts, in Klaipėda – Gandrališkės microdistrict. Those areas were selected in order to compare the Soviet era urban projects with modern spatial planning projects, estimating their volume and quality. Dainava and Lazdynai districts (Fig. 1) were selected as examples of Soviet urban development in different cities, revealing the state's approach of that period to the development of residential areas, housing of people. These are large residential areas with their own infrastructure, a complex layout, which cannot be said of modern urban projects, which even by their volume cannot be compared to the construction of that time.

Fig. 1. Lazdynai microdistrict

Perkūnkiemis and Gandrališkės microdistricts were selected as examples of modern urban development (Fig. 2). They are small, but one piece urban complexes, solved architecturally by their engineering infrastructure depending on urban base.

Fig.2. Gandrališkės residential area

In order to better and more accurately analyze urban residential areas, to assess the spatial planning factors, functional zoning, the internal structure, the survey among representatives of urban population and specialists in Vilnius, Kaunas, Klaipeda was carried out.

The questionnaires with questions on urban residential areas, their correspondence to the present day needs, infrastructure condition, the meeting of needs of green areas as well as recreational areas, the architectural and urban attractiveness, and the meeting of social needs were sent out electronically to representatives of urban population. The questionnaire was filled only by persons living in urban residential areas.

As for professionals, the questionnaires were filled in on the paper. The survey involved architects working according to their profession, lectures. They were expected to express their professional approach towards today's residential areas, their problems, development trends, architectural expression, harmonious society trends.

During the survey a total of 279 questionnaires were received from Vilnius, Kaunas, Klaipeda urban population. The demographic analysis of respondents showed that 73.8% were 19-29 years of age, 21.4% – up to 60 years of age, 4.8% – up to 18 years of age; 64.3% of respondents were women, 66.7% of respondents were with higher education.

Ten architects, including six professors and lecturers, participated in the survey and expressed their opinion. All respondents indicated an age range from 30 to 59 years, of which four were men and six were women.

Discussion and results

The results of the survey results reflect the current situation in residential urban areas: the internal and external factors, parts of the city's specifics. According to the population and professionals' survey data, the urban structure of the city is gradually changing because of business and public investments, general life quality indicators have been increasing, however, the most important problems of the city show the disparities in the development of individual areas. According to the architects, the future of the cities in Lithuania is mainly dependent on the existing spatial planning framework and efficiency of planning methodologies. The population survey show that urban residents positively estimate ongoing changes. Most of them, 61.9% are satisfied with their places of residence, 9.5% expressed dissatisfaction as they live in old buildings, 33.3% are unsatisfied, because they live with their parents, or there is too noisy for them. Even 30.3% of respondents who are satisfied with their place of residence state a quiet environment as the main reason, 20.2% – well-developed public transport, the city center, 19.1% – the benefits of the greenery.

The sector of social services development lacks jobs, 42.9% of respondents indicated that there are not enough jobs, and only 7.1% do not see it as a problem. An even greater problem is considered to be the lack of entertainment, 59.5% of the population believe that entertainment opportunities are not enough in a residential district, 4.8% believe that this problem does not exist.

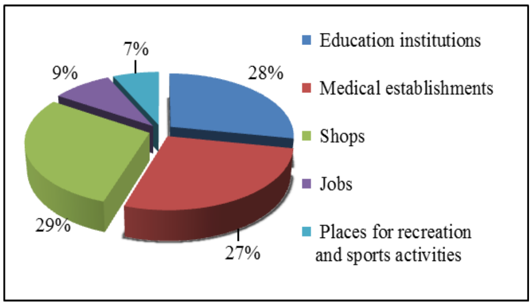
The survey data reveals the fact that the residents do not really miss the rest zones. 33.3% of respondents indicate that there are simply no rest zones in the places they live, 19.0% use them once a week and only 4.8% use them daily. All the others just do not use rest zones or do not have time for that.

From the architectural and urban point of view, the residents are pleased with current building density (81.0%) and height (57.1%), and there is no need to change anything. The current infrastructure does not meet the needs of the interviewees, the insufficient quantity of car parks is indicated by 38.1%, the insufficient quantity of pedestrian paths and parks was expressed by, respectively 40.5% and 38.1% of the population, 47.6% of the respondents missed bicycle paths.

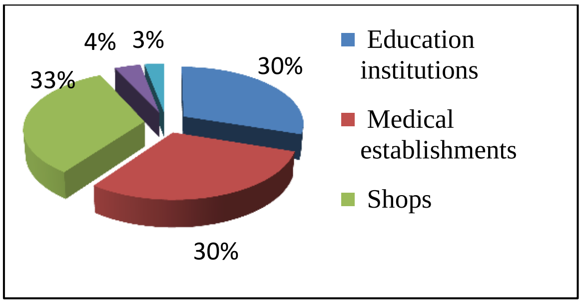
54.8% of respondents assess the architectural appearance of residential buildings as average, 21.4% – as bad. 40.5% of the population use public transport and private vehicles, 16.7% walk on foot and only 2.4% ride a bicycle. 59.5% of respondents keep their cars in yard sites, 16.7% – to the street side of the road and 14.3% – in their own garage. 42.9% of respondents prefer the place for residential area with respect to the city on outskirts of the city, a large number of population gives priority to the city center – 35.7%, in the suburbs –19.0%, out of town – 2.4%. 42.9% of respondents indicated that house should be of modern architecture, modern construction residential house. The most popular is the new housing construction – a private dwelling house followed by new construction cottages in second place, and the least acceptable – the Soviet era buildings.

Their approach to the creation trends of new residential areas is clearly positive, but that development should be regulated to avoid architectural chaos (66.3%), others pointed out that we have to use what we have, and then create a new one. Development of residential areas is also available, but it must be regulated so as to be carried out in a compact development pattern by recycling of the existing residential fund.

Respondents consider that social services network is the best developed in the old microdistricts, the worst developed – in residential areas of new construction. 50% of those surveyed assess territorial layout as the average, others appreciate the layout of old microdistricts as bad – of new ones. Opinion of residents and professionals overlap in the sector of social services development (Fig. 3).



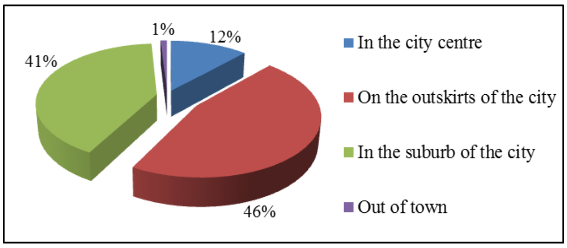
Residents' opinion



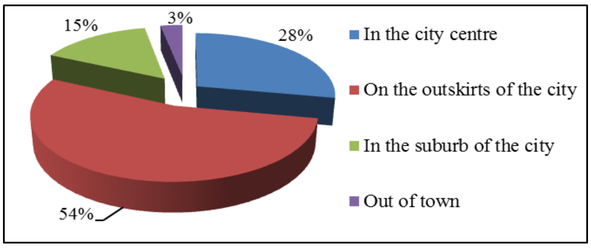
Specialists' opinion

Fig.3. Analysis of the development of social services

Most residents prefer the outskirts of the city as the perfect place for their residential area, only with different causes (Fig. 4). Professionals see efficient and economical houses, urban construction compaction and urban development opportunities while reconstructing urban space of the city, and the residents would like to see peaceful environment. However, in the more remote urban areas kindergarten and school infrastructure problem remains relevant. Typically, residents are forced to use the network of social institutions in the surrounding areas. And it causes them some discomfort.



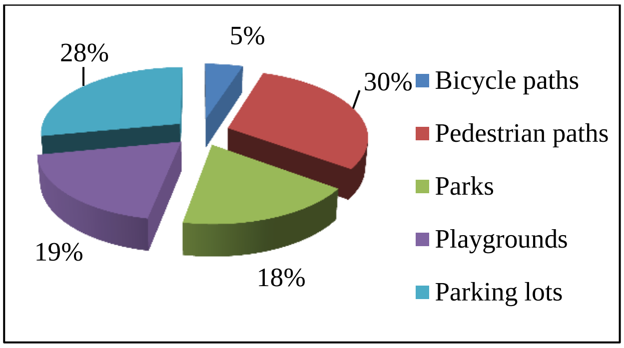
Residents' opinion



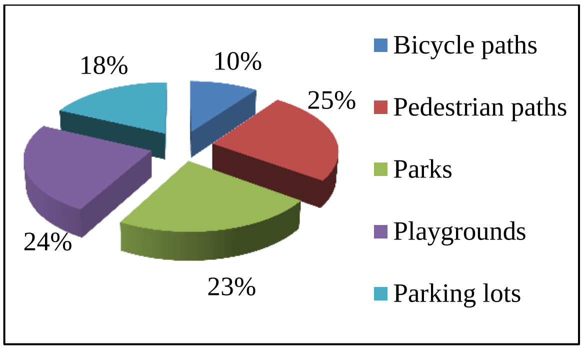
Specialists' opinion

Fig.4. Analysis of residential areas' situation with respect to the city

Unambiguously, a bad situation is with bicycle paths infrastructure. Respondents have two options for replies: the situation simply does not exist or situation is bad. The development of pedestrian paths is better in the old microdistricts, the situation is worse in new ones. The majority of respondents assessed their condition as moderate. There is a shortage of parks as well. If the medium of parks is sufficient in the old districts, there are no parks at all in the new districts. The opposite situation is with children's playgrounds. If in some new areas they are already being arranged, their situation in old ones is bad, because no one is restoring the deteriorated playgrounds. The old districts do not satisfy the requirements for car parking. In new areas this problem is solved better. It is proposed to expand the network of underground garages, to increase the yard areas or build car parking facilities near the street (Fig. 4).



Residents' opinion



Specialists' opinion

Fig. 5. Infrastructure development analysis.

The architectural expression of the buildings is being evaluated as average, because there is no unified concept of the whole quarter, blocks group, district. Construction of apartments is dominated by economy-class quality. There is a lack of regulation of visual harmony and attention to it. Most respondents believe that the most appropriate development of residential areas should be in the outskirts of the city or the suburbs. The city should limit the spatial development into the natural areas. In the center and inner areas the conversion and renovation would be possible, in the suburbs – new construction, but limited. Most of the speakers named modern building as the preferred architecture, because they do not have problems of old houses, i.e. central heating, poor thermal resistance and so on. All respondents were in favor of a compact city model, whereas the urban area is a finite environmental resource, so it is preferable from ecological point of view.

Conclusions

1. The collected and systemized survey results of residents and specialists show that residents care about their environment, but usually their quality of life is determined by the financial possibilities. Specialists expressed an opinion, their vision encourages the planning development of residential areas, while maintaining the principle of seniority and responsibility for assessing architectural - urban coherence importance. However, it can also be argued that modern residential construction does not fulfill all the essential requirements related to population's comprehensive welfare. Just private initiatives are not enough for its implementation, appropriate public policies helping the private investors to create the perfect environment for the country's urban population are necessary.
2. Residents and professionals have the same opinion on social services sector regarding the importance of education, medical facilities and stores network which dominate the suburban and urban outskirt areas in relation to residential areas; the infrastructure development sector lacks bicycle paths and playgrounds for children. Professionals pay great attention to green areas, pedestrian and bicycle paths infrastructure in both the newly designed areas as well as in existing urban ones.
3. After having analyzed the results of the research as well as having drafted conceptual principles, it can be stated that the future of Lithuanian residential areas and cities depends on the spatial planning system, which is affected by free market and democratic society. Territorial spatial planning of residential microdistricts or blocks is the key to building sustainable and attractive cities.

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INVENTORY OF LAND AS THE FORMING TOOL FOR THE STATE LAND CADASTRE OF UKRAINE IN MODERN CONDITIONS

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Abstract
One of the primary measures of the land reform is to create the national land registry and related land information database, which can be formed only through a complete inventory of land. This article analyses land inventory data in the current stage of land cadastre functioning and development of land relations, as well as discusses justification of organizational and legislative preconditions for land inventory in Ukraine.
Keywords: land inventory, land management, the state land cadastre, foreign experience.

Introduction
Land conversion in Ukraine led to significant changes in land relations, land use and land ownership. The transition to a market economy has put the community challenges. Under these conditions, arrays of land parcels require additional continuous surveying and clarification of land ownership rights essential to prevent conflicts and loss of land relations subjects caused by unreliable public inventory information about them.
The problems of the state land cadastre and land inventory in Ukraine have been investigated in the works of national scientists, such as V. M. Gorbatyuk, B. S. Huzar, V. N. Dmytrusenko, V.M. Zhuk, D. S. Dobriak, O.S. Dorosh (Dorosh, 2015), M. N. Kalyuzhny (Kalyuzhny, 2011), A.G. Martyn (Martyn, 2011) A.M. Tretiak and others. Nevertheless, the debate about the nature and contents of the inventory of land as a means of obtaining, updating and correcting information on the status of land ownership and land use, which should be entered into the State Land Cadastre of Ukraine are continuing nowadays.
The aim of the article is to highlight the problems of effective implementation and use of land inventory materials in the current land relations in Ukraine.

Methodology of research and materials
General scientific principles, theoretical principles of economic science to evaluate the efficiency of the land inventory in the process of filling in the database of the state land cadaster serve as the theoretical and methodological basis of the research.
To achieve the aim of the research, the following research methods were used: monographic (when writing scientific works on problems of land inventory); abstract - logical (in the justification of the theoretical basis of land inventory for the purposes of the state land cadastre); analysis and synthesis (for complex assessment and justification of the current state of the land inventory in Ukraine, analysis of foreign cadastral systems); statistical, analytical, comparative analysis (the study of the inventory of land in Ukraine, establishing quantitative and qualitative characteristics of lands according to categories, owners and users), abstraction and concretization, by which the mechanism and features of reflection of inventory results in accounting were studied.
The research is based on the laws of Ukraine, decrees of the Cabinet of Ministers of Ukraine and the Verkhovna Rada of Ukraine; statistical data of the State Service of Ukraine on Geodesy, Cartography and Cadastre, State statistics Committee; monographs and scientific articles, the literature of national and foreign scientists, materials of scientific conferences, Internet resources, as well as the author's own research.

Results and discussion
The current cadastral registration system is designed to provide a permanent inventory of land in Ukraine in the process of comparing available public data on land ownership objects with their actual state and use.
It can be effective when making strategic decisions on territorial development, building infrastructure, implementation of other major investment projects for change of land use.
Development of land property relations in Ukraine has now a stronger impact on the state economy and welfare improvement. One of the key aspects of sustainable development of the economy and improvement of the investment climate is authenticity, depth and ease of access to inventory data. In this context, the construction of the cadastral system in Ukraine should be based on the best

achievements of cadastral systems of the leading countries with taking into account national traditions, laws, and technological approaches to available material and technical base.
With the adoption of the Law of Ukraine ”On State Land Cadastre” we faced an urgent need for the formation of a single state geographic information data system on land located within the state borders of Ukraine, therefore improving the quality of cadastre data should be linked with inventory of lands. It is believed that the inventory will transfer land relations to a qualitatively new level of development that will answer the burning questions related to the current state of land use and tenure (Law of Ukraine, 2011).
The term “inventory” (from the Latin ”invenire”) is a process drawing up a detailed description of the property (Pustovit, 2000, pp. 713). Often the term ”inventory” is used to determine an element of an accounting method, which is determined by the actual amount of assets, capital and liabilities as well as a comparison of the results of the accounting data.
Word form ”inventory” is borrowed from German and is a derivative of ”equipment” (in 1713 - ”inventarium”, in 1743 - “inventor” and only in 1797 - ”inventory”) (Bardash, 1999).
We can conclude that, at the time of its inception, inventory solved two main tasks: identified the value of property, which actually has a particular owner, and ensured its proper storage. This is because the accounting itself in ancient Egypt, China, Greece and other countries was intended more for the registration of facts than for making decisions; not only for property management, but how to ensure its preservation (Demyanenko and Chudovec, 2008).
The condition of the state land cadastre in Ukraine will soon reach the level of leading European countries, where each land parcel has its cadastral number, which will be one of the steps to complete the land reform and regulations of land relations.
In the internationally accepted definition of Cadastre, approved by the United Nations together with the International Federation of Surveyors in its Bogor Declaration at the international meeting of UN experts in inventory (1996), ”inventory” means constantly updated information system data on land, divided into sections (parcels), which registered property rights (rights, burdens and responsibilities) (The Bogor declaration, 1996).
As regards the practice in the world, there are three basic inventory systems (Larsson, 2001):

- Torence, which operates in the US, Canada and other Latin American countries.
- Napoleonic (French), at France and its former colonies.
- Prussian or German - Germany and other countries in Central and Northern Europe.

