Digital learning technologies within geo-information management

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Abstract. Recently, there is digital transformation of university education, including new concepts for obtaining and presenting learning materials. In article, there is considered digital learning technologies for geo-information management within Industry 4.0 while modern global economic crisis in last years. In research, there are used Foresight technologies, theory of decision making under uncertainties and risk management. Also, there are used methods of data bases constructing, web-technologies and virtual reality tools. As base technology, authors propose to use digital educational platforms, which integrate heterogeneous hardware and software resources using web technologies in distributed networks and a wide use of cloud services. Authors propose to use Google Classroom as essential digital educational platform. As study result, there are proposed enlarged groups of didactic works in geo-information management, oriented on practical purposes and adapted to Covid-19 pandemic conditions. There are considered the issues of digital content creation within university education, essentially in practical training. Presented in article results of study have a significant scientific novelty and can be used in educational and training purposes, including the preparation of Master's programs in geo-information management.

1 Introduction

Modern global economics including logistics [1] is functioning in Industry 4.0 period, and when while climate change and covid-19 pandemic. Now, wide range of information technologies are planning and implementing by many businesses [2-10], including transportation sector [11, 12]. Industry 4.0 leads to serious information technological changes, including natural risks management (NRM) within geo-information management (GIM) for natural-industrial systems (NIS) [11-17], that requires the development of new managerial tools, including practical learning area [18-21].

The purpose of this article is to develop digital learning technologies (DLT) at university level (UL) within GIM paradigm [22] in environmental economics [23-25] while climate

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change and Covid-19 pandemic. In the article, the authors describe the development results of such. We paid significant attention to the issues of information collection [26] and processing, including modern digitalization approaches [27-30].

2 Materials and Methods

In research, authors used Foresight technologies, Internet of Things (IoT) and big data technologies [26-29], risk management approach, methods of data bases constructing, web-technologies and virtual reality tools. From the point of view of GIM, geo-space is structured to allocate the interconnected components of the solution space [22]. While study, , there are used data bases and tools of geo-information digital online platform (GIDOP) Earth https://earth.nullschool.net/.

3 Results

While research, there are developed digital learning technologies (DLT) at university level (UL) within GIM paradigm [22] in environmental economics [23-25] while climate change and Covid-19 pandemic. Preference is given to digital educational platforms (DEPs), that integrate heterogeneous hardware and software resources with the use of web-technologies in distributed networks and wide application of cloud services. Here, Google Classroom is used as DEP. Its main advantages are ease of use, universal access, flexible feedback system and its free of charge. This DEP usage eliminates a system administrator because of Google servers implementing, and also a content Manager because each teacher is responsible for the content of his course.

For digital content development, there is used the decomposition as a technique for methodological basis preparation. In figure 1, there is presented the enlarged groups of didactic works, oriented on practical purposes in GIM learning at UL. While study, digital content of practical works within UL in the field of geo-information management disciplines while Covid-19 pandemic for all above-mentioned groups (figure1) was developed using freely distributed recording program CamStudio.

As essential part of DLT in the field of GIM disciplines while Covid-19 pandemic, it was proposed to use GIDOP Earth https://earth.nullschool.net/ for data mining and visualization. Usage of GIDOP Earth allows to find and use GIM data for learning purposes at UL within geo-information support for environmental economics. In figure 2, there is main menu of GIDOP Earth. With GIDOP Earth, you can access data on atmospheric and hydrological processes throughout the planet.

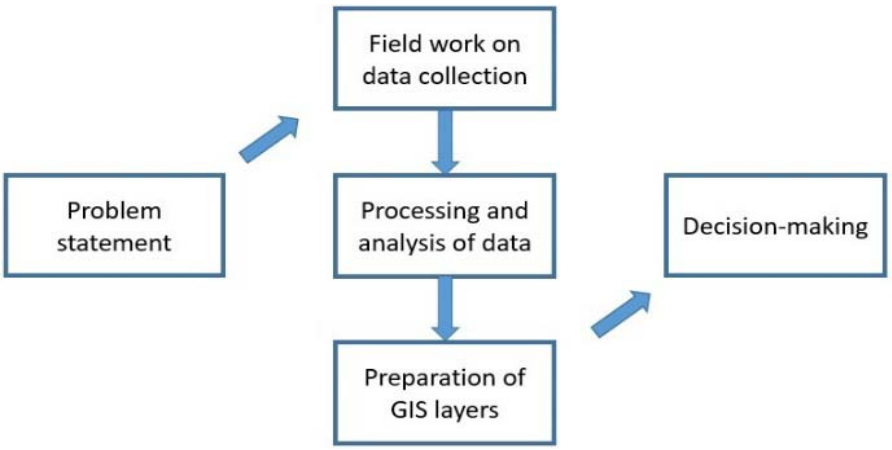

Fig. 1. Enlarged groups of didactic works for GIM purposes.

