International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 13, Number 12 (2020), pp. 5309-5316

Definition of Transition Parameters between Coordinate Systems for Documentation on Territory Planning For Geospatial Support of State Registers

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Abstract

The subject of study is the possibility to use for cadastral work on the filling of state and municipal information resources the parameters of transition between plane coordinate systems according to developed and approved documentation on territory planning within the boundaries of several cadastral blocks. The article considers the necessity to calculate the parameters of transition between coordinate systems for cadastral works, surveying, and monitoring within localities, integrate municipal geoinformation systems and registers in geoinformation systems, as well as registers of higher territorial coverage. Foreign experience in restoring land-use boundaries is given, regardless of the coordinate systems used. According to the planning project of cadastral blocks No. 305005, 305006, 305009, 305010, 305011, 305012, 305015, 305016, 305019 within the boundaries of cadastral sector No. 24 of cadastral district No. 35, 12 reference points were selected, the coordinates of which are known in the city false grid system and the local regional system. The data points are used to calculate the parameters of transition from a false grid to a regional system: the rotation angle of coordinate axes, the scale factor, and the origin coordinates of a false grid system in the regional one. Based on the obtained mean square error (for the axes rotation angle – 1.34 angular seconds, for the origin – 0.007 m), it was established that the accuracy of the definition of transition parameters between two planar coordinate systems documentation for planning the territory of several city blocks is sufficient.

Keywords: Unified State Real Estate Register, Cadastre, Local Coordinate System, Land Surveying, Data Points, Regional Coordinate System

I. INTRODUCTION

At present, when applied to engineering and geodetic surveys, topographic, cadastral and land surveying works in the same territory, different coordinate systems can be applied and used: local, city, local for the Unified State Register of Real Estate (USRRE). The USRRE has been maintained by the Federal Service for State Registration, Cadastre and Cartography since 2017, after merging the State Real Estate Cadastre and the Unified State Register of Immovable Property. Data on real estate objects have a geospatial reference – the measured points of the contours are defined in a special coordinate system created for the USRRE and can be combined with planning and cartographic material and remote sensing data, materials of engineering and geodetic surveys carried out to justify the construction of capital objects. However, for such transformations, transition keys or transition parameters between two planar rectangular coordinate systems operating in the same area may not always be known or obtained quickly enough.

These problems are especially prevalent on urbanized lands – the lands of populated areas. This is due both to the active turnover of land and its use and to the higher accuracy of the description of the land and real estate, including capital construction objects, as compared to other lands. Thus, for example, the mean square error of determining the location of a land plot on a city territory to the point of the initial geodetic basis is 0.10 m, for lands under the objects of industry, transport, communication, and other similar special purposes – 0.50 m, for lands of agricultural purpose – 2.50 m, and for lands of the forest fund and water fund – 5.00 m.

Thus, the article considers the possibility of using information related to the graphic part of the planning documentation developed for a certain urban area to determine the transition parameters: the territory planning project and the territory surveying project. One of the main tasks is to determine the sufficiency of the accuracy of determining the transition parameters between two planar coordinate systems for documentation on the territory planning of several city blocks.

II. LITERATURE REVIEW AND METHODS

Conversion of coordinate systems is now an urgent issue for the territories where work on land monitoring is carried out, documentation on their development is developed, municipal registers with the introduction of geographic information systems (GIS) are maintained [4], construction of a network of permanent base stations and introduction of global navigation satellite systems are carried out to automate the process of topographic and cadastral surveying [8]. The issue of coordinate and cartographic support is quite acute when integrating several spatially linked databases and registers at the municipal level in different coordinate systems within one large regional GIS [10].

Also, in the works by foreign and domestic scientists, the necessity of constant modernization and specification of the coordinate systems applied to land surveying and cadastre is specified. It is specified that it is possible to use long-term objects on the ground, such as the corners of contours of capital construction projects, as the coordinate basis for federal and municipal information resources, with sufficient accuracy in determining their location [9] to minimize the work on the verification of registers in connection with changes in coordinate systems in a territorial entity. It seems reasonable to apply some foreign experience of cadastral works on the establishment and restoration of borders of land uses in part of the application as an initial geodetic basis of the long-term signs fixing already placed lands that can promote the reduction of a number of register errors arising due to the "overlay" of an newly marked area on the already placed cadastral account, in particular, because of the recalculation of coordinates at the transition to a new cadastre coordinate basis and the loss of points of state geodetic networks from which coordinates were previously determined [6]. At such long-term fixation of borders, the lost boundary markers can be restored quickly enough by linear measurements [3] irrespective of coordinate systems operating in the given area.