The study of modern world experience of inventories shows that in almost all developed countries this process is the task of the national scale. In most European countries land registration is in the form of land inventories, in addition, in many countries there is inventory as a form of registration of all real estate, but the more common single state cadastral registration system that contains information about legal rights, value and purpose of the estate objects.
Today in Ukraine institutional support and formation of the state land cadastre and registration of real estate significantly lags behind the needs of the practice and regulation of property relations. The creation of a single state cadastral system that provides individualization and identification of real estate and development of tax assessment institute of land is one of the major problems (Zayats et. al., 2016).
Legislature inventory of land in Ukraine is imperfect. According to the Cabinet of Ministers of Ukraine ”On approval of inventory lands” (Resolution of the Cabinet of Ukraine, 2012) and Article 35 of the Law of Ukraine ”On Land Management” (Law of Ukraine, 2013), state land inventory in modern conditions is designed to solve the following tasks:

- to ensure the completeness of information on all land plots, cadastral zones and quarters, administrative and territorial units in Ukraine in the state land cadastre;
- to provide validation of semantic and mapping data on land with already existing state registered documents;
- to ensure the identification and registration restrictions in land use (territorial zones) around existing objects of special regime (Martyn, 2007).

The total area of land in Ukraine is 60.4 million hectares. Of these, 70% - 42.4 million ha are agricultural land, of which 32 mln. ha are annually handled over. To compare, in Poland in agricultural production twice smaller areas are involved - 14 million ha, in Germany - 12 million ha, in Romania - 9 million ha. Amount of chernozem soil in Ukraine is the largest in the world and comprises 28 million ha.

In Ukraine, an inventory of land has been implemented since 1991 - land settlements, non-agricultural land outside settlements and agricultural lands of state properties. According to the State Service of Ukraine on Geodesy, Cartography and Cadastre in Ukraine an inventory is required for: 7 579.63 thousand ha of land settlements, 10 512.12 thousand ha of non-agricultural land outside settlements and 8463.077 ha agricultural land of state properties (Table 1). Table 1 contains the data from the State land cadastre service about of the inventory of lands in Ukraine by 01.07.2016.

As of July 1, 2016, the inventory was made for 5167.89 thousand ha, which is 68.2% from the total land area of settlements. The analysis of the data (Fig. 1) show that the inventory has been implemented in almost all the land within settlements (90 - 100%) in Vinnytsia, Rivne and Chernivtsi regions. The lowest percentage (50%) which was covered by the inventory belongs to lands within Cherkassy, Chernihiv and Zhytomyr regions. This low percentage within settlements creates issues for the organization of permanent control over land use in towns and out of towns; adoption of decisions on land relations by local authorities and executive bodies under their competence defined by the Land Code of Ukraine.

Currently in Ukraine there are 27,590 settlements, including 1,345 in urban areas; they have been incorporated in 170 communities since November 1, 2016.

The community of a village or a city, as a result of inventory, should:

- receive already created complete database of all land within the settlement in paper and electronic media. Because of this, investment attractiveness increases making easier to search for potential investors for land and urban needs;
- authorities obtain an opportunity of constant monitoring of the use of land in the settlement;
- receive an ability to identify all land users, land owners with the establishment of the boundaries of their land parcels;
- be able to identify land parcels unused or inefficiently (inappropriately) used.

In connection with the future decentralization of authorities which should take place in Ukraine and the future consolidation of communities through their associations, land inventory will be a key factor in their future success and development of each community in particular.

An inventory was made for 8401.96 thousand ha of non-agricultural lands outside settlements, which is 79.9% (Table 1). In Chernivtsi and Zakarpatska regions 100% of the inventory was implemented. According to Zaporizhia, Ternopil, Vinnytsia, Rivne, Chernihiv and Luhansk regions, surveyors conducted an inventory of more than 90% of the land. The smallest area of the implemented inventory of land belong to Sumska and Ivano - Frankivska regions (Fig. 2).

The inventory of agricultural land of state property was implemented on the area of 1549.329 thousand hectares, this is done to update the data of quantitative and qualitative characteristics of lands into categories, owners and users. This is one of the highest percentages of inventory of land in Ukraine – 18.3 % (Table 1). Only Chernivtsi region fully completed the work on land inventory (100 %). Surveyors of Ternopil, Ivano - Frankivsk, Rivne and Volyn regions partly completed the inventory of agricultural land state property (41.8% - 52.6%). The least covered territory of the implemented inventory of land belongs to 6 regions of Ukraine (10% of area) (Fig. 3).

42.1 million hectares of land were recorded in the State Land Cadastre as of January 1, 2017, which represented 70% of the total area of Ukraine. The information was recorded on 15.9 million plots of land, of which 6 million was agricultural land with the total area of 21.5 million hectares.

Experts in land management estimated which land parcels have been irrationally contaminated and those that are subject to conservation. However, filling in the content of the national cadastral system is slow due to controversial delimitation of adjacent areas, the presence of boundary disputes, discrepancy in coordinate systems and others.

Analyzing these data (Table 1 and Fig. 1, 2, 3) it can be noted that only one region (Chernivtsi) has completed inventory of all lands. This is because currently, the volume of work on the inventory of land in Ukraine is insufficient, due to both underfunding by the state and the lack of interest in their local performance. This problem needs attention from both public authorities and local governments.

Table 1

Information of the inventory of lands in Ukraine

№	Name of administrative territorial unit	Total area region, thousand hectares	Settlements		Non-agricultural lands outside settlements		Agricultural lands of state property's	
			Total area, thousand hectares	Areas where inventory was made, thousand hectares	Total area, thousand hectares	Areas where inventory was made, thousand hectares	Total area, thousand hectares	Areas where inventory was made, thousand hectares
1	Vinnytsia region	2649.2	380.40	346.70	369.60	357.80	464.493	196.170
2	Volyn region	2014.4	312.00	241.80	561.70	493.68	234.720	98.228
3	Dnipropetrovsk region	3192.3	362.83	261.87	262.93	132.11	616.496	216.985
4	Donetsk region	2651.7	365.40	205.07	186.10	123.06	310.732	28.108
5	Zhytomyr region	2982.7	312.83	129.70	1174.00	1044.50	364.800	39.510
6	Zakarpatska region	1275.3	222.70	189.60	601.70	601.70	157.022	46.287
7	Zaporizhia region	2718.3	237.90	207.49	120.56	108.61	405.817	119.680
8	Ivano-Frankivsk region	1392.7	427.07	239.59	606.70	102.40	81.863	41.859
9	Kyiv region	2812.1	420.69	259.06	663.20	379.47	189.956	58.396
10	Kirovohrad region	2458.8	227.90	166.80	165.40	144.40	526.406	62.694
11	Lugansk region	2668.3	422.00	300.10	345.00	330.20	209.296	13.754
12	Lviv region	2183.1	438.60	306.98	722.80	552.90	349.423	61.469
13	Mykolayiv region	2458.5	146.70	105.80	163.10	144.70	449.100	59.524
14	Odesa region	3331.4	282.30	186.00	205.10	183.30	354.160	32.558
15	Poltava region	2875	426.31	236.79	289.33	228.06	514.730	20.745
16	Rivne region	2005.1	209.50	199.70	760.60	738.00	166.140	70.034
17	Sum region	2383.2	238.96	152.48	469.11	224.44	274.562	45.121
18	Ternopil region	1382.4	335.18	263.60	176.19	164.38	84.867	44.630
19	Kharkiv region	3141.8	306.74	157.00	397.96	332.41	525.811	94.472
20	Kherson region	2846.1	135.30	91.73	299.60	267.20	424.510	37.958
21	Khmelnytskyi region	2062.9	299.01	265.61	284.71	237.10	260.875	38.114
22	Cherkassy region	2091.6	284.22	138.93	334.69	265.14	319.711	59.622
23	Chernivtsi region	809.6	198.50	191.10	269.00	269.00	14.257	14.257
24	Chernigiv region	3190.2	300.80	147.30	679.60	667.80	1163.331	47.156
	Total		7579.63	5167.89	10512.12	8401.96	8463.077	1549.329

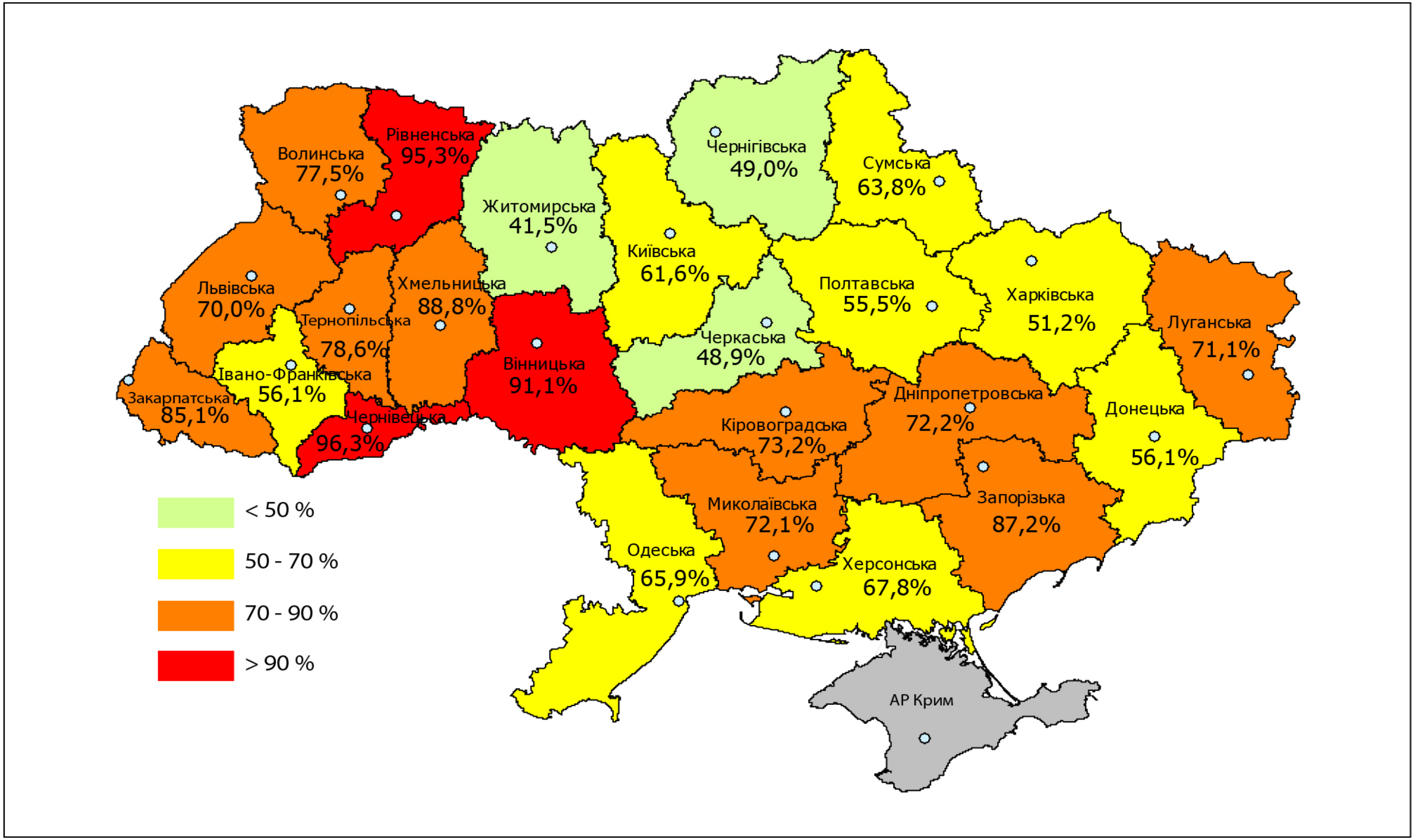

Fig. 1. The percent of lands within settlements where were inventory was made, in the structure of land region

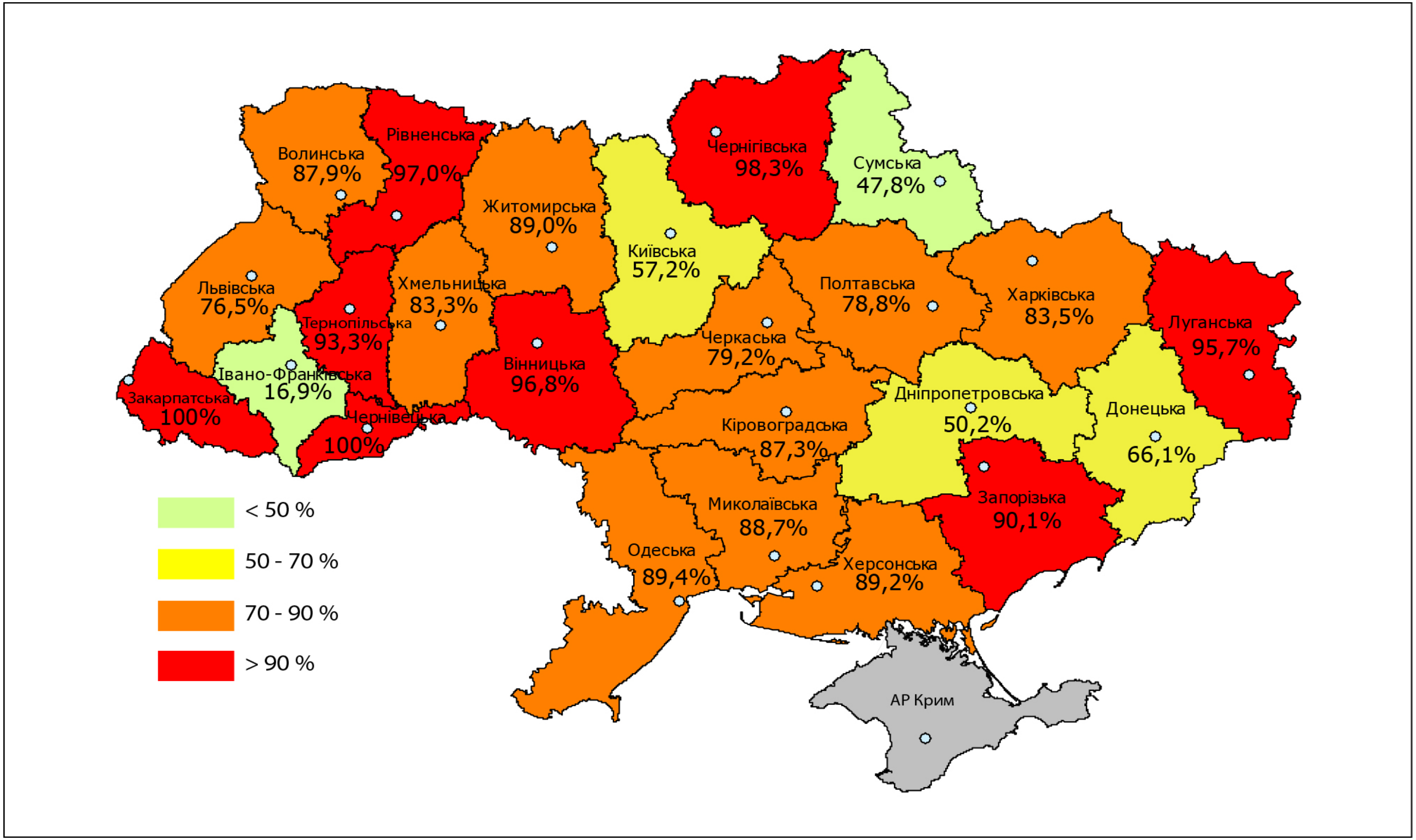

Fig. 2. The percent of non-agricultural lands outside settlements where were inventory was made, in the structure of land region