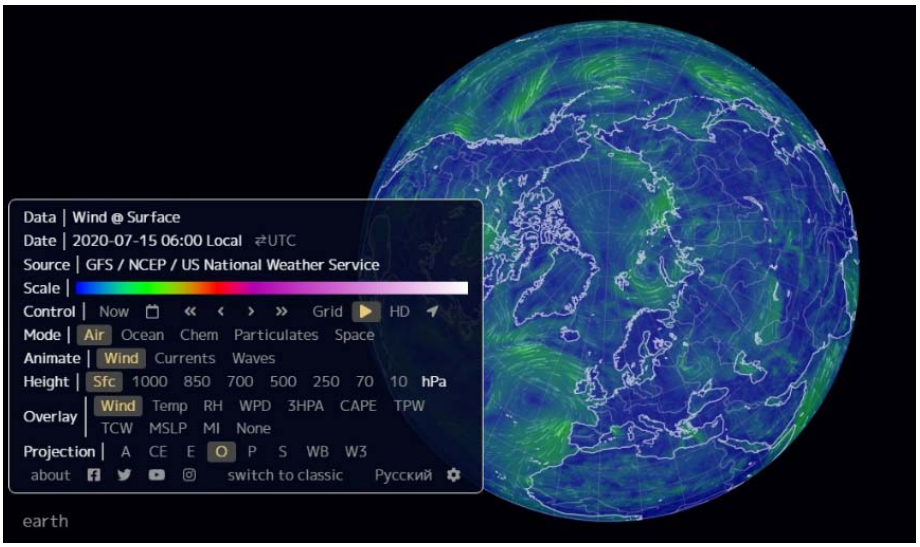

Fig. 2. Main menu of GIDOP Earth.

Let's go to examples. In figure 3 - 8, it is shown the sequential training operations performed in online educational regime for the Baltic Sea. It should be noted that the Baltic Sea is a large maritime object with a developed port infrastructure and intensive maritime transport logistics. The region is undergoing an intensive process of developing logistics facilities, including Russian territorial waters. This circumstance, coupled with climate changes, makes the Baltic Sea an object of intensive training at the university level in various areas of environmental economics. Such training is particularly relevant during the Covid-19 pandemic, when many existing maritime transport logistics projects are in danger of being closed or slowed down.

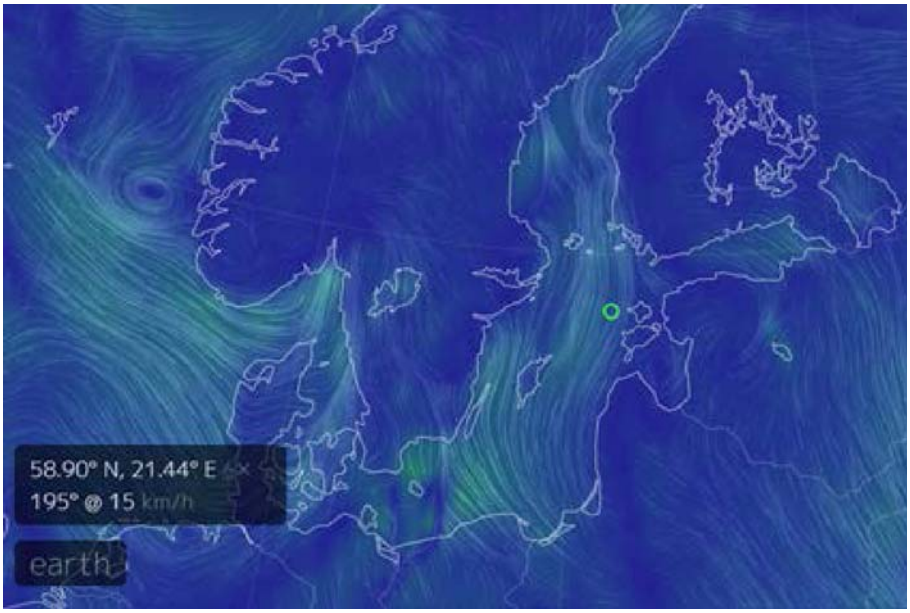

Fig. 3. Wind field visualization for Baltic Sea on 15/07/21.

In black left window, there is information on green circle coordinates and geo data.

Fig