Fig. 1 shows the transition elements from one plane coordinate system to another:

- the axis rotation angle θ of the second coordinate system (X'O'Y') relative to the first coordinate system (XOY);
- offset of the coordinate origin: coordinates of the origin of the second coordinate system 0’ in the first coordinate system $X_{0'}$ and $Y_{0'}$;
- - the scaling factor m [7; 1].

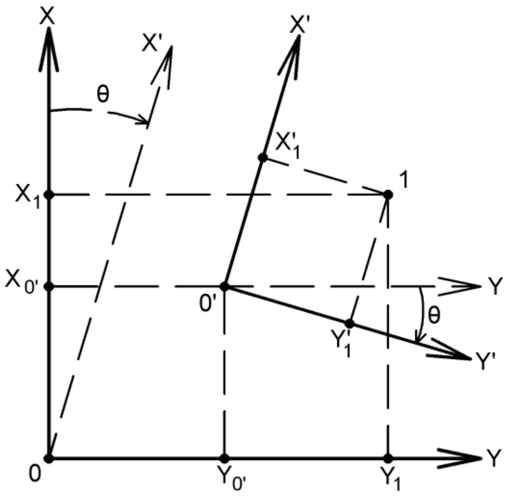

Fig.1. Elements for transforming one plane coordinate system into another.

The sufficiently full account of the scale factor value is necessary not only at the transition from a spherical surface of the Earth (coordinates: latitude and longitude) to a plane (coordinates in meters) [2] but also at the transition between two plane coordinate systems. The rotation angle of the coordinate axes θ is typical both for the border areas of the adjacent coordinate zones in the zonal coordinate systems [5] and in general for the work areas where false grid and local coordinate systems are used for convenience.

The study should determine the possibility and accuracy of determining the parameters of transition between the city false grid system and the local regional system. In the two-dimensional transition method, the coordinates of two or more change points are required – points for which the coordinates are calculated in the first and second systems. The coordinates of such points and the points themselves were obtained from the project of planning and surveying, approved by Resolution No. 462 of the Vologda City Administration of April 23, 2019.

Following the provisions of land management and urban planning legislation, the boundaries of building lines and blocks are set in the draft area plan. Further, the project of land surveying within the block boundaries sets the location and coordinates of measured points of land plots to be formed during cadastral works and entering information about land plots in the USRRE.

Part of the initial information for the development of the surveying project and cadastral work (land inventory materials, previously carried out engineering and geodetic surveys, layout drawings, architectural and planning solutions) can be available only in the city false grid system, and the USRRE is maintained in the local regional system. Since all land plots formed after the approval of the draft area plan are located inside the perimeter of the approved building line boundaries, the transition parameters between coordinate systems obtained from the building line coordinates can be applied to calculate

International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 13, Number 12 (2020), pp. 5309-5316

the land plot coordinates.

For the calculation of transition parameters based on the coordinates of the ends of one segment – two data points 1 and 2 in city false grid system and local regional system, the inverse geodetic problem is solved. The coordinate increments in both systems are calculated (Fig. 2):

$$\Delta X_{1-2} = X_2 - X_1;$$

$$\Delta X'_{1-2} = X'_2 - X'_1,$$

$$\Delta Y_{1-2} = Y_2 - Y_1;$$

$$\Delta Y'_{1-2} = Y'_2 - Y'_1,$$

where: X_1 and Y_1, X'_1, and Y'_1 are plane rectangular coordinates of the origin of a segment in both coordinate systems, m; X_2 and Y_2, X'_2, and Y'_2 are plane rectangular coordinates of the end of a segment, m.