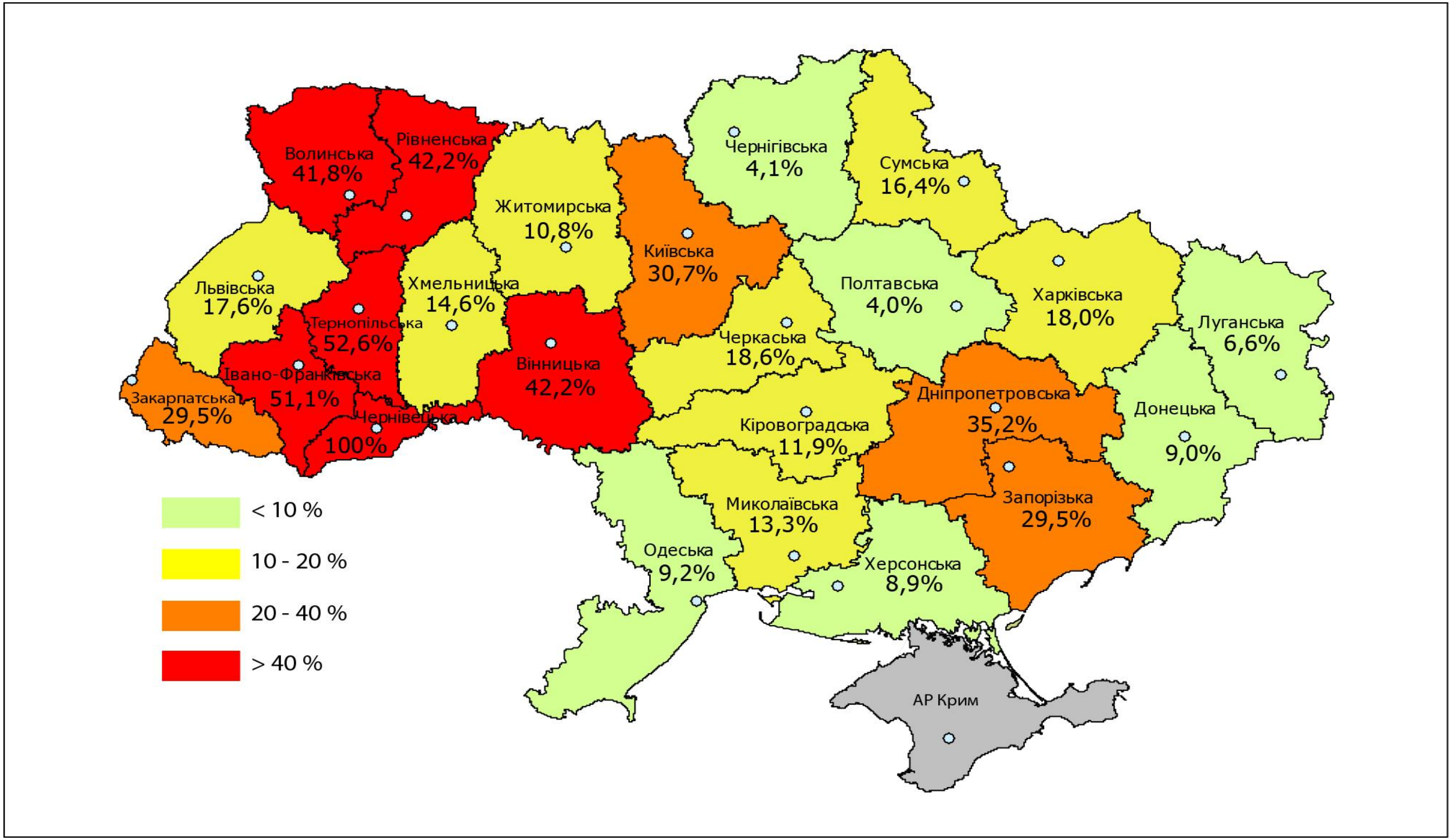

Fig. 3. The percent of agricultural lands of state property's where were inventory was made, in the structure of land region

Conclusions

1. The analysis of the cadastral information system of foreign countries allows to conclude what is common in cadastral information systems, and what are significant differences in the understanding of the land cadastre, its organizational structure and methods of implementation.
2. Inventory is an effective way to ensure the relevance and reliability of the state land cadastre data, land parcels used in various respects by their authorized subjects.
3. Implementation of the inventory of land in Ukraine will help to replenish and update information database for the cadastre. This will allow to transfer the State Land Cadastre data about land, details of which are missing in the state land cadastre, and registered documents of title to land.
4. Ukraine needs to speed up the the inventory of agricultural land. This will help fill in the National Cadastral System of Ukraine to complete the land reform and activate land market.
5. Inventory process for certain arrays of land parcels as a form of continuous inspection of properties (attributes) of the objects of property must be the result of feeling the need of land relations. This primarily refers to the local communities. This approach not only facilitates solving the problem of funding, but also will ensure efficient use of the funds ensuring the implementation of the principle of sufficiency when forming the database of the State Land Cadastre.
6. Techniques and components of inventory process are subject to improvement based on technology of land information systems. It takes into account the characteristics of each object of property through the use of advanced survey methods and descriptions that provide inventory data corresponding to their physical characteristics and use.
7. The state should provide adequate quality control of surveying and mapping procedures. The greatest economic impact at the state level and at the local government level can only be achieved with consistent work on the inventory process routine from the initial level - from a land user data to the overall - national system – the state land cadastre.

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MAIN DIRECTIONS OF URBAN LAND OPTIMIZATION IN KIEV AGGLOMERATION

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Abstract
Land as a production factor occupies a special position in the economic activities of the urban population. Land resources in big cities are not only territorial basis for placing industrial and production structures, but also a space for urban life in general. However, to assess the effectiveness of urban land use, primarily the ecological and economic potential of the use of the urban land resources should be determined aimed at sustainable development of urban agglomerations (Volodchenkov, 2010). The rapid pace of development of large cities in the world and an increase of their impact on the environment and society is accompanied by the set of economic, ecological and social problems which significantly influence the development of settlements in general (Stol′berh, 2000; Onyshchuk, 2001). However, the process of urbanization as a result of rapid scientific and technological revolution requires large areas for deployment of large scale production facilities and urban settlements in the conditions of natural resource management (Kontorovich, Rivkin, 1986).
Keywords: optimization, land resources, urban land resources.

Introduction

In general, "optimization" (from the Latin "optimus" - best) in scientific sources is understood as the process of providing anything of most favorable characteristics (Krivov V. M., 2010, p. 147). Considering the value of land resources as environmental, economic and social aspects of human life, the process of optimizing the spatial resources should also be combined with relevant areas of optimizing land use in general (Krivov V. M., 2010, p. 147). M. Maksimenko notes that (Maksimenko M. I., 2012, p. 164) "environmental component of optimization of land use is the perceived need of conservation and reasonable use of the land as the basic natural resource and the basis of environmental component, economic – in land use in those lands, where they will generate the most revenue, social – the adequacy of the nature of the land use status of social consciousness and social system's (social) needs" (Martin A. G., 2004, p. 8). So the term "optimizing the structure of land use" should be understand like the process of achieving optimal ratio and relative different types of land within a specific landscape (territory)" (Maksimenko M. I., 2012, p. 166).

Also, R. I. Bespalko, S. Yu. Hryschuk analyzing the identity of concepts "rationalization of land use" and "optimization of land use" in their work noted (Bespalko R. I., Hryschuk S. Yu., 2013, p. 227) that under the law of Ukraine "On the general scheme of planning the territory of Ukraine" (2002), one of the main tasks of perspective development of settlements is to optimize the structure of land use order to ensure their sustainability. According to the concept of sustainable development of settlements (1999) the term "optimization of the structure of land use" is used in the sense of measures to ensure the sustainable use of land resources".

A quite interesting analysis about the classical theories of spatial economy and agglomeration effects were made by Sh. I. Ibatullin (2007) in his scientific work. The scientist has presented his understanding about the theory of "concentric rings" by I. Tyunina. The main idea of it is the differential rent regulations and the main factor for the accommodation is transport costs. That is the land rent is equal to the saving on transport costs in the farms which are located near the centre of the city.

The problem of optimization of urban land in Kyiv is largely associated with the lack of science-based, rational land use policy. Today there is a steady trend of the lack of free land parcels in the downtown for the development of urban infrastructure, while the majority of urban land is used inefficiently. In particular, the density of buildings in some urban areas is low, but large areas are occupied by secondary objects, such as industrial warehouses, virtually non-working enterprises, farm buildings, excessive railways and transport infrastructure. All these factors motivate investors to establish new engineering objects in the new territories of (undeveloped) land that will lead to increased costs for installing the communications and their construction, repairing and modernization in the future. So the exploitation of these new buildings, from an economic point of view, is less effective than reconstruction (modernization, reindustrialization); displacement outside of settlements despite the irrational land using, which also occupy large areas of urban land (Novakovska I. O. et.al., 2014, P. 118).

The aim of research is to identify the main ways of optimizing land in Kiev for their ecological, economic and effective use.
Main object of research: industrial land use in Kyiv city.
Methodology of research and materials. The analysis was conducted using the methods of scientific publications, statistical analysis and synthesis.

Discussion and results
An important step to intensify the economic activity, business development, attraction of foreign investment in the city is the rational use of urban land considering international experience (deindustrialization of large settlements) and trends in modern developed cities. The main reasons for optimizing industrial areas of Kyiv are:

- Economic factors:
  - low tax revenues to the local budget from the land tax of the industrial lands compared to other functional land using;
  - costs of salaries for employees in industrial enterprises in Kiev are higher than in the suburbs;
  - the market value of the surrounding city land is low compared to similar areas without industrial facilities ”in the neighborhood”;
  - the logistics network of Kyiv city is inefficient for industrial needs.
- Environmental factors:
  - air pollution;
  - pollution of water sources of the city;
  - soil pollution.
- Social factors:
  - the trend of a decrease in the number of the employed in industry in Kiev; in particular, 122.1 thousand people were employed in the industrial sector in January of 2016, which is by 2.4 thousand people less than in 2015.

However, environmental and economic potential of Kyiv is associated with industrial development within urban land and expediency of transforming as an inefficient industrial facilities outside the city.
The total number of active companies in Kiev account for 1,044 industrial and other enterprises, in total they occupy 3.8 thousand hectares of land (Table 1).

Table 1

Area of land under industrial and other enterprises in the city of Kyiv

Industrial and other enterprises	**Quantity**	**The total land area, thousand hectares**
	1,044	3.8
Enterprises of mining industry	25	0.1
Metallurgical enterprises and enterprises of metal processing	58	0.3
Enterprises of production and distribution of electricity	10	0.1
Enterprises of building materials production	139	1.0
Food industry and agricultural products processing enterprises	62	0,5
Enterprises of other industries	750	1.8

The largest area is occupied by companies producing building materials (1.0 thousand hectares); enterprises of other industries occupy 1.8 thousand hectares; the least amount of area is occupied by the companies of producing and distributing electricity (0.1 thousand hectares) and mining enterprises (0.1 thousand hectares).
Chemically dangerous industry objects have a particularly negative impact on the ecological state of Kyiv. There is environmental pollution by hazardous chemicals, including: ammonia, hydrochloric acid, caustic soda, chlorine, mercury and other dangerous chemicals.
However, according to our calculations, the further development of technologically-hazardous industrial facilities in Kiev should be limited. The zone of possible effect from an emergency situation covers 93.4% of the total area of the capital city with the 96.9% of the population.
It is obvious that, regarding ecological and economic aspects, the decline of industrial production has led to negative results, in particular, large industrial areas in Kyiv are in the state of deep stagnation or

spontaneously and unsystematically used in legal and semi-legal ways, usually without taking into account the real needs of the city and the interests of urban residents. So at the current stage, one of the most pressing issues for Kyiv city is the optimization of non-functioning industrial areas into a territory reserve for future development of the city through an integrated approach to its solution (Mazur T. N. et.al., 2006) (Fig. 1).

In our opinion, the basic principles of optimizing industrial areas should be focused on the sustainable development the big city in the way that future purpose of the land use is considered from the standpoint of the need to make a functional element in the urban area, which is located on land. The main factor is meeting the needs of territorial-planning zone of the city: the centre, median, peripheral (Abakumov A. V., 2014).

Fig. 1. An example of not functioning industrial facilities in Kyiv city (Kyiv plant "Budshlyahmash")
Sources: made by the authors according to the data of the website: URBAN3P Project.

Three main approaches of optimization of industrial objects and their areas should be identified in order to effectively use urban land (Votinov M. A., 2014):

- complete safety of the production function through reorganization, reconstruction, restoration, adaptation and modernization of industrial areas (Table 2);
- partial preservation production function – this approach is advisable in social and cultural terms, because it allows to keep production function and also improve the aesthetic characteristics of the environment by combining production function of the object and functions of the city. In this case, partial re-functionalization allows to expand social infrastructure of the city and transform the industrial area according to the current requirements;
- the elimination of production function; it is realized by the conservation, revitalization, renovation, environmental rehabilitation, full re-functionalization of industrial areas (Table 3).

Table 2

The directions to optimize industrial areas with complete preservation of production function of enterprises

Name	Explanation
Reorganization	The transformation of organizational and management structures while preserving fixed assets and production potential of the company. A variety of complex radical innovations, which suggests a restructuring of the organizational structure (systems, goals, relationships, norms) of any object. Reorganization of industrial buildings and structures gives an opportunity to effectively control under the development of the spatial environment of the city.
Reconstruction	From (lat.) – fundamental alteration, improvement ordering anything. Reconstruction in architecture - restructuring the city, an architectural complex of buildings, caused by new living conditions. Reconstruction first of all involves reconstruction of current cost-effective enterprises, which are form the budget of the city and provides a large number of workplaces. In order to improve the ecological and economic industrial environment for these enterprises should be provided the reconstruction of industrial areas with creation of ergonomic spaces for recreation (short rest) and improve the ecological and aesthetic environment indicators.
Restoration	It is used for improving the aesthetic features of the industrial environment. Basically involves restoration of facades, if the architecture of industrial buildings have the historical value or this is a architectural monument.
Adaptation	Restructuring industrial object for its partial using with functional changes. Concerning industrial buildings or complexes envisaged measures for placing the technological process, which related to other industrial sectors, typically, with less environmental impact on the environment of the city.
Modernization	Reconstruction of buildings, technical re-equipment, landscaping, more efficient using the available area with implementation of new technologies. Through these measures, the city does not lose taxpayer in the face of the company and the workplaces for urban residents.

Sources: developed by the authors according to the data of Votinov M. A., 2014; Sysoeva O. I. et.al., 2005.

Table 3

The directions to optimize industrial areas with liquidation of the production function of enterprises

Name	Explanation
Conservation	The type of activity which includes cultural and historical aspects, directed to research and preserving industrial facilities which are the part of world cultural heritage.
Revitalization	Revitalization allows to find the new more efficient and cost-effective ways to transform former industrial objects. Unlike the renovation (redevelopment), revitalization requires considerably less investment. It allows to significantly reduce the period from the beginning of works on revitalization to the commissioning of the object with a new internal and external.
Renovation (redevelopment)	The set of measures aimed on the changing the functional purpose of industrial objects. The main measures during the renovation process are: removal production function; preserving the industrial character of the building; forming a new functional use of the urban territory. Inactive or inefficient industrial objects and areas which prevent proper development of urban infrastructure, become to the subject to renovation.
Environmental rehabilitation	Involves using the territory under the industrial objects in recreational purposes (creation of parks, systems of recreational rides etc.)
Full re-functionalization of industrial areas	Implemented within dilapidated industrial facilities. Total demolition of old industrial objects. The territory used for building a new effective buildings.

Sources: developed by the authors according to the data of Votinov M. A., 2014; Sysoeva O. I. et.al., 2005.

However, the development of plans to optimize land use in Kyiv is regulated by modern development strategy of the city on the basis of the adopted (current) General Plan of Kyiv for the period until 2020. Within this document, a phased implementation optimization measures for reproduction of natural resources (lands) of Kyiv and rehabilitation of disturbed (under the industrial objects) areas for environmental protection within the big city are provided. The main ones concerning the renovation of industrial areas are (General Plan of Kyiv for the period until 2020):

- re-functionalization of production with reducing the class of ecological hazard;
- displacement of industrial enterprises and some manufacturing plants which are located in residential areas and on the lands of water fund;
- in total, it is envisaged relocate 32 companies and production plants, therefore 118.45 hectares of urban areas will be exempted.

Conclusions and proposals

General Plan of Kyiv defines not only an economic but also ecological model of the city development. From the ecological point of view, preservation and expansion of the environmental "corridor" for normal life of population is envisaged. However, sanitary-protection zone of enterprises which amount to 500 metres, does not allow to actively explore the area around them. That is why the General Plan of Kyiv envisages rehabilitation of residential environment by transferring some of the industrial enterprises, which, according to environmental, urban planning and other requirements, should not be present in current locations.

We should also mention that the process of transfer of enterprises or building new objects elsewhere requires significant investments, which companies generally do not have. It is therefore necessary to activate all managerial, organizational, administrative measures to find investors who will continue the development of exempt urban areas, and to help companies with their investments. Then the mechanism of attracting investors might be different: auction for lease rights of this land or direct discussions with the signing of relevant documents etc.

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METHOD OF DEMAND ASSESSMENT OF TECHNICAL SERVICE IN AGRICULTURAL FARMS

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Abstract
The volume of demanded groups of farms is defined with the help of the developed method taking into account a type of farm machinery in accordance with their purpose and set of properties.
Key words: assessment of demand; regression analysis; technical services; farms; economics of farming

Introduction

The paper studies economic performance of tractors and agricultural machines. Effective agricultural production depends on minimum cost of agriculture machinery operations. It is necessary to harmonize the system of machinery management and technical services according to the purpose and organizational forms of production and the real demand for equipment. The demand for technical equipment is characterized by the potential annual payments for the purchase of machinery or payment to the third-party organizations for their repair work and maintenance. In this context, the demand is comparable to the actual operating costs which are an integral part of the cost of works on the mechanization of crop production and are characterized by the indicator of operating costs per one hectare (Seyfullin, 2001).

To determine the actual demand for the analysis of the effectiveness of the machinery, it is necessary to compare the use of forms of machines by customers with the performance of this work on their own, taking into account the capabilities of each customer and its ability to pay. The lack of finances often leads to the abandonment of maintenance services of the machinery, even if the need for them exists. The ability of paying for the required technical services by agricultural producers largely depends on trends in the economic situation in the agricultural sector.

The effectiveness of the technical system in general is characterized by the ratio of costs and results of Z, R. The analysis method is based on the allocation of the aggregate cost indicators (capital stock, labor, material and energy resources) and comparing them with the results that represent a set of final products or intermediate inputs.

Indicators highlight certain aspects of efficiency in the natural proportions of cost or cost-effectiveness. The ratio Z / R means specific material, energy and capital intensive and the cost per unit of output. It is possible to reduce the cost by efficient means and rational system of technical service for groups of farms with similar production and economic conditions of the use of agricultural machinery.

In view of the objectives of the study, the requirements for technical systems are formed taking into account natural production conditions of their operation. What matters is the formation of the requirements to quality indicators (machinery systems and technical service) within specific groups of agricultural enterprises.

Methodology of research and materials

A set of technological, technical and financial and economic indicators which characterize efficiency of production economic activity of organizations mentioned in the article were used. It is shown that statistical methods of multidimensional classification allow not only to minimize the quantity, but also to find correlation dependences on each indicator which are a basis of improvement of a technique of an integrated approach to an assessment of results of functioning of the organizations. We used the following basic research methods: abstract, logical, analytical, statistical, constructive, economics and mathematics.

Discussions and results

The aim of the article is to choose between available options for groups of farms taking into account the developed organizational and technical system of agricultural machinery, to find a rational option to provide performance of field mechanized works with the minimum operational expenses (Sabirova A.I. et.al., 2001).

The number of country individual farms have grown in recent years in Almaty area (Fig.1), however, the share of their cultivated areas gradually decreases (Fig.2). The share of products of country farms in production of grain has reduced from 27.4% in 2012 to 20.7% in 2016 over the last 5 years.

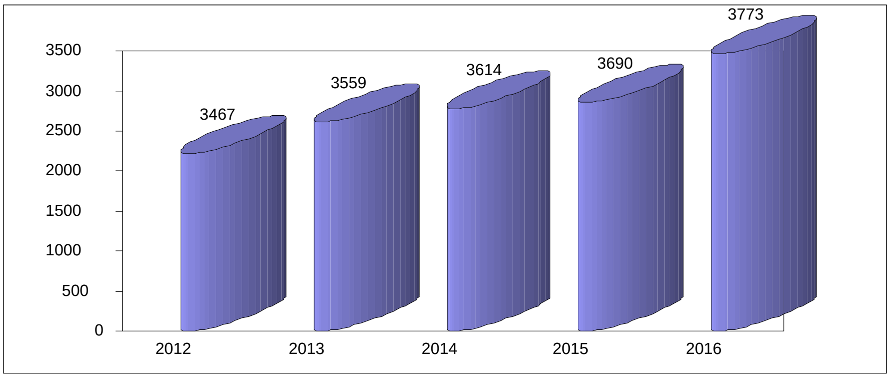


Fig.1. Dynamics of growth of country farms in Almaty region.

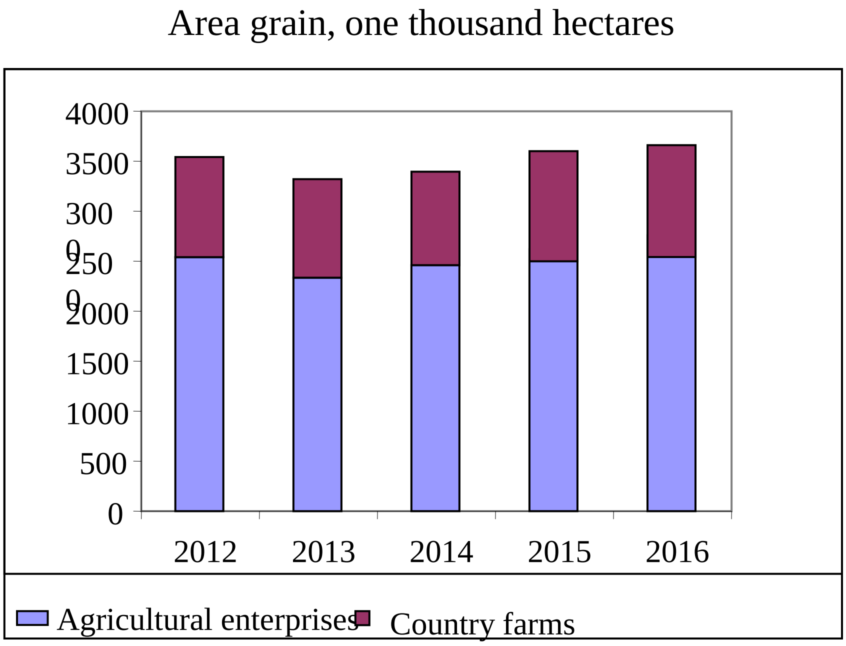


Fig.2. Dynamics of cultivated areas under grain crops in Almaty region.

It is explained by lower productivity for this category of farms in comparison with agricultural enterprises (Fig.3). One essential reason for this is insufficient amount of technical equipment and agricultural machines in small and average farms. The analysis of technical and economic indicators shows unevenness of technical equipment and agricultural machines both by categories of farms, and by their zone arrangement.

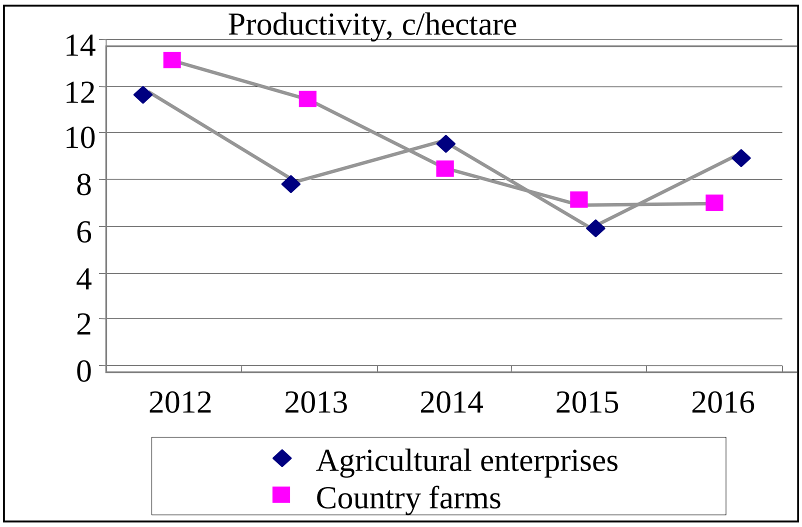


Fig.3. Productivity of grain crops in agro formations of Almaty region.

The comparative analysis of activity of farms of some profitable regions in Almaty region is provided in Table 1 (the general level of profitability is more than 12%, for grain - more than 43%) in 2016 depending on weather conditions.

Table 1

Technical and economic indicators of farms of Almaty region

Category farms	**Index**	**Regions**				
		The Enbekshikazakhsky	The Talgarsky	The Dzhambulsky	The Kerbulaksky	The Aksusky
Agricultural enterprises	Number of farms	14	21	19	14	22
	Average size of an arable land, hectare	8,127	9,890	10,891	14,591	11,213
	Average productivity, c/hectare	9	9.3	10.7	11.8	9.1
	Existence of tractors on 1,000 hectares	5.2	4.8	3.81	3.2	4.04
	Existence of combines on 1,000 hectares	3.8	3.1	2.6	2.4	3.4
Country farms	Number of farms	203	445	189	130	77
	Average size of an arable land, hectare	634	397	777	495	995
	Average productivity, c/hectare	8.2	8.9	10.1	12	8.8
	Existence of tractors on 1,000 hectares	1.8	3.7	3.4	6.5	2.7
	Existence of combines on 1,000 hectares	1.5	3.5	2.8	5.9	2.8
Note: Made on the basis of data of the Management of Statistics of Almaty region.						

The data on agricultural machines and equipment of agricultural enterprises are rather uniform and are within the limits of 2.8-3.4 for combine harvesters, 3.5-5.1 for tractors on 1,000 hectares of arable land; the same cannot be said about the category of country farms. The dispersion of values is obvious for tractors and combines: the bottom and top borders differ in more than 5 times (Statistics Plus 2.0 software (2001).

The distribution of crop areas in Almaty region matches with normal law of distribution with variation coefficient ν = 0.462076, Pearson's matching criterion χ2 = 0.0321981, matching probability= 0.857594. For South Kazakhstan region the distribution of crop areas in the farms is described by the function of distribution by Veibul's law. Variation coefficient ν = 0.745431. The probability of matching was χ2 = 0.317085 by Pearson's criterion and P (λ) = 0.892512 by Kolmogorov-Smirnov criterion (which is above the value 0.05) (Saparbayev A.D.,1995).

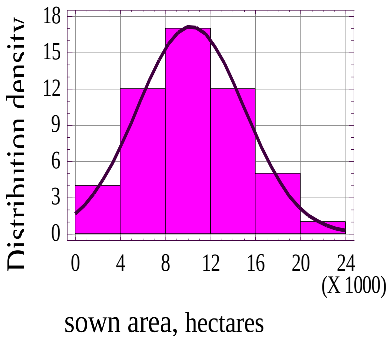
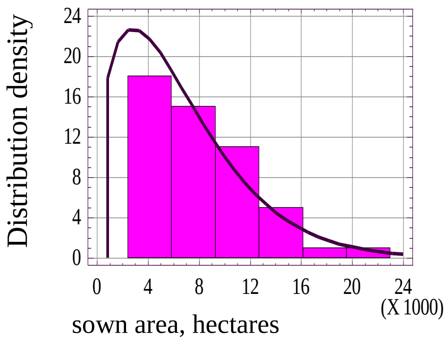
distribution parameters:	**distribution parameters:**
$f(F) = \frac{b}{a} \cdot S^{b-1} \exp(-\frac{F}{a})^{b}$, where a =1,32221 and b =7476,51	$f(F) = \frac{1}{\sigma\sqrt{2\pi}} \cdot \exp(-\frac{(F-\bar{f})^2}{2\sigma^2})$ where σ = 69,218 and $\bar{f}$ = 10305,6
	
a) Almaty region	b) Southern Kazakhstan region

Fig. 4. Histogram of distribution of cultivated areas of farms.

Some difference in laws of distribution of two areas is caused by distinction in zone conditions of plant growing. More favorable conditions in the Southern Kazakhstan area causes high productivity by the level of fallouts. Therefore in the analysis of distribution averages show that there are more average-sized farms which are the first intervals of distribution.

The regression analysis of dependence of loads of a tractor from the area of an arable land of farms showed that best of all it will be coordinated with logarithmic model and looks like:

$$Q_T = -211.61 + 80.0787 \cdot \ln(S) \quad (1)$$

The coefficient of correlation is equal to R2 =0.430546.

The change of an average annual operating time of combine harvesters from a cultivated area is described by dependence (Fig. 2.5):

$$Qk = 1 / (0.00229615 + 1.84871/S), R2 = 0.899487 \quad (2)$$

where Qт-load of a tractor, hectare,

Qк-an average operating time on a combine, hectare,

S –cultivated area, hectare.

It is apparent from Fig.5, the operating time intensively increases with an increase in the area for farms with a cultivated area up to 5 thousand hectares, but further value of the operating time is stabilized and makes about Q = 400 hectares, limited to productivity of combine harvesters.

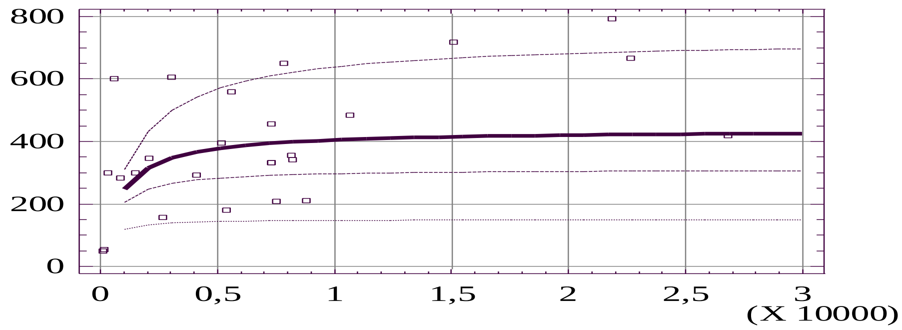


Fig.5. Dependence of an average annual operating time on the combine from a cultivated area of farms

Results of the research allowed to conclude that the need for agriculture machinery is higher in small and average farms than in the large ones. So, per 1,000 hectares of arable land the need for agriculture machinery at the average sizes of farms of 1,000 hectares is 1.4 times higher, per 4,000 hectares the need is 1.2 times higher.

In the regression analysis of dependence of specific expenses for maintenance and repair in relation to productivity and a cultivated area of farms, the following dependence is received:

$$З_{TOP} = 108{,}074 \bullet U + 4{,}42562 \bullet F \quad (3)$$

where - specific expenses on TORAHS, tenge/hectare,

- productivity of grain crops, c/hectare,
- cultivated area, one thousand hectares.

Criterion of R2 = 86.6759%, standard statistical mistake δ = 364.406, and average absolute mistake Δ = 283.979.

Considering the above-stated dependences of requirement for agriculture machinery, costs of their service and repair in relation to the sizes of farms, it is possible to predict demand for agricultural machinery according to a share of the actual specific operational expenses in the income from production realization. Knowing efficiency (productivity) and the average prices of realization of grain, it is possible to construct the chart of change of the demand depending on the sizes of farms and their profitability at the fixed price of production.

Conclusions and proposals

This methodical approach to an assessment of the potential demand for main types of agriculture machines allows predicting the need for means of production and risks of investment in agricultural production of Kazakhstan in conditions of unstable efficiency of grain production and fluctuations of market prices of grain. The assessment of a potential demand can be used also for the choice of rational option of machinery in agro-industrial companies depending on production and organizational system of use of machinery.

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MODELLING AND ANALYSIS OF COLLECTION OF LAND PAYMENTS IN THE MUNICIPAL AREAS DEPENDING ON ECONOMIC AND GEOGRAPHICAL FACTORS

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Abstract
Taking into consideration all the data of collectibility of land payments (land tax and rent), the dependence of collectibility of land payments on economic and geographical factors is analysed in municipalities of the Samara region. The factors are defined with the help of mathematical methods, which are closely associated with payments growth from the land area of a municipality and the number of residents.
The dependence simulation of the level of land payments on geographical and demographic characteristics has been implemented in a municipality. This model allowed allocating ”normative level” for each municipal district which corresponds to the result of the ”average area” with given objective characteristics. This assessment allowed the authors to identify the areas with high and low levels of land payments collectibility.
The efficiency assessment of municipality local governments in the Samara region on land management is made taking into consideration objective factors that limit their opportunities.
Key words: land, land relations, management efficiency, land payments, land tax, rents, Samara region.

Introduction

One of the most important objectives of the state policy in the field of sustainable socio-economic development is the involvement of land resources into economic activities and improving the efficiency of their use. Private land ownership in Russia, paid land use, land market development and reforming of taxation system of real estate cause the relevance of efficiency assessment of land management at the level of municipalities (urban and municipal districts) (Voronin et al., 2011; Varlamov, 2014). Effective land management is essential for modern sustainable economy development, as rational land use plays an important role not only in agriculture development, but also in the economic development of the country in general (Taratula et. al., 2015; Baumane, 2016).
One of the criteria for efficiency assessment of land management is to increase the revenues of the federal, regional or municipal budgets. At the local level, this criterion is expressed in the increase of total land payments (land tax and rent) in the municipalities (Galchenko, 2003). Local authorities actively influence the system of land relations in a municipality by issuing regulations that are mandatory for all entities of land relations, as well as performing various socio-economic and economic functions (Vlasov et.al., 2013).
In the Russian Federation the database of the state cadastre of real estate started to be formed and increased (until 2011 it was called the land registry) after the land reform implementation and the emergence of private land ownership in 1990 – 1993. The tax system was changing and increasing together with increasing of database of real estate cadastre that resulted in the growth of land payments collectibility – land tax and rent (Varlamov, 2011).
Land tax is very crucial in the tax system of the Russian Federation as it is a local tax. Therefore, land tax is one of the main sources of filling the budgets of municipalities as well as the source of financial base formation of local authorities. Therefore, the necessity to improve land management efficiency is a key issue in modern conditions.
The aim of the article is the analysis of the dependence of land payments collectibility on economic and geographical factors in the municipalities of the Samara region.
To achieve the aim, the following tasks were set: firstly, to analyse statistics, by the total collectibility of land payments in the municipalities of the Samara region and using various information concerning the municipality (location, total land area of the district, the distance of the territory from the regional capital, number of inhabitants, population density, etc.); secondly, to identify the indicators which influence the volume of land payments; thirdly, to assess the effectiveness of local self-governing authorities of municipalities of the Samara region on land management taking into consideration objective factors that limit their opportunities.