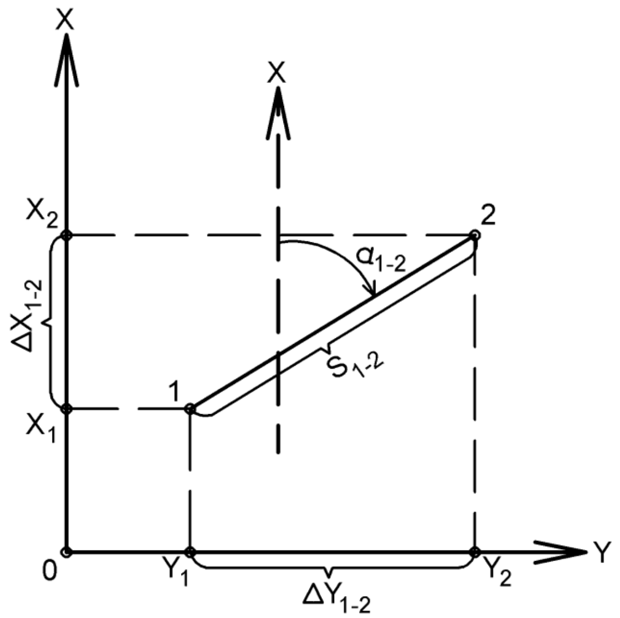

Fig.2. Elements of the forward and reverse geodetic task for calculation of parameters of the transition of one plane coordinate system into another.

Two horizontal distances (distance between points) in both S and S' coordinate systems are calculated by coordinate increments:

$$S' = \sqrt{\Delta X'^2_{1-2} + \Delta Y'^2_{1-2}}\ ;$$

$$S = \sqrt{\Delta X^2_{1-2} + \Delta Y^2_{1-2}}\ .$$

The scaling factor is calculated from the distances S and S':

$$m = \frac{S'}{S}.$$

By coordinate increments, the solution of the inverse geodetic problem calculates two reference angles in both coordinate systems α and α':

$$\alpha'_{1-2} = arctg\,\frac{\Delta Y'_{1-2}}{\Delta X'_{1-2}},$$

$$\alpha_{1-2} = arctg\,\frac{\Delta Y_{1-2}}{\Delta X_{1-2}}.$$

Based on the calculated directive angles α and α' in both coordinate systems, the rotation angle θ between the first and second systems is calculated:

$$\theta = \alpha'_{1-2} - \alpha_{1-2}.$$

After calculating the scale factor m and the angle of rotation of coordinate axes θ, solving the direct geodetic problem, there are coordinates $X_{0'}$ and $Y_{0'}$ of the first coordinate system origin in the second system (Fig. 1):

$$X_{0'} = X_1 + mS_{1-0}\cos(\alpha_{1-0} + \theta);$$
$$Y_{0'} = Y_1 + mS_{1-0}\sin(\alpha_{1-0} + \theta).$$

For monitoring, the coordinates $X_{0/}$ and $Y_{0/}$ are calculated using the distance $S_{2\text{-}0}$.

Further, the general working formulas can [7] be used to calculate the coordinates:

$$\mathrm{X}'_{\mathrm{i}} = \mathrm{X}'_0 + X_i \mathrm{m}\cos\alpha - Y_i m \sin\theta;$$

$$\mathrm{Y}'_{\mathrm{i}} = Y'_0 + Y_i m \cos\alpha + X_i m \sin\theta.$$

Several data points were selected from the area surveying project, the rotation angle of the coordinate axes and the scaling factor were calculated several times, and accuracy was assessed. The origin coordinates of one coordinate system in another system were also calculated several times, the mean square error was determined, and it was compared with the standard limit value.

III. RESULTS

The project of planning and area surveying, approved by the Resolution No. 462 of the Vologda City Administration of April 23, 2019, applies to the territory of cadastral blocks No. 305005, 305006, 305009, 305010, 305011, 305012, 305015, 305016, 305019 within the boundaries of cadastral sector No. 24 of cadastral district No. 35. Six pairs of data points 32 and 100, 150 and 45, 99 and 39, 163 and 13, 38 and 178, 160 and

15 from the building line drawing were selected to calculate the transition parameters between the city false grid system and the local regional system (Fig. 2).