Methodology of research and materials

During the research implementation the methods of mathematical statistics, regression, methods of factor and cluster analysis were used to allocate efficiency levels of municipalities of the Samara region by collectability of land payments, as well as to identify the factors influencing the level and the growth rate of land payments.

Statistical data were analysed on consolidated revenues of land tax and rents on municipalities of the region provided by the Ministry of Finance Management of the Samara region, and the State Tax Inspectorate of the the Samara region. The object of the research was the municipalities of the Samara region (Khasaev et.al., 2016).

Discussions and results

One of the problems arising in the analysis of land payments collectibility by municipalities of the region, is the assessment of the activities of local authorities taking into consideration various factors that limit their opportunities. If one of the districts is significantly ahead of the other one in land payments per unit area, it can be caused by its location, population density, etc. (Konstantinova, 2015). In this case, local authorities do not play a key role. Their efforts in this area can deserve a lower rating in comparison with the second district with adverse objective characteristics (Khasaev et.al., 2016).

There is the problem of separating the influence on land payments collectibility of objective characteristics of a municipality, on the one hand, and quality management of this process, on the other hand (Koryagina, 2008). One of the approaches to its solution is to simulate the dependence of land payments level on geographical and demographic characteristics of the municipality. The construction of such models allows assessing ”regulatory level” for each municipality that corresponds to the result that would ”an average area” have with given objective characteristics. The assessment helps identify areas with high and low levels of land payments collectibility (respectively, ”regulatory level” and below it).

Simulation of this dependence was performed according to the given land payments (per unit area) of twenty-seven municipalities of the Samara region in 2012-2014 (Table 1), and the geographical and economic characteristics of these areas (Table 2).

Table 1

Land payments of the municipalities of the Samara region
(thous. RUB per km^2)

Municipal district	Years			Average over 3 years	Municipal district	Years			Average over 3 years
	2012	2013	2014			2012	2013	2014	
Aleexseevskii	23.0	7.6	8.54	13.0	Krasnoarmeiskii	10.8	10.8	10.4	10.7
Bezenchukskii	16.4	18.4	21.4	18.7	Krasnoyarskii	31.4	33.1	42.3	35.6
Bogatovskii	11.3	12.7	15.0	13.0	Neftegorskii	63.5	55.1	69.0	62.6
B.-Glushitskii	26.6	15.8	12.0	18.1	Pestravskii	27.2	17.6	15.7	20.1
B.-Chernigovskii	15.3	10.6	8.3	11.4	Pochvistnevskii	12.5	14.2	15.5	14.1
Borskii	7.7	8.3	11.0	9.0	Privolzhskii	13.8	11.8	13.9	13.2
Volzhskii	70.0	57.6	83.2	70.3	Sergievskii	20.1	25.8	33.0	26.3
Elchovskii	8.4	9.1	10.4	9.3	Stavropolskii	29.3	30.7	41.4	33.8
Isaklinskii	7.1	10.0	7.8	8.3	Syzranskii	23.2	24.2	29.2	25.5
Kamyshlinskii	41.2	17.2	19.2	25.9	Hvorostyanskii	6.7	7.8	8.0	7.5
Kinelskii	38.0	40.2	41.0	39.7	Ch.-Vershinskii	14.9	15.3	15.3	15.2
K. - Cherkasskii	34.8	40.3	45.4	40.2	Shentalinskii	13.2	12.2	19.2	14.9
Klyavlinskii	22.3	22.9	22.7	22.6	Shigonskii	17.4	20.8	22.6	20.3
Koshkinskii	17.4	14.9	40.0	24.0	TOTAL	623.5	565.2	681.5	623.4

Table 1 shows that in 2013, the volume of land payments fell sharply, and in 2014 it increased again, exceeding the level of 2012 in many (but not all) areas. These effects require further substantial analysis.

Table 2

Characteristics of municipalities of the Samara region used for the analysis of land payments collectibility

Municipal district	Area km^2	Land of village admini-strations, km^2	Area of inter-settlement territories, km^2	Settlement area, km^2	Population, thous. people	Population density, people per 1 km^2	Number of settlements	Distance to Samara, km
Aleexseevskii	1 891	2548.3	1 827	42	11.6	6.2	28	131
Bezenchukskii	2 020	3712.3	1 690	66	40.9	20.4	49	64
Bogatovskii	824	2798.7	671	49	14.2	17.2	32	93
B.-Glushitskii	2 534	3036.6	2 446	70	19.6	7.6	33	111
B.-Chernigovskii	2 806	2927.9	2 743	40	18.4	6.5	34	144
Borskii	2 103	7378	1 548	95	24.1	11.5	51	122
Volzhskii	2 481	5616.3	2 106	102	84.4	34.8	57	1
Elchovskii	1 201	2992.4	1 086	42	10.0	8.1	39	96
Isaklinskii	1 577	2856.6	1 258	44	12.8	8.1	52	156
Kamyshlinskii	823	1513.1	636	30	11.1	13.4	22	179
Kinelskii	2 104	5703.8	1 649	91	32.4	15.8	63	42
K.-Cherkasskii	2 457	6369	2 127	108	44.9	18.2	50	112
Klyavlinskii	1 256	3108.9	980	48	15.2	12.0	1	211
Koshkinskii	1 647	3684.9	1 418	79	1.0	13.9	82	141
Krasnoarmeiskii	2 129	4386.5	2 030	57	18.7	8.1	43	79
Krasnoyarskii	2 479	5475.3	1 742	98	55.9	22.7	93	41
Neftegorskii	1 408	2585.5	1 302	43	34.0	24.0	19	96
Pestravskii	1 960	4053	1 859	53	18.0	8.8	30	111
Pochvistnevskii	2 105	4703.6	1 444	91	27.9	13.3	80	160
Privolzhskii	1 379	1949.8	1 072	56	24.0	16.6	24	146
Sergievskii	2 756	8977	2 316	108	45.6	16.7	68	136
Stavropolskii	3 662	7349.6	2 602	129	69.4	18.1	52	91
Syzranskii	1 881	4787.2	1 255	38	25.2	15.6	69	138
Hvorostyanskii	1 845	4347.1	1 699	58	15.4	8.6	27	131
C.-Vershinskii	1 162	4341.8	968	62	15.4	13.5	53	186
Shentalinskii	1 338	3340.3	921	68	15.8	11.9	60	189
Shigonskii	2 134	2348.4	1 160	54	20.0	10.1	47	200

To analyse the influence of the factors on the payments' level and simulation of relevant dependencies, the average level of land payments in 2012 - 2014 was used. The coefficients of linear correlation of this average level with different factors, and also factors between them are shown (Table 3).

The calculation of the correlation shows that population density (x_6) and total population (x_5) in the area considerably affect specific land payments (km^2).

We should notice a high level of correlation between the area of the administrative district (x_1) and the area of inter-settlement territories (x_3) therefore the factor x_3 was excluded from the analysis.

Despite the high correlation between the land area of the rural authorities (x_2) and settlement area (x_4) both of these factors were taken into account while constructing the model.

Table 3

Correlation between land payments of municipalities and influential factors

Factor	Coefficients of linear correlation							
	x_1	**x_2**	**x_3**	**x_4**	**x_5**	**x_6**	**x_7**	**x_8**
Average land payments for 2012-2014, RUB. per km^2 (Y)	0.249	0.263	0.198	0.380	**0.714**	**0.834**	0.132	-0.519
Area, km^2 (x_1)		0.649	**0.910**	0.683	0.652	0.149	0.367	-0.386
Land of village administrations, km^2 (x_2)			0.522	**0.841**	0.614	0.324	0.531	-0.361
The area of the inter-settlement territories, km^2 (x_3)				0.512	0.504	0.035	0.165	-0.439
The settlement area, km^2 (x_4)					0.721	0.468	0.579	-0.412
Population, thousand people. (x_5)						0.795	0.332	-0.635
Population density, people per 1 km^2. (x_6)							0.283	-0.570
Number of settlements (x_7)								-0.262
The distance to Samara, km (x_8)								

To analyse the dependence of the average level of specific (per km^2) land payments in municipalities in 2012-2014 on seven factors (x_1, x_2, x_4, x_5, x_6, x_7, x_8), three basic mathematical models were built:

- additive linear model of type Y:

$$Y = a_0 + a_1 * x_1 + a_2 * x_2 + \dots \quad (1)$$

where Y denotes average land payments for 2012-2014, RUB. per km^2,
a_0, a_1, a_2 denotes factor coefficients determined by regression using the least squares method,
x_1 denotes area, km^2,
x_2 denotes land of village administrations, km^2.

- multiplicative exponential model of type Y

$$Y = a_0 * a_1^{x1} * a_2^{x2} * \dots \quad (2)$$

Where Y denotes average land payments for 2012-2014, RUB. per km^2,
a_0, a_1, a_2 denotes factor coefficients determined by regression using the least squares method,
x_1 denotes area, km^2,
x_2 denotes land of village administrations, km^2.

- multiplicative power law model of type Y:

$$Y = a_0 * x_1^{a1} * x_2^{a2} * \dots \quad (3)$$

Where Y denotes average land payments for 2012-2014, RUB. per km^2,
a_0, a_1, a_2 denotes factor coefficients determined by regression using the least squares method,
x_1 denotes area, km^2,
x_2 denotes land of village administrations, km^2.

Figure 1 shows land payments of municipalities in 2012-2014 in comparison with ”typical” level of payments, which was calculated for each district using the specified model. The diagram shows that, despite the same level of payments in Privolzhskii and Chelno-Vershinskii districts, the results of Privolzhskii district is far behind its potential, and the results of Chelno-Vershinskii district fully meet its potential.

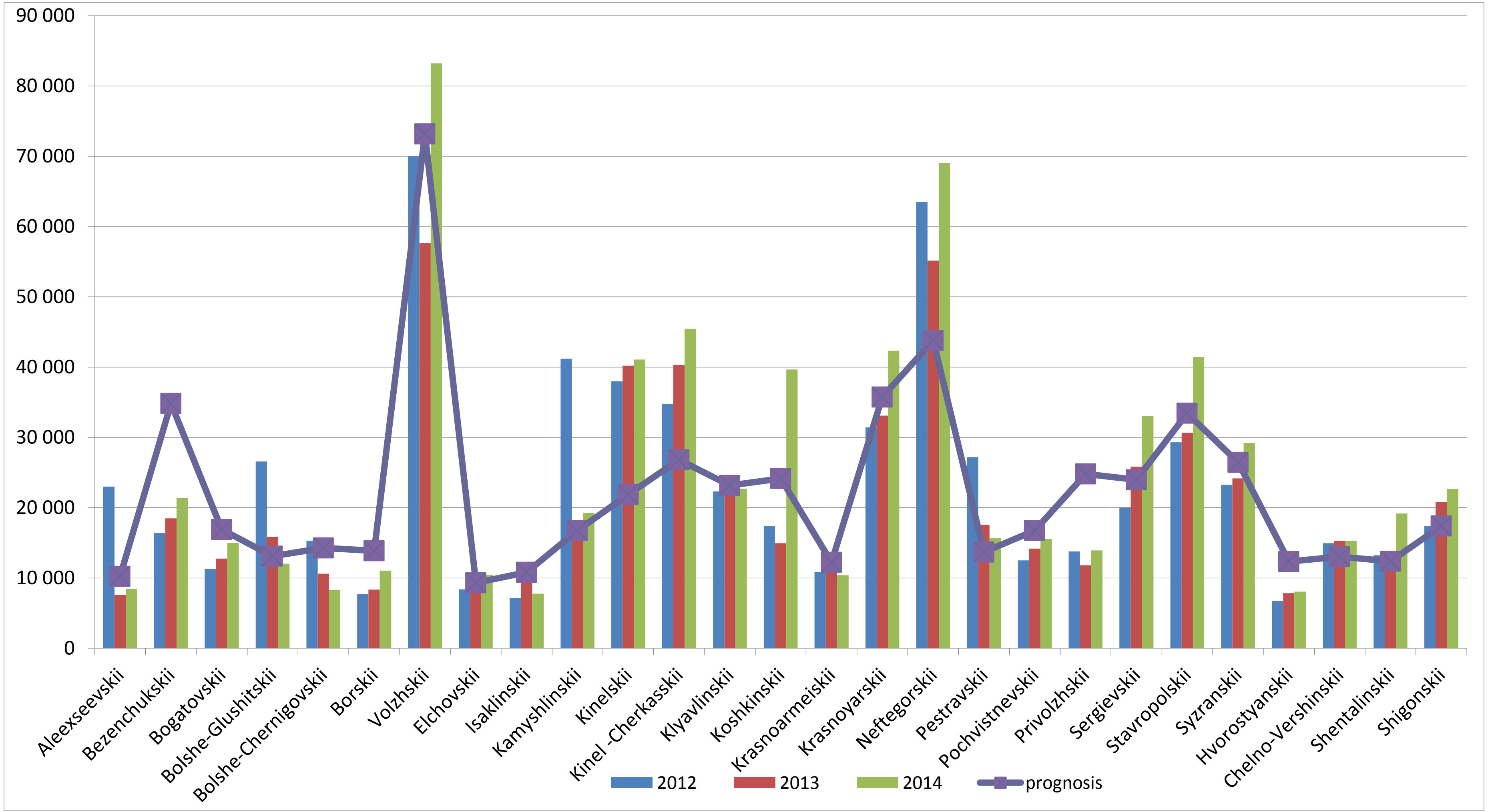

Fig. 1. Specific land payments of municipalities in comparison with the average level for standard models

We can see integral characteristics of the results of applying these models for dependence approximation of average specific land payments on municipality characteristics (Table 4).

Table 4

The results of dependence approximation of specific land payments on municipalities characteristics

The type of model	**The coefficient of determination**	**Correlation of result simulation and the fact**	**Average absolute percentage deviation of result simulation from the fact**
Additive linear	0.754	0.868	32.6%
Multiplicative exponential	0.674	0.821	28.2%
Multiplicative power	0.706	0.840	26.0%

From simulation results given in Table 4 we can conclude that all three models describe the analyzed dependency in details. According to determination coefficient the linear model has turned out to be the best and according to percentage deviation power multiplier is the best one. We chose a multiplicative model power type for further analysis on the basis of the above-formulated main simulation tasks, comparison of municipalities by the efficiency of land payments collectibility. Checking on students t-criterion shows that all the coefficients of the model are statistically significant at a significance of alpha level which is equal to 5%.

Table 5

Analysis of land payments level of municipalities according to approximation models

Municipal district	**Deviation of land from the "typical" level, obtained by the approximation model**				**Rank percentage (relative place) area for land payments collectibility**			
	2012	**2013**	**2014**	**Average for period**	**2012**	**2013**	**2014**	**Average for period**
Aleexseevskii	56%	-34%	-21%	22%	96%	23%	23%	47%
Bezenchukskii	-112%	-89%	-63%	-86%	0%	4%	8%	4%
Bogatovskii	-49%	-33%	-13%	-30%	19%	20%	24%	21%
Bolshe-Glushitskii	51%	17%	-9%	28%	92%	83%	25%	67%
Bolshe-Chernigovskii	7%	-35%	-72%	-25%	69%	17%	4%	30%
Borskii	-81%	-66%	-26%	-54%	8%	5%	14%	9%
Volzhskii	-4%	-27%	12%	-4%	54%	14%	43%	37%
Elchovskii	-11%	-3%	11%	0%	50%	50%	40%	47%
Isaklinskii	-51%	-8%	-39%	-30%	15%	47%	11%	24%
Kamyshlinskii	59%	3%	13%	35%	100%	61%	44%	69%
Kinelskii	42%	46%	47%	45%	85%	100%	100%	95%
Kinel -Cherkasskii	23%	34%	41%	33%	77%	100%	100%	92%
Klyavlinskii	-4%	-1%	-2%	-2%	58%	60%	27%	48%
Koshkinskii	-39%	-62%	39%	-1%	23%	7%	100%	43%
Krasnoarmeiskii	-13%	-13%	-18%	-14%	46%	31%	15%	31%
Krasnoyarskii	-14%	-8%	16%	0%	38%	50%	58%	49%
Neftegorskii	31%	21%	37%	30%	81%	91%	100%	91%
Pestravskii	50%	22%	13%	32%	88%	100%	50%	79%
Pochvistnevskii	-34%	-18%	-8%	-19%	27%	22%	22%	24%
Privolzhskii	-80%	-110%	-78%	-88%	12%	0%	0%	4%
Sergievskii	-20%	7%	27%	9%	31%	71%	86%	63%
Stavropolskii	-14%	-9%	19%	1%	35%	50%	67%	50%
Syzranskii	-14%	-9%	9%	-4%	42%	40%	40%	41%
Hvorostyanskii	-83%	-57%	-53%	-64%	4%	0%	0%	1%
Chelno-Vershinskii	13%	15%	15%	14%	73%	67%	33%	58%
Shentalinskii	7%	-1%	36%	17%	65%	50%	100%	72%
Shigonskii	0%	16%	23%	14%	62%	100%	100%	87%

The table 5 shows the deviation of the level of land payments for each municipality in percentage in 2012-2014 from the calculated potential and the average deviation for the period (Table 5). Positive deviations correspond to the high level of payments (higher than typical), and the negative - to the low one (below ”typical”).
It also shows the percent rank of each district for each year and on the average for the period. If this rank is equal to 100%, the district achieved the best result in the region. And if the rank is 0%, the district has the worst result for the year or period on the average.
Figure 2 shows zones with high and medium levels on the map of the Samara region. A preliminary qualitative assessment of the level of land payments collectibility in municipalities. Thus the municipalities with the rank above 75% (top quarter) are assessed as the districts with high collectibility rates; the districts with the rank lower 25% (lower quarter) are assessed as the districts with low collectibility rates and others with middle collectibility rates.

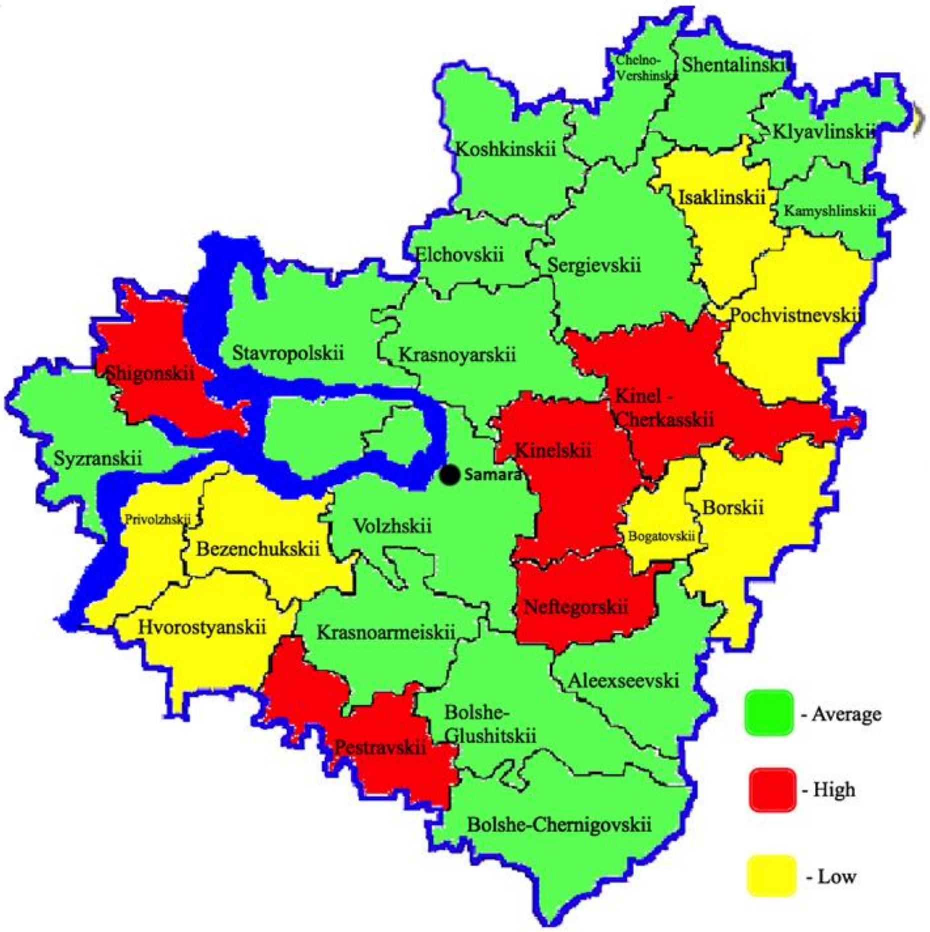

Fig. 2. Distribution of municipal districts of the Samara region by the level of collection of land payments

Of course, to apply the described technique in practice, further analysis is necessary which will take into account more factors and longer periods.
Thus, the issue of efficiency assessment of land management at the municipal level is very important. Land and land relations are one of the defining factors of socio-economic development of the country (Molzhigitova et. al. 2013, Pomelov, 2013). The finances of local budgets are hardly enough for minimal social expenses with the increasing responsibilities of local government, while regional governments are not often able to affect revenue mobilization of their territories. Therefore, more efficient municipal property management is becoming more important. (Khasaev et. al., 2016; Ainur, 2014).
An important issue is land quality accounting for lands taxation of different categories as well as improving the quality of agricultural land. It is necessary to develop measures to ensure rational use of land resources, preservation and increasing of soil fertility, as well as control over the observance of land legislation (Parsova, Cahrausa, 2015).

However, the increase of land payments should be based not only on the change of results of the cadastral assessment, as it occurred in the studied period, but on the involvement of other mechanisms of land management. To improve land payments, the following measures should be taken:

- regular monitoring of the conditions of land resources;
- inventory implementation in order to clarify the boundaries of land sites and other objects of real estate;
- it will enable to correct the database and start the procedure of registration of newly formed land boundaries, to solve the issues with the land rent and buying and as a result increase revenues from land payments (land tax and rent).

Currently, land monitoring is not carried out, which does not allow solving the issue. In addition, despite the fact that at the cadastral assessment all real estate objects are evaluated, registration is implemented according to declarative principle, therefore, the proportion of properties fall out of the tax base.

Conclusions and proposals

According to the results of the conducted research the following conclusions can be drawn:

1. Analysis of statistical data by the total land payments collectibility has shown a steady growth in the studied period, although the growth rate was considerably uneven.
2. Parameters that mostly affect the amount of land payments from the territory of the municipalities in the Samara region are the following: the area of the land fund of the district, the number of population.
3. Taking into account the objective factors that limit management opportunities, efficiency assessment of local self-governing authorities of the municipalities of the Samara region on land management helped identify the areas in which management mechanisms are imperfect and require changes.

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MODELLING OF THE SPATIAL STATE OF THE IONOSPHERE FOR THE NETWORK GNSS STATIONS OF UKRAINE

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Abstract
The results of the determined ionization identifier *TEC* (Total Electron Content) for continuously operating reference Global Navigation Satellite Systems (GNSS) stations are analysed. On the one hand, the data reflect the state of the ionosphere during the observation; on the other hand, it is a substantial tool for accuracy improvement and reliable determination of coordinates of the observation place. It was decided to solve a problem of restoring the spatial position of the ionospheric state or its ionization field according to the regular definitions of the TEC identifier, i.e. *VTEC* (Vertical *TEC*). We have described one possible way of solving this problem, which is based on mathematical modelling by using degree polynomials and trigonometric Fourier series. Degree polynomials describe the trend of function, whereas the trigonometric Fourier series are used in order to better simulate the fluctuation. The method was tested for network of permanent stations ZAKPOS.
Key words: ionosphere parameters, degree polynomials, trigonometric Fourier series.

Introduction

Global Navigation Satellite Systems (GNSS) are currently the most effective and promising means of ionosphere on all radio physical methods. Remote diagnostics has several advantages using such measurements compared to classical radio physical means of probing the atmosphere, in particular - continuity of measurement, high spatial, temporal resolution and global monitoring ionospheric disturbances of different nature (Yankiv-Vitkovska, Pauchok, 2012).
Generally, all errors carried by these sources can be described by the equation:

$$L = \rho + c \cdot (dT - dt) + \lambda \cdot N - d_{ion} + d_{trop} + d_{mp} + e \quad (1)$$

where L – the distance to satellite, measured with a phase method,
ρ – geometric distance to satellite,
(dT-dt) – unsynchronism of a reciever's and sattelite's clocks,
N – the number of waves which insert in distance from the satellite to a reciever,
d_{ion} – an error by influence of atmosphere,
d_{trop} – an error by influence of troposphere,
d_{mp} – an error by multipath of signal spreading,
e – a user's error,
c – spreading speed of a radio signal.

The errors caused by the external environment influence have a significant impact on their precisions among these sources of GNSS measurements' errors. When a radio signal (the satellite – a receiver) goes through the Earth's atmosphere - inhomogeneous covering of the Earth which contains the sum of gases, it changes speed. This change is the biggest when the radio signal goes through the ionosphere – the part of atmosphere, which is characterized by high content of ions and free electrons.
The free electrons in the ionosphere strongly affect the propagation of radio waves, which leads to errors distances the signals GNSS (Kelley, 1989). For single-band GNSS receivers errors caused by the ionosph1gere currently are the major errors affecting the accuracy of the positioning. The value of residual ionospheric delay can cause a distance error of about 10 meters.
In the view of the above, the aim of the paper is to recreate the time state of the ionosphere according to regular observations indicator *TEC*, i.e., *VTEC* (Vertical *TEC*) station SULP (NU "Lviv Polytechnic") and create one's own ionospheric model that could locally carry the latest information on the status of ionospheric plasma at certain times.

Methodology of research and materials

The permanent station SULP finds the meaning indicators of *TEC* every second by the satellite radio navigation measurements - pseudorange to satellites (Yankiv-Vitkovska, 2014). These indicators *TEC* content of the total number of electrons make it possible to follow the change in the ionospheric plasma state, increase or decrease in the number of electrons per unit volume and build a suitable

model that would describe the state of the ionosphere best at a given time. Therefore, in this study, we propose a method for creating a model of the ionosphere parameters values *TEC*.
In order to obtain analytical dependence describing large amounts of data, including regular Indices *TEC*, the method of approximating power polynomials is used, which describes trends in the data and provides the minimum sum of squared deviations of experimental data from this function (Matviychuk, 2000).
The best criterion for approximation problems is the criterion of standard deviation. For the solution of this problem polynomial power law of the form must be found:

$$M(x) = \sum_{i=0}^{m} C_i \cdot x^i \qquad (2)$$

The sum of squared deviations polynomial M (x) from a given experimental points system would be minimal. This problem is reduced to determining the polynomial coefficients $\{c_0, c_1, c_2, \dots c_m\}$.
Considering the important elements of the vector - column C (x), we can build the time ionosphere model according to the definitions of regular rate *TEC*. This model is shown in Figure 1.

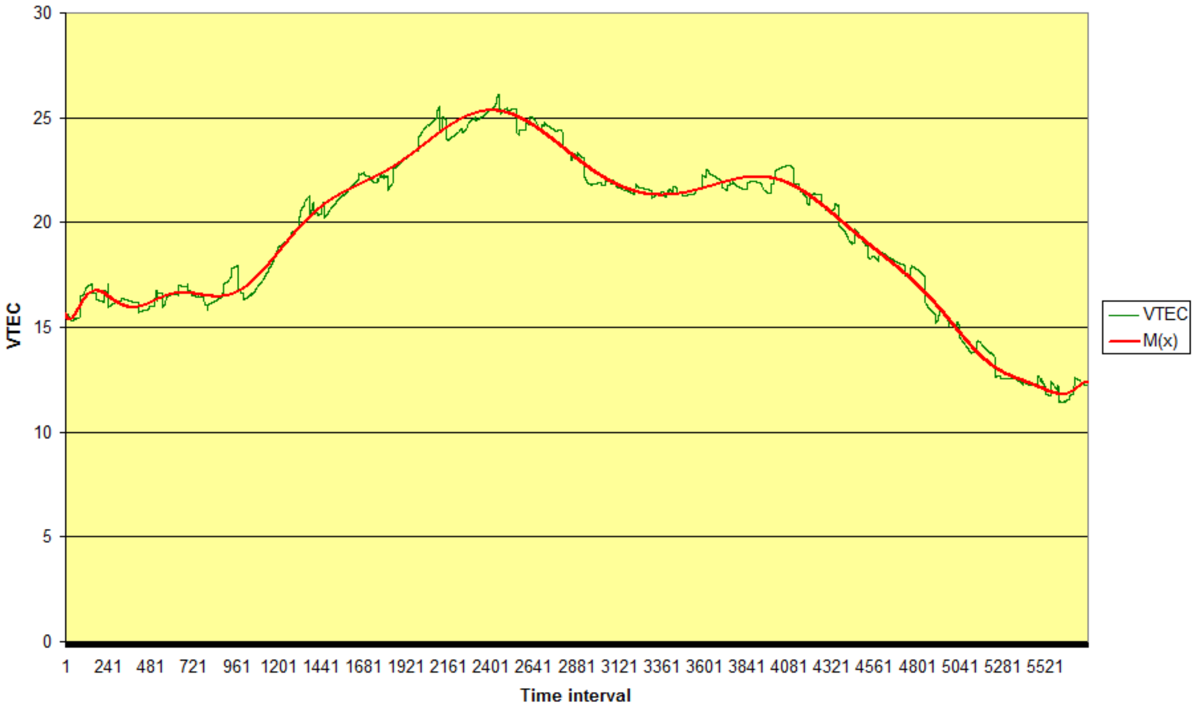

Fig. 1. The time ionosphere model M (x) built by approximating power polynomials

The criteria for evaluation of accuracy is the value of mean square error (MSE), which is given by:

$$\mu_{M_{(x)}} = \sqrt{\frac{V^T V}{n-1}} \qquad (3)$$

where V is mentioned deviations i-th point of the experimental data of *VTEC* i-th point created a model with a power polynomial.
Then, following the appropriate matrix calculation, meaning MSE model M (x), built by power polynomials will be $\mu_{M\,(x)} = 0.39$
This value MSE is generally acceptable. Therefore, our proposed method, which is to reduce deviations (fluctuateons) functional model of the ionosphere, is made by using approximating polynomials on values of experimental data *VTEC* (vector L). The essence of this technique is to create another model based on fitting deviations V_i using trigonometric Fourier series.
Let us consequence of temporal ionosphere model M (x); there is an array of variations $V = (v_1, v_2, \dots, v_n)$ the model of experimental points of the study. As a result, we get a model V (x), which by adding

to the polynomial M (x), form a new temporal model of the ionosphere I that will be the best place for experimental values *VTEC* and MSE indicator which is much smaller than power polynomials.
To sum up, let us note:

$$V(x) = \sum_{i=1}^{g} (a_i \cos ix + b_i \sin ix) \tag{4}$$

where g is an order of trigonometric Fourier series.
The task of a modelling variation V is reduced to determine trigonometric Fourier series coefficients $\{a_1, a_2, \dots a_n\}$ and $\{b_1, b_2, \dots b_n\}$. It is well known, that these factors can be determined by the close integration.

Discussions and results
General model *I*, which restores the state of the ionosphere time according to regular indices *TEC*, is found as the sum of the previous two models:

$$I = M + V. \tag{5}$$

If we analyze the resulting of model *I* it should be noted that it approximates values of *VTEC* with sufficient accuracy. The criteria for evaluation of the accuracy of the value will mean square error (MSE), which is given

$$\mu_I = \sqrt{\frac{W^T W}{n-1}} \tag{6}$$

where W is a column vector containing important deviations w_i (Fig. 2).
Then MSE values for the model is $\mu = 0.12$. This value MSE model ***I*** demonstrates the correctness of all actions in its creation, as implemented by the following inequality:

$$\mu_I < \mu_{M(x)} \tag{7}$$

Software developed to restore VTEC field for permanent GNSS-stations SULP and its graphical display can be used in automated real-time, as well as data processing systems of other stations. Because the technique enables the detailed analysis of the ionosphere in any area, it will make short-term forecasting of ionosphere impact for high-precision coordinate determination using GNSS - technologies.

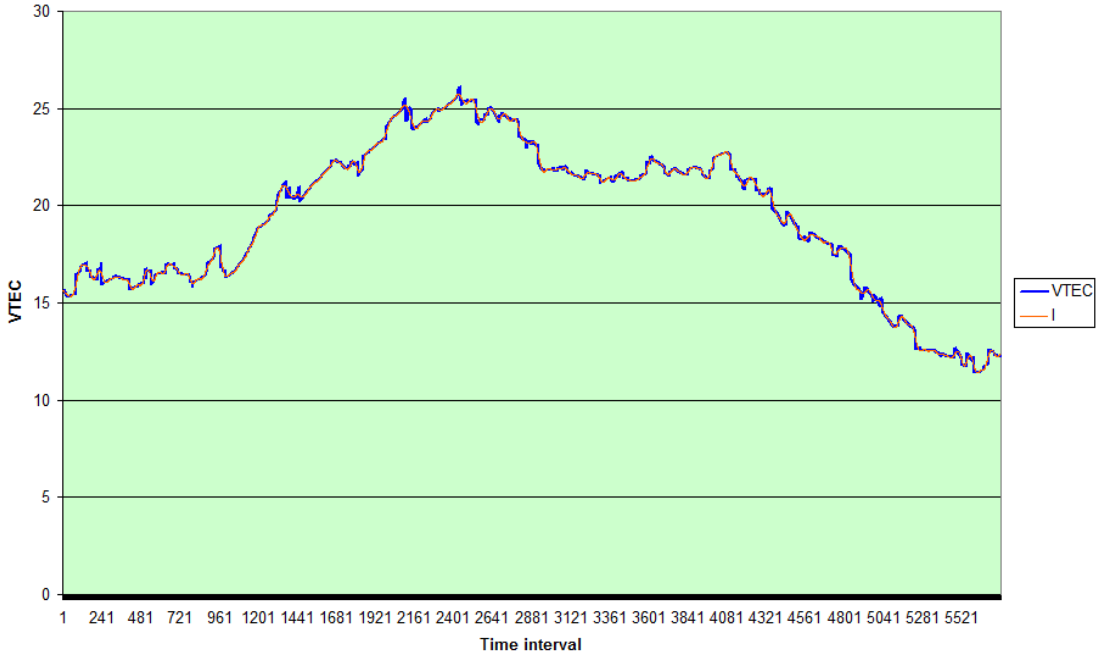

Fig. 2. The time ionosphere model and built using approximating power polynomials and trigonometric Fourier series

Rejection w_i of model ***I*** that was built using approximating power polynomials and trigonometric Fourier series of experimental parameters *VTEC* is acceptable.
Therefore, the application of this algorithm for data processing opens up opportunities to create temporal ionosphere models, analyse features of ionosphere parameters, to study external influences on their change over time and to improve solving coordinate and time support.