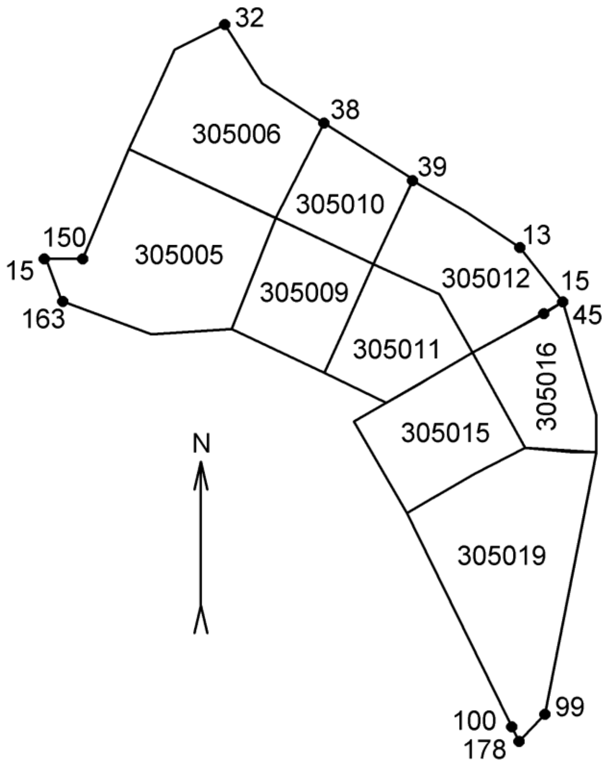

Fig.3. Location of data points within the boundaries of cadastral blocks No. 305005, 305006, 305009, 305010, 305011, 305012, 305015, 305016, 305019.

The following indexes are accepted to indicate the coordinate systems below:

- L – city false grid system;

- R – local regional coordinate system for the USRRE.

The directional angle of the line 32-100 in the city coordinate system, calculated by solving the inverse geodesic problem, was:

$$\alpha_L^{32-100} = arctg\frac{X_{100}-X_{32}}{Y_{100}-Y_{32}} = arctg\frac{-1445.09}{580.55} = 158°6'45.8"$$

The directional angle of the line 32-100 in the local regional coordinate system for maintaining the USRRE is:

$$\alpha_R^{32-100} = arctg\frac{X_{100}-X_{32}}{Y_{100}-Y_{32}} = arctg\frac{-1433.17}{609.37} = 156°57'55"$$

The angle of rotation between the city false grid and local regional coordinate systems θ, calculated through the side 32-100, is:

$$\theta = \alpha_L^{32-100} - \alpha_R^{32-100} = -1°8'50.8''.$$

For each of the sides 32 and 100, 150 and 45, 99 and 39, 163 and 13, 38 and 178, 160 and 15, the rotation angles θ_i and their average value θ_{AV} were calculated. Data are shown in Table 1.

Table 1. Calculation of the average rotation angle of the coordinate axes θ_{AV}

Side	Rotation angle of the coordinate axes	
	θ_i	θ_{AV}
32-100	-1°8’50,8”	-1°8’50,7”
150-45	-1°8’50,7”	
99-39	-1°8’48,6”	
163-13	-1°8’50,3”	
38-178	-1°8’50,9”	
160-15	-1°8’52,8”	

The mean square error m_θ, determining the rotation angle of the city false grid relative to the local regional coordinate system, was calculated using the Bessel formula:

$$m_\theta = \sqrt{\frac{\sum(\theta_i - \theta_{AV})^2}{5}} = 1.34''.$$

The length of the side 32-100, calculated by the coordinates of points in the city false grid system, was:

$$S_L^{32-100} = \sqrt{(X_{100}-X_{32})^2 + (Y_{100}-Y_{32})^2} = 1557.345\,(m),$$

the length of 32-100 in the local regional coordinate system:

$$S_R^{32-100} = \sqrt{(X_{100}-X_{32})^2 + (Y_{100}-Y_{32})^2} = 1557.340\,(m).$$

The scale factor for the transition from the city false grid to the local regional coordinate system *m*, calculated using the 32-100 side, was:

$$m = \frac{S_R}{S_L} = \frac{1557.340}{1557.345} = 0.999997.$$

For each of the sides 32 and 100, 150 and 45, 99 and 39, 163 and 13, 38 and 178, 160 and 15, the scale factors m_i and the mean value m_{AV} were calculated. Data are shown in Table 2.