Conclusions and proposals

Software developed to restore *VTEC* field for permanent GNSS-stations SULP and its graphical display can be used in automated real-time, as well as data processing systems of other stations. Because the technique enables the detailed analysis of the ionosphere in any area, it will make short-term forecasting of ionosphere impact for high-precision coordinate determination using GNSS-technologies.
Rejection w_i of model ***I*** that was built using approximating power polynomials and trigonometric Fourier series of experimental parameters *VTEC* is acceptable.
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Liubov Yankiv-Vitkovska. PhD, Associate Professor of Institute of Geodesy, NU Lviv Polytechnic. St. Bandery, 12 str., 79013 Lviv, Ukraine, +380322582181, luba_y@ukr.net/ Solar-terrestrial connections, Ionosphere, Macromodelling, GNSS.

SEASONAL DEFORMATION PROCESSES AT UNDERGROUND GAS STORAGE STATIONS

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Abstract
This article is concerned with the problem of establishing process equipment deformation regularities, in particular, gas engine compressors at the compressor station of underground gas storage facility in Bohorodchany due to ground topographic surface vertical movements caused by gas flooding into and extraction from the reservoir bed in different seasons. Values of longitudinal and lateral pitches of gas-engine-compressor units' foundation plates were determined using the results of topographic surface vertical movements monitoring. This provides an opportunity to predict adverse processes in gas engine compressors operation. On the other hand, this monitoring facilitates resolution of land resources sustainable and efficient use issues at underground gas storage territories.
Key words: deformations, gas engine compressors, topographic surface movements, monitoring.

Introduction

As regards the global ranking of underground gas storage capacities, Ukraine ranks second in Europe. Arrangements of underground gas storage facility (UGSF) and its process operation are connected with withdrawal of land areas for wells, process pipelines, compressor stations and other industrial facilities. In certain cases during gas storage facility operation cultivated land changes, ground surface subsidence, topsoil and groundwater regime disturbance, as well as wells, process piping and gas engine compressors operation disturbances occur. Hence, there is a need of UGSF safe operation monitoring. In particular, integrated monitoring is performed at such facilities consisting of geochemical, geophysical, geodetic and special industrial surveillances with nondestructive testing methods. One of these methods can be the method based on geodetic measurements results.

Research methodology and materials. Discussion and results

The research objective is determining quantitative indicators of gas engine compressor foundations' deformation parameters on the basis of geodetic measurements. The research methodology is based on the results of long-time geodetic measurements performed at Bohorodchany UGSF. The papers of A. Maznitsky, I. Perovych and R. Oleskiv most completely reveal the issues of UGSF safe operation in modern science and practice.

The issues related to ground surface technogenic movements' impact on underground gas storage facility tightness are considered in the research paper (Maznitsky, 1995). The publication of I. Perovych" Geodynamic processes of underground gas storage facilities territories" is dedicated to ground surface monitoring at UGSF. It contains established main regularities of ground surface movement, and mathematical approximation of vertical movements processes on the basis of geodetic measurements (Perovych, 2004). The article R. Oleskiv, V. Sai "Ground surface deformation at underground gas storage facilities in Ukraine" reveals research related to establishing regularities of gas storage facility roof movements' impact on deformation parameters of rocks, casing tubes and production tubing in production wells bores. Bohorodchany UGSF, which is one the largest in Western Ukraine, was chosen as pilot facility (Oleskiv, Sai, 2015).

Special geodetic network was built at UGSF territory consisting of primary level Line 1 with total length of 6.1 km, based on two bunches of support benchmarks equipped beyond the reservoir bed boundary. The first group of support benchmarks include RP 1, RP 2 and RP 3, and the second group include RP 4, RP 5, and RP 6. Support benchmarks' groups are laid into the basement rocks (Fig. 1).

Two additional level lines were arranged in order to determine an aggregate picture of ground surface vertical movements throughout UGSF territory: Line 2 and Line 3. Level Line 2 is supported by operating benchmarks RP 157 and RP 53 of level Line 1. This level line is used for determining vertical shifts of the ground surface, the well mouths, as well as for distributing the common system of heights upon observation over vertical movements of engineering buildings, utilities, process equipment and gas compressor units.

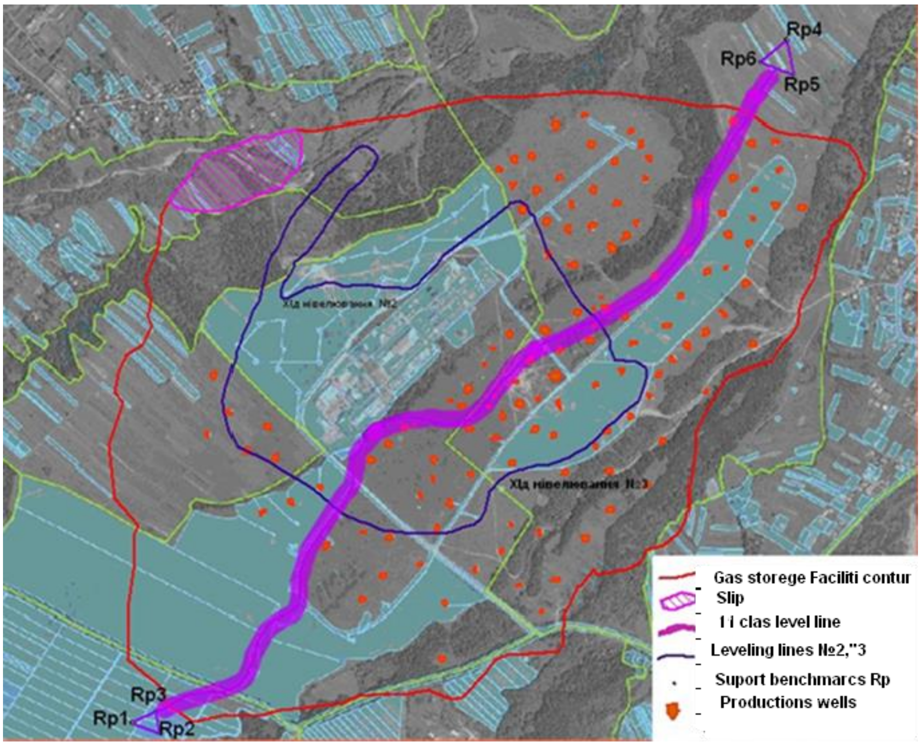

Fig. 1. Vertical geodetic control network diagram

Level Line 3 as well as 2, are supported by operating benchmarks RP 157 and RP 53 and used for determining vertical movements of the ground surface and wells.
According to the existing requirements, heights of operating benchmarks were determined by second-order levelling method.
Stability of benchmarks' base (bunches of support benchmarks) was determined by V. Runov's method.
Eleven series of observations were performed at this UGSF in total, associated with two boundary processes of UGSF operation. The first boundary observation process is carried out after full gas flooding into the reservoir bed (autumn), the second one is made after full gas extraction from the reservoir bed (spring). Therefore, heights of operating benchmarks obtained after geodetic measurements processing will represent dynamics of vertical movements to the full extent.
The mean square exceeding error per 1 km of line was measured for each series of observations

$$m_{1km} = \sqrt{\eta^2 + \tau^2} \qquad (1)$$

where η - a random error,

τ - a constant error.

Based on the results of calculation in all series of observations $m_{1km} \langle 5mm$, that corresponds to the requirements of second - order levelling.
Using the data of UGSF roof movements' average values calculations, the chart of operating benchmarks' vertical movements was provided (Fig. 2).

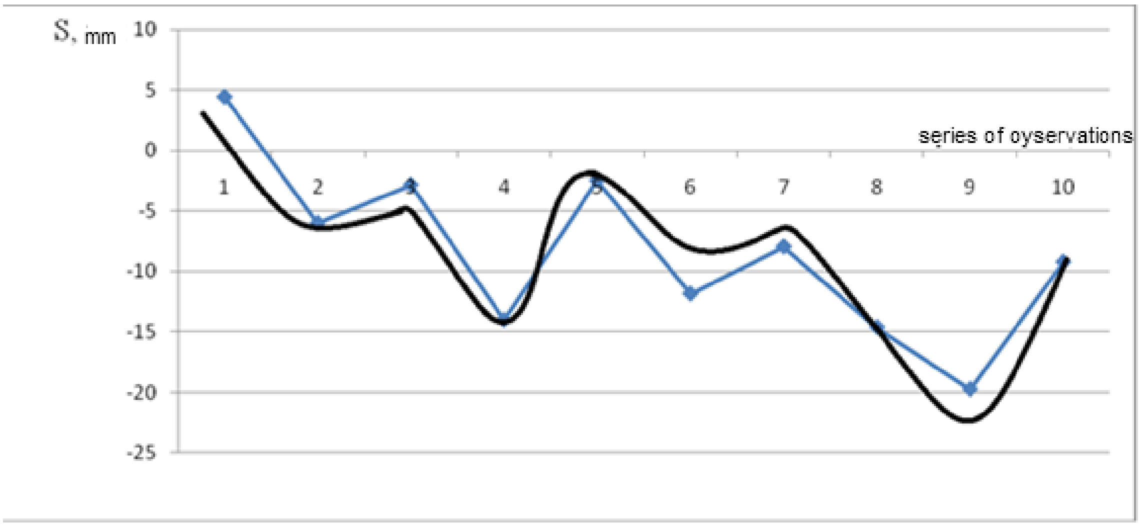

Fig. 2. UGSF roof vertical movements

Vertical movements' approximation function is the following:

$$\Delta S(t)=a_0+a_1t+a_2t^2+a_3t^3+\sum_{j-1}^{n}\left[A_j\cos(jt)+B_j\sin(jt)\right] \qquad (2)$$

where $a_0, a_1, a_2, a_3 \ldots$, A_j, B_j – empirical coefficients,

t – forecast period.

Data on vertical movements of the well mouths upon full load of UGSF reservoir bed and gas extraction present some features of interest (Fig. 3).

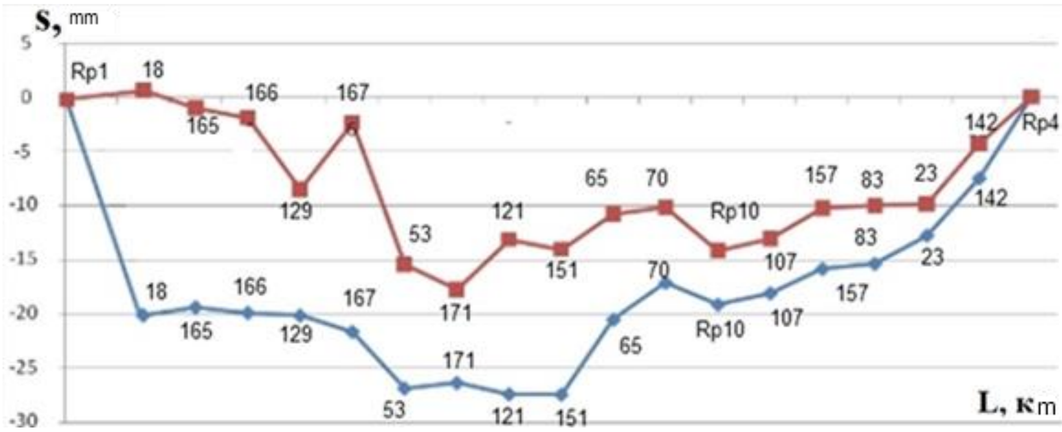

Fig. 3. Vertical movements of well mouths by level line 1

Analysis of the obtained results allows to make a conclusion that the well mouths are lowered upon gas extraction, and flow up upon loading. This phenomenon has a cyclical pattern and a negative impact on UGSF operation process. Moreover, the maximum range of movements is at UGSF center and the minimum one is at its edges.

A special attention in UGSF safe operation system shall be paid to determining deformation parameters of engineering buildings and gas engine compressors. For this purpose special bench marks were installed at supporting columns of engineering buildings, foundation plates of gas engine compressors and engineering elements of compressor shop inlet and outlet piping. High-altitude position of the mentioned marks was made under the second-order levelling program.

It should be noted that there are six gas engine compressors (GEC) in the compressor shop, and bench marks were laid in foundation plates of each GEC along the foundation edges. Therefore, four marks are installed in each plate. Average values of GEC foundations' vertical movements, as well as values of longitudinal and lateral pitches for the observation period are provided below (Table 1).

Table 1

Gas engine compressor foundations deformation

GEC number	Vertical movements, mm	Pitches, mm/m	
		Longitudinal	**Lateral**
1	+12.3	+0.20	+0.54
2	+8.4	-0.28	-0.21
3	+9.8	-0.19	+0.96
4	+10.2	-0.16	-0.21
5	+9.8	-0.15	-0.05
6	+8.6	+0.16	-0.02

Foundation vertical movements for each GEC were calculated by the formula:

$$\Delta S = H_c^{\circ} - H_c^{k} \tag{3}$$

Where $H_c^{\circ}; H_c^{k}$ – average value of heights from four bench marks in the initial and final measuremenal series.

Longitudinal and lateral pitches of foundation plates for separate GEC are calculated by the formula

$$k_{1,2} = \frac{\Delta h_{1,2}}{l_{1,2}} \tag{4}$$

Where $k_{1.2}$ – pitch in longitudinal (1) and lateral (2) directions of foundation plate,

$\Delta h_{1,2}$ – average value of difference in bench marks exceeding in longitudinal and lateral directions, mm,

$l_{1,2}$ – average distance between the bench marks in longitudinal and lateral directions, m.

The analysis of the results provided in the table allows to make a conclusion that vertical movements of all foundation plates have a positive value that indicates the buckling of ground surface at the compressor station territory in the central part of UGSF.

Foundation plates pitches for various GEC differ both by value and direction (+; - signs). The most adverse for operation are lateral pitch of foundation plate of GEC № 3 with the size of 0.96 mm/m and pitch of GEC No. 1 with size of 0.54 mm/m. These pitches can result in GEC vibration, and possibly, in GEC bearings breakdown that will require special engineering operations.

Conclusions

The specified research reflects a real picture of ground surface geodynamic movements of operated underground gas storage facilities. It was established that dynamics of ground surface and process equipment vertical movements has a definite cyclical pattern connected with UGSF operation conditions.

Deformation parameters of gas engines compressors' foundation plates were determined on the basis of processing of geodetic measurements. This is an important constituent part of general methods of UGSF safe operation nondestructive testing.

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TRANSPORT SUSTAINABILITY IN KAUNAS CITY (LITHUANIA) AND JELGAVA CITY (LATVIA)

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Abstract
This research study explores urban planning for transport sustainability in two cities Kaunas (Lithuania) and Jelgava (Latvia). As part of the analyses, a transport sustainability was compared in relation to three main aspects – economy, environment and society. The aim of this research is to review the existing transport system in two cities – Kaunas and Jelgava, and to evaluate their sustainabily in environmental, social and economic dimensions. The study is based on the information about configuration and location of the existing transport system in two cities – Kaunas and Jelgava. It is important to submit proposals to decision making bodies in order to improve sustainability of transport.
Key words: land management, sustainability in urban territories, sustainable transport.

Introduction

The city is an important state or a particular region's economic and social development engine. It is concentrated in the cities is the most important commercial, industrial and residential areas, public authorities. In a world of accelerating urbanization and growing number of people living in cities, and they have certain ecological, economic and social problems. Urban development and its sustainable development in terms of the developed countries have started long ago, and not the exception, and Lithuania and Latvia. However, sustainable urban development strategy is a complex process which must be included in the whole community: authorities, various organizations, businesses and local residents. Every city in the world is unique, only exposed its inherent environment. Some kind of social, economic, natural environment is an industrial European or North American countries, quite different - in poor regions of Africa. Therefore, obstacles that hinder the sustainable development of cities, is also different. Evaluation of urban coherence, it is necessary to take into account a number of parameters - or a convenient city transport in relation to whether it is free from contamination, or have enough green areas and the like (Ciegis, Zaleviciene, 2012).

Sustainability tools are not new. Architects, industrial designers and engineers (and even economists) have assessment tools that are intended to improve the performance of buildings, structures and objects. Thinking about sustainability on the large scale infrastructure project, a neighborhood, a city or even a region has to take various dimensions into account: environment, mobility systems, social structure and society, culture and identity, the creation of economic welfare, complex negotiations and development processes, participation and so on. The three main themes – economy, environment and society – are a logical division of sustainability however as they are so general, they have allowed much confusion and false or incomplete interpretation of the approach.

Seeking to evaluate sustainability in urban territories, it is necessary to take into account many factors: whether the city has convenient transportation with respect to whether it is free from contamination, or have enough green areas and so on. Jabareen Y. R. (2006) identified seven criteria for sustainable city: compactness, sustainable transport, density, mixed buildings, diversity, the use of solar energy, ecology (landscaping) (Narijauskas, Banaitiene, 2010).

Sustainable transport covers one of these mentioned criterias that have recently become highly relevant to sustainable urban development. Transportation is the most prominent challenge in the field of sustainable urban development, followed by socio-cultural awareness. The concern of transportation and socio-cultural conscious issues can propel sustainable urban development forward and improve other problems related it (Hassana, Leea, 2015). Besides, three forces can be identified that would shape the future development of cities: the attraction of existing urban centres; the attraction of major transportation links; and the aesthetic attractions for people of proximity to seas, lakes, rivers and other places of scenic beauty (Marull, Fonta, Boix, 2015). The transport sector is a major user of fossil energy, which causesair pollution and also contributes to global warming. Negative environmental and social impactsof transport imposes large costs on society. It is estimated thatair pollution, noise and accident related costs are at least 5% of GDP for industrialised countries. Hence, the transport sector with its significant environmental, social and eco-nomic impacts is an important element of urban sustainability (Reisi, Aye, Rajabifard, Ngo, 2015).

This work aims to explore cities of Kaunas and Jelgava as sustainable cities, a situation assessment of the transportation system and its impact on the environmental, social and economic aspects.
The aim of research is to review the existing transport system in two cities – Kaunas and Jelgava, and to evaluate their sustainabily in environmental, social and economic dimensions.

Methodology of research and materials

Scientific, historical literature analysis, inventory methods were used for the preparation of the article. The object of research is existing transport system in Kaunas and in Jelgava. Comparative, analytical as well as statistical and logical analysis methods were used for this research. Lithuanian, Latvian and other foreign scientific literature and legal acts were analysed in the article. The analysis of cartographic material was done. Also, the spacial planning documents were analysed. The collected material was analyzed, systematized and generalized.

Discussions and results

The current situation in Kaunas city.

Roads. Due to favorable geographical position, Kaunas is connected by road to other major Lithuanian and foreign centers. The first roads connecting Kaunas to Vilnius, Riga and Warsaw appeared in the middle ages. In year 1836 the construction of the St. Petersburg-Warsaw highway Kaunas-Zarasai stretch has been completed - the first in Lithuania with the pavement, a solid compacted gravel surface. In year 1939 the first paved street in Lithuania - Zemaiciu linking Kaunas and Klaipeda has completed.

Public transport. The first Kaunas public means of transport were horse trams, known as the Konkan, which operated from 1892 to 1929, when it was replaced by bus services. In the period from 1915 to 1935, public transport services and Kaunas civil use narrow-gauge railway were used. On December 31, 1965, trolley was introduced in Kaunas. At present in Kaunas there are four types of public transport: buses, trolley buses, taxis and shuttle taxis. 160 trolleybuses operate in 16 routes connecting the various city districts. The total route length is 368.3 km. The annual traffic volume is about 33 million passengers. Every day the route served by 31 after Kaunas city and relatives in the suburbs. Their total length is 1,160 km. On a work day buses travel 36,000 km. The average daily traffic volume is 90,000 passengers. There are also a 7-route taxi lines.

The current situation in Jelgava city.

Roads. Jelgava is an intersection of six national roads and five railway lines, it is a transit centre of national importance. Street network is a prerequisite for economic development creating urban spatial environment. Jelgava has 368 streets which are 270 km long, 58% of streets are covered with with asphalt, 40% are gravel roads. Some main streets have been reconstructed and infrastructure has been improved during 2007-2013, but it is necessary to continue the improvement of streets and traffic modernization by providing better condition for people with special needs and by building bike paths. The length of bike paths at present is 18.3 km, there are plans to develop cycling infrastructure as an alternative mode of transport. Jelgava is a city of the national importance with good accessibility to other cities - Riga, the capital, Liepaja, Jekabpils, as well as the city in Lithuania - Siauliai (Fig. 1).

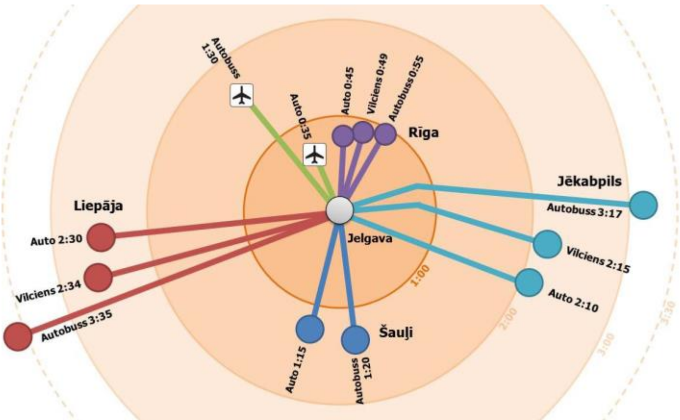

Fig. 1. Connection of Jelgava with other cities (measured by the required time)
Source: Jelgavas pilsetas attistibas programma 2014-2020

Jelgava is linked to the capital of Latvia, Riga; it is an important centre for both cargo and passenger transport: Riga as a large city concentrates the majority of the Latvian business, transport and logistics companies, and business environment causes a stable, continuous traffic flow (Fig. 2).

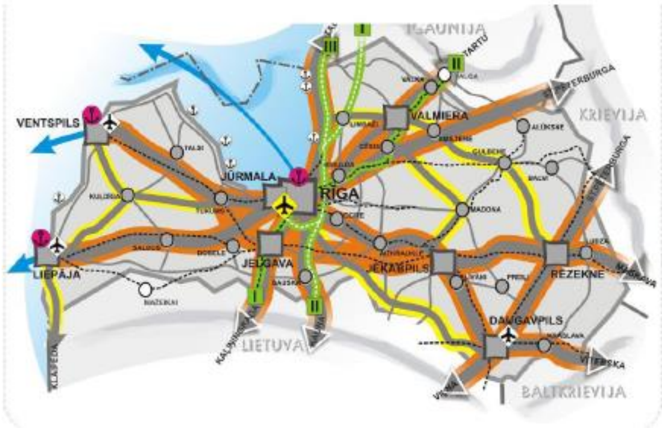

Fig. 2. Jelgava's location
Source: Jelgava city development program 2014-2020

Railway. Jelgava Latvia is a significant railway junction, where several lines intersect Zilupe - Krustpils - Jelgava - Ventspils, Riga - Jelgava - Liepaja, Riga - Jelgava - Gluda - Mazeikiai, Riga - Jelgava - Meitene - Šiauliai. These lines are very busy except for the line to Mazeikiai which has stopped operating. The most important cargo line is Krustpils - Jelgava - Ventspils, through which a great number of transported cargo move to the port of Ventspils; a less amount of cargo is transported via other routes, such as Riga - Jelgava, Jelgava - Liepaja. The most intensive passenger flow is in the direction of Jelgava – Riga, but the train to Liepaja leaves only twice a week.

Public transport. Jelgava has well-developed public transport network, the city is connected by roads and rails with other destinations. Bus transport provides connections by inter-regional and local routes to other cities, however, bus connections to Liepaja and Jekabpils (via Riga) are considered to be insufficient. Public transport services in Jelgava are also provided by mini-buses and taxis.

Kaunas city and Jelgava city territorial-urban problems.

The analysis and comparison of data of existing solutions of transport systems in Kaunas and in Jelgava helped to determine the common territorial-urban problems of both cities which have been divided into six groups:

Asymmetric configuration of the city. We can conclude that development in both cities has occurred asymmetrically from their central part in the direction of north-east and north-west. Due to the increased distance between the centre and residential and industrial districts, the travel time to work places has increased thus increasing environmental pollution. The southern part of Kaunas, despite being close to the center, is underdeveloped; a lot of funds are required for the construction of bridges, streets and engineering networks. To reduce pollution in the city centre of Jelgava, it is necessary to finish the construction of bypass for intercity and cargo transport in the northern part of Jelgava that will foster logistic and industrial development.

Excessive functional differentiation. Large areas of one predominant purpose are formed in the cities, especially in Kaunas, such as residential (homestead and multifamily housing) and industrial sites. There is a lack of a balance among areas of work places, housing and recreation areas in all parts of the cities that could decrease residents' commuting from work to home.

Physical and built environment features. The elements of natural environment, the rivers Nemunas and Neris in Kaunas and the Lielupe and Driksa in Jelgava, are of great value, however, small streams and their valleys in Kaunas and flood threat in Jelgava cause many difficulties in developing urban structure designs and improvement. Kaunas needs 300-400 m long bridges, installed slopes, which, in turn, eliminate valuable ravines and valleys of the natural environment.

The connection among cities' other parts goes through the centre. Most of the traffic flow connecting the parts of Kaunas city and Jelgava city go through the centre of the cities and the Old Town. The centre has become the distribution node connecting different parts of the cities. There is a good connection among the parts of the cities, but such a connection is missing outside the centre.

Insufficient attention to the natural environment. Kaunas city in its plan's structure with the main streets and squares is detached from natural values – the rivers and slopes. The banks of the rivers are separated from the city with public and residential industrial plots, warehouses and highways streets. Green areas and riverside slopes are neglected and therefore unattended. Slopes block the access to industrial and residential areas, their users deplete the slopes. There is a lack of safe illuminated paths, green terraces, playgrounds. Jelgava city faces these problems in some parts of the city, however, it should be noted that in recent years infrastructure projects have renovated and improved the area between the two rivers: a pedestrian bridge across the Driksa was built, the territory of an island has been improved, there are many walking paths, public swimming sites, an open-air stage as well as illuminated promenades.
Maintenance of Urban Environment. The created environment in Kaunas and Jelgava of streets and utility networks gradually gets worn out or damaged (a high degree of amortization). Annual capital investments in construction and repairs do not cover the environmental support costs.

<u>Infrastructure development in Kaunas city.</u>
Actual places for development of infrastructure in Kaunas city seeking to become as a sustainable city and sustainable region – connecting Kaunas district with Kaunas city, and other municipalities (Fig. 3):
1. South-East Kaunas city road (Kaunas-Vilnius A1 magistral road);
2. Tilto str. connection with Marijampole road and Rokai village (Kauno district munic.);
3. Baltu pr. connection with Zeimenos str.;
4. Kedainiu str. connection with Juodelynes str. (Kauno district munic.);
5. Raudondvario pl. connection with Pakalnes str. (Kauno district munic.);
6. Lakunu pl. connection with Z. E. Zilibero str. and Ironiskiu str. (Kauno district munic.);
7. Alksniu str. connection with Garsves str. and Roku village (Kauno district munic.);
8. Europos pr. connection with magistral road A5 ir Gelzkeliuko str. (Kauno district munic.);
9. Piliakalnio str. connection with Kalkines str. and Karkazu str. (Kauno district munic.);
10. Varniu str. and Prusu str. connection with Kedainiu str.

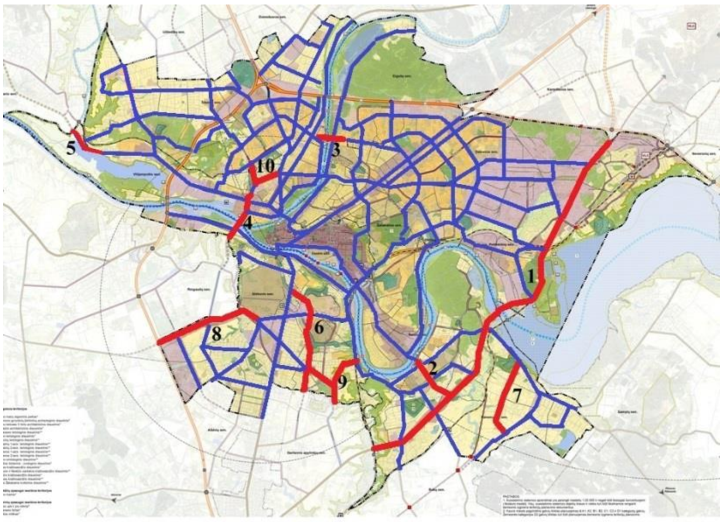

Fig. 3. Proposed places for development of transport (infrastructure) in Kaunas city
Sourse: Kaunas city municipality general (master) plan for 2013-2023

<u>Infrastructure development in Jelgava city.</u>
Actual places for development of infrastructure in Jelgava city seeking to become as a sustainable city and sustainable region – connecting Jelgava district with Jelgava city, and other municipalities (Fig. 4):
1. Reconstruction of Dobeles soseja and Atmodas iela;
2. Dobeles soseja connection with Loka magistrale (building of new bridge) via Kalnciema cels;
3. Reconstruction of Kalnciema cels;
4. Kalnciema cels connection with South-East Jelgava city road (Joniskis-Jelgava-Ryga A8 magistral road);

5. South-East Jelgava city road (Joniskis-Jelgava-Ryga A8 magistral road) connection with Rupniecibas iela;
6. Rupniecibas iela connection with Tervetes iela.

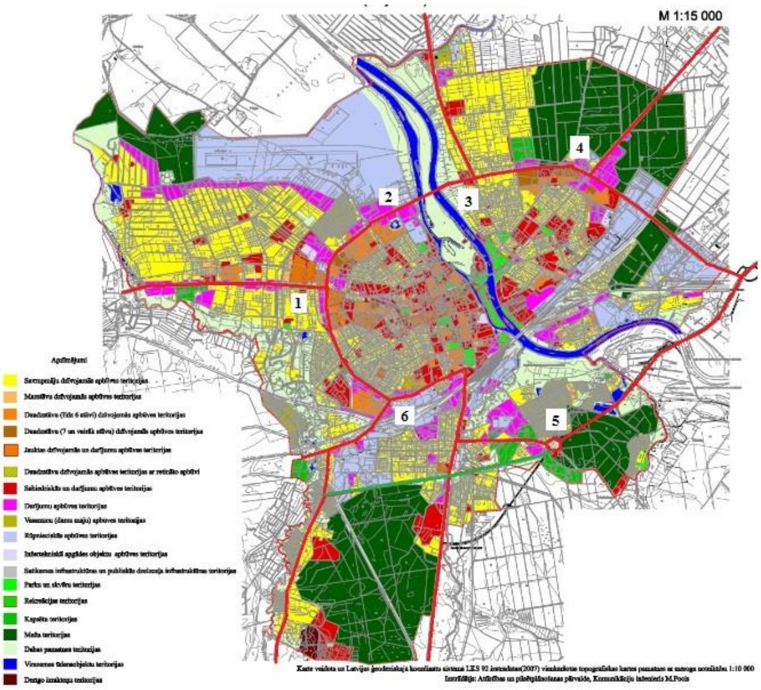

Fig. 4. Proposed places for development of transport (infrastructure) in Jelgava city
Source: Jelgava territory plan 2009 – 2021 year (the planned use the territory)

According to these findings of the transport system, the development of evaluation is carried out (Table 1):

Table 1

Evaluation of transport sustainabily in environmental, social and economic aspects

Economic aspects (possible)	**Environmental aspect (possible)**	**Social aspect (possible)**
Positive: Attract investment; decrease vehicle operating costs *Negative*: Long drafting (preparation of territorial planning documents); The high cost of the projects	*Positive*: Evenly will be distributed the existing pollution in urban areas and its approaches for shorter passing time *Negative*: The slight increase in pollution in areas where new roads will be constrcted; Some parts of new roads will pass through protected areas, culture heritage areas	*Positive*: Create new jobs; It will reduce traffic congestion; Shorten the transport time between highways; Residential areas will be populated and social infrastructure will be created *Negative*: Some residential areas become unattractive

Conclusions and proposals

1. The implementation of infrastructure projects would have an influence on the mobility of both cities – Kaunas and Jelgava, and it would let to achieve the decreasing of air pollution and noise in richly populated Kaunas and Jelgava urban areas, promote investment, pruned congestion and contribute to the well-being of the population.

2. For the cities, especially for Kaunas, in the protected areas (parks, reserves and etc.), cultural heritage sites, the implementation of some parts of the city is not without engines. Also, in order to address the issue of an "environmentally friendly" aspect the project cost would be increased.
3. Kaunas city and Jelgava city would become more attractive, more open for investment.

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