Table 2. Calculation of the scale factor

Side	Side lengths, m		Scale factor	
	S_L	S_R	m_i	m_{AV}
32-100	1557.345	1557.340	0.999997	0.999997
150-45	950.414	950.426	1.000013	
99-39	1124.427	1124.410	0.999985	
163-13	940.746	940.743	0.999997	
38-178	1319.054	1319.056	1.000002	
160-15	1059.709	1059.715	1.000006	

The origin coordinates of the city false grid system in the local regional system (X_R^0 and Y_R^0) through the coordinates of the change point in the local system – the point 32 with the coordinates X_R^{32} and Y_R^{32}, the origin coordinates 0 of the city system in the city coordinate system X_L^0=0.00 (m) and Y_L^0=0.00 (m), the length 32-0 in the city coordinate system S_L^{32-0}, the directional angle of the line 32-0 α_L^{32-0}, taking the rotation angle of the local regional coordinate system relative to the city false grid system *θ=-1°8’50,7”* and the scale factor m=0.999997, are computed as follows:

$$S_L^{32-0} = \sqrt{(X_L^0 - X_L^{32})^2 + (Y_L^0 - Y_L^{32})^2} = 2156.197\,(m);$$

$$\alpha_L^{32-0} = arctg\frac{X_L^0 - X_L^{32}}{Y_L^0 - Y_L^{32}} = 234°11'33.3'';$$

$$X_R^0 = X_R^{32} + mS_L^{32-0}(\cos\alpha_L^{32-0} + \theta) = 3741.922\,(m);$$

$$Y_R^0 = Y_R^{32} + S_L^{32-0}(\sin\alpha_L^{32-0} + \theta) = 6215.229\,(m).$$

Similarly, the origin coordinates of the city false grid system in the local regional system are calculated through the remaining change points 13, 15, 38, 39, 45, 99, 100, 150, 160, 163, 178, the coordinates of which are also obtained from the draft area plan approved by the Vologda City Administration Resolution No. 915 of July 22, 2019. The calculated coordinate values and their P_i weight are given in Table 3.

Table 3. Calculated Coordinate Values X_R^0 And Y_R^0 of the Origin of the City False Grid System in the Local Regional System, Calculated Through 12 Data Points

Points relative to which coordinates are defined	Coordinates, m; weight		
	X^0_{Ri}	Y^0_{Ri}	P_i
13	3741.917	6215.232	0.63574265
15	3741.921	6215.232	0.62360188
32	3741.922	6215.229	0.72946396
38	3741.921	6215.240	0.70967806
39	3741.932	6215.227	0.67658326
45	3741.919	6215.243	0.63427902
99	3741.924	6215.235	0.66042964
100	3741.921	6215.232	0.67319488
150	3741.921	6215.233	0.95329551
160	3741.919	6215.235	0.99198149
163	3741.920	6215.233	1.00000000
178	3741.930	6215.241	0.67479434

The P_i weight in calculations is the ratio of the smallest distance from the origin of the coordinate system to one of the data points (point 163) $S_{0\text{-}163}$=1572.868 (m) to the distance to each of the data points.

The sum of weights has been calculated from Table 2:

$$\Sigma P_i = 8.96304469,$$

the sum of products of the abscissas of the origin of the city false grid system in the local regional system:

$$\Sigma X_{R\,i}^0 \cdot P_i = 3170604.656\ (m)$$

and the sum of products of ordinates of the origin of the city false grid system in the local regional system:

$$\Sigma Y_{R\,i}^0 \cdot P_i = 20849971.12\ (m).$$

The weighted average coordinates of the origin of the city false grid system in the local regional system:

$$X_R^0 = \frac{\sum X_{Ri}^0 P_i}{\sum P_i} = 3741.922\,(m);$$

$$Y_R^0 = \frac{\sum Y_{Ri}^0 P_i}{\sum P_i} = 6215.234\,(m).$$

The mean square error in determining the origin location of the city false grid system in the local regional system M_t and the mean square errors in determining the location on the coordinate axes m_X and m_Y through 12 data points were:

$$m_X = \sqrt{\frac{\sum (X_R^0 - X_{Ri}^0)}{11}} = 0.004\,(m);$$

$$m_Y = \sqrt{\frac{\sum (Y_R^0 - Y_{Ri}^0)}{11}} = 0.005\,(m);$$

$$M_t = \sqrt{m_X^2 + m_Y^2} = 0.007\,(m).$$

The mean square error in determining coordinates during cadastral works in the territory of localities following the values approved by the regulatory authority in the field of cadastral activities must not exceed 0.100 meters. The obtained error value is 0.007 meters less than the limit value. Thus, the definition of transition parameters between plane coordinate systems on documentation on territory planning for cadastral activity in the given territory is admissible [12-24].

IV. CONCLUSION

There are many federal information resources in the territory of Russia, including linked to such databases geographically [25-33]. The USRRE is an example of such an information resource [34-47].

In the project of planning and surveying of the territory of cadastral blocks No. 305005, 305006, 305009, 305010, 305011, 305012, 305015, 305016, 305019 within the boundaries of cadastral sector No. 24 of cadastral district No. 35, approved by the decree of the Vologda City Administration, 12 data points were selected for calculating the parameters of the transition from the city false grid system to the local regional one:

- the coordinate axes rotation angle of coordinate systems θ;

- the scaling factor m;

- the origin coordinates of the city false grid system in the local regional system X_R^0 and Y_R^0.

The mean square error of determining the rotation angle of the city false grid to the local regional coordinate system was m_θ=1.34". The mean square error of determining the origin location of the city false grid system in the local regional system was M_t=0.007 meters. The resulting error value of 0.007 meters did not exceed the limit value of such an error of 0.100 meters.

Thus, the main task of the study was fulfilled: it was found that the accuracy of determining the transition parameters between the two plane coordinate systems for the documentation on the planning of the territory of several city blocks was sufficient for cadastral activities aimed at providing information support for maintaining state registers within the boundaries of these blocks.

REFERENCES

[1] Zeng H. Planar coordinate transformation and its parameter estimation in the complex number field. Acta Geodaetica et Geophysica. 2014 Mar 1;49(1):79-94.

[2] Hooijberg M. Geometrical Geodesy: Using Information and Computer Technology, Berlin: Springer.2008:452 p.

[3] Robillard WG, Wilson DA. Brown's boundary control and legal principles. John Wiley & Sons; 2013 Nov 25.

[4] Popov YP, Avdeev YM, Hamitova SM, Tesalovsky AA, Kostin AE, Lukashevich M, Lukashevich MV, Kozlov AV, Koposova NN, Uromova IP. Monitoring of green spaces' condition using GIStechnologies. International Journal of Pharmaceutical Research. 2018 Oct;10(4).

[5] Zhiping Lu, Shubo Qiao, Yunying Qu. Geodesy: Introduction to Geodetic Datum and Geodetic Systems. Berlin: Springer. 2014:401 p.

[6] Tesalovsky AA, Avdeev YM. Geodetic basis of the state land surveying system in the United States, Bulletin of the Ryazan State University. S. A. Yesenin. 2018;2:88-97.

[7] Poklad GG, Gridnev SP. Geodesy: a textbook for universities. Moscow: Academic project. 2007:592 p.

[8] Abzhdaparova DA. Converting coordinates from the Gauss-Krucher projection to the coordinates of the stereographic Gaussian projection on the example of Southern Kyrgyzstan, Bulletin of SGUGiT. 2017;22(2):78-87.

[9] Meteleva MV. Development and research of a methodology for coordinate support of cadastral activities in territorial entities, the dissertation author's abstract for the degree of candidate of technical sciences. 2015;25.00.26:24 p.

[10] Anisimov NV, Bely AV, Maksutova NK. Geoinformation and cartographic support of environmental, economic and social aspects of sustainable development of the Vologda region, Interkarto. Intergis. 2019;25(1):89-101.

[11] Dokka Z, Liubov N, Filatova I. Problems of oil refining industry development in russia. International Journal of Engineering Research and Technology.2020;13(2):267-270.

[12] Novikova NV, Barmuta KA, Kaderova VA, Il DP, Abdulov RE, Aleksakhin AV. Planning of new products technological mastering and its influence on economic indicators of companies. International Journal of Economics and Financial Issues. 2016;6(8S).

[13] Glotko AV, Polyakova AG, Kuznetsova MY, Kovalenko KE, Shichiyakh RA, Melnik MV. Main trends of government regulation of sectoral digitalization. Entrepreneurship and Sustainability Issues. 2020;7(3):2181-95.

[14] Shagiakhmetov A, Tananykhin D, Terleev A. Development of water-shutoff composition on the basis of carboxymethyl cellulose for fractured and fractured-porous oil and gas reservoirs. Acta Technica CSAV (Ceskoslovensk Akademie Ved). 2018;63(3):475-80.

[15] Tananykhin D, Saychenko L. Sand control methods for the development of oil & gas fields with hard to recover reserves. Espacios (ISSN: 07981015). 2017;38(48):31.

[16] Movchan IB, Yakovleva AA. Refined assessment of seismic microzonation with a priori data optimisation. Записки Горного института. 2019;236.

[17] Ivanova TS, Malarev VI, Kopteva AV, Koptev VY. Development of a power transformer residual life diagnostic system based on fuzzy logic methods. InJournal of Physics: Conference Series 2019 Nov (Vol. 1353, No. 1, p. 012099). IOP Publishing.

[18] Aleksandrovich LV, Pavlovna KP, Kimovich TI, Sergeevich TD. Development of smart well units for multilayer reservoirs operated with the system of simultaneous-separate exploitation. Journal of Applied Engineering Science. 2018;16(4):561-4.

[19] Aleksandrova TN, Nikolaeva NV, Potemkin VA. Beneficiation of carbonaceous rocks: New methods and materials. InInnovation-Based Development of the Mineral Resources Sector: Challenges and Prospects-11th Conference of the Russian-German Raw Materials 2018 Oct 11 (pp. 391-398).

[20] Bondarenko A, Islamov S, Mardashov D. Features of oil well killing in abnormal carbonate reservoirs operating conditions. InEngineering and Mining Geophysics 2019 15th Conference and Exhibition 2019 Apr 16 (Vol. 2019, No. 1, pp. 1-5). European Association of

Geoscientists & Engineers.

[21] Chen T, Babanin A, Al-Qāsim MA, Chapron B, Chen J, Md SH. Prototype of web-based daily work report management system using smart pens. Journal of Applied Engineering Science. 2019;17(3):280-3.

[22] Filatova I, Shabalov M, Nikolaichuk L. Regulation methods in natural monopoly markets case of russian gas network companies. International Journal of Engineering Research and Technology. 2019;12(5):624-30.

[23] Jafarpour H, Moghadasi J, Khormali A, Petrakov DG, Ashena R. Increasing the stimulation efficiency of heterogeneous carbonate reservoirs by developing a multi-bached acid system. Journal of Petroleum Science and Engineering. 2019 Jan 1;172:50-9.

[24] Filatova I, Shabalov M, Nikolaichuk L. Regulation methods in natural monopoly markets case of russian gas network companies. International Journal of Engineering Research and Technology. 2019;12(5):624-30.

[25] Podoprigora DG, Korobov GY, Bondarenko AV. Acid stimulation technology for wells drilled the low-permeable high-temperature terrigenous reservoirs with high carbonate content. International Journal of Civil Engineering and Technology. 2019;10(1):2680-96.

[26] Prischepa O, Nefedov Y, Grokhotov E. Geochemical and petrophysical studies of hydrocarbon potential of domanic shale formation (timan-pechora petroleum province). InEAGE/SPE Workshop on Shale Science 2019 2019 Apr 8 (Vol. 2019, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.

[27] Shagiakhmetov A, Tananykhin D, Terleev A. Development of water-shutoff composition on the basis of carboxymethyl cellulose for fractured and fractured-porous oil and gas reservoirs. Acta Technica CSAV (Ceskoslovensk Akademie Ved). 2018;63(3):475-80.

[28] Tarasov VI. Technological and economic prospects and regulatory support for the production and sale of Russian biofuels. Industrialist of Russia.2008;9.

[29] Tananykhin D, Saychenko L. Sand control methods for the development of oil & gas fields with hard to recover reserves. Espacios (ISSN: 07981015). 2017;38(48):31.

[30] Tica S, Živanović P, Bajčetić S, Milovanović B, Nađ A. Study of the fuel efficiency and ecological aspects of CNG buses in urban public transport in Belgrade. Journal of Applied Engineering Science. 2019;17(1):65-73.

[31] Yemelyanov V, Tochilkina T, Vasilieva E, Nedelkin A, Shved E. Computer diagnostics of the torpedo ladle cars. InAIP Conference Proceedings 2018 Oct 31 (Vol. 2034, No. 1, p. 020008). AIP Publishing LLC.

[32] Bondarenko A, Islamov S, Mardashov D. Features of oil well killing in abnormal carbonate reservoirs operating conditions. InEngineering and Mining Geophysics 2019 15th Conference and Exhibition 2019 Apr 16 (Vol. 2019, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.

[33] Almeida MD, Silva ED, Gomes NÂ, Nunes LA, Curi WF. Environmental quality of campina grande landfill based on technical and operational aspects. Periódico Tchê Química. 2019;16(32):77-86.

[34] Chupin S, Bolobov V. Influence of thermomechanical treatment modes on wear resistance of mining equipment material. 2018. doi:10.4028/www.scientific.net/MSF.945.695

[35] Sobota J, Malarev VI, Kopteva AV. Calculation of oil-saturated sand soils' heat conductivity. Записки Горного института. 2019;238.

[36] Tananykhin D, Tcvetkov P, Kamoza V. Analysis and recommendations of sand consolidation methods to limit sand production in gas wells. InJournal of Physics: Conf. Series 2018 Aug (Vol. 1072, p. 012022).

[37] Shagiakhmetov A, Tananykhin D, Terleev A. Development of water-shutoff composition on the basis of carboxymethyl cellulose for fractured and fractured-porous oil and gas reservoirs. Acta Technica CSAV (Ceskoslovensk Akademie Ved). 2018;63(3):475-80.

[38] Kuznetsova AN, Gunkin AS, Rogachev MK. Dynamic modeling of surfactant flooding in low permeable argillaceous reservoirs. InIOP Conference Series: Earth and Environmental Science 2017 Oct (Vol. 87, No. 5, pp. 1755-1315).

[39] Bondarenko A, Islamov S, Mardashov D. Features of oil well killing in abnormal carbonate reservoirs operating conditions. InEngineering and Mining Geophysics 2019 15th Conference and Exhibition 2019 Apr 16 (Vol. 2019, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.

[40] Panfilova E, Dzenzeliuk N, Domnina O, Morgunova N, Zatsarinnaya E. The impact of cost allocation on key decisions of supply chain participants. International Journal of Supply Chain Management. 2020 Feb;9(1):552-8.

[41] Khaibullina K. Technology to remove asphaltene, resin and paraffin deposits in wells using organic solvents. InSPE Annual Technical Conference and Exhibition 2016 Sep 26. Society of Petroleum Engineers.

[42] Aleksandrova TN, Nikolaeva NV, Lvov VV, Romashev AO. Ore processing efficiency improvements for precious metals based on process simulations. Obogashchenie Rud. 2019;2:8-13.

[43] Raupov IR, Shagiakhmetov AM. The results of the complex rheological studies of the cross-linked polymer composition and the grounding of its injection volume. Int. J. Civil Eng. Tech. 2019;10:493-509.

[44] Cheremisina OV, Sergeev VV, Chirkst DE, Litvinova TE. Thermodynamic investigation into extraction of cerium (III) by tributyl phosphate from phosphoric acid

solutions. Russian Journal of Non-Ferrous Metals. 2015 Nov 1;56(6):615-21.

[45] Vien LL, Azmalia AT, Cott GW, Azwina MS. Development and assessment of free-flow speed models based on different methods of measurements for inter urban multilane highways in Malaysia. Journal of Applied Engineering Science. 2019;17(3):256-63.

[46] Cheremisina O, Sergeev V, Fedorov A, Iliyna A. Problems of protection of urban areas from radionuclides strontium-90 and caesium-137 after technological disasters. Journal of Ecological Engineering. 2017;18(3).

[47] Shagiakhmetov AM, Raupov IR, Terleev AV. Investigation of selective properties of the gel-forming composition for the limitation of water inflow to carbonate reservoirs conditions. International Journal of Civil Engineering and Technology. 2019;10(2):485-92

[48] Pavlyuk AV., Kokorev AS., Lazareva TG., Artemova EI. Assessment of the economic security of the region (on the example of chelyabinsk region). Journal of Applied Economic Sciences. 2018; 13(8): 2309-2322.

[49] Sharafutdinov RI, Polyakova AG, Gerasimov VO, Shpakova RN, Mikhailova MV. Inclusive growth: A dataset on key and institutional foundations for inclusive development of russian regions. Data in Brief. 2019; 23.

[50] Polyakova AG, Pavlyuk AV, Meshkova GV. Investment appeal of a region and its impact on investment inflows. Entrepreneurship and Sustainability Issues. 2019; 7(2): 1089-1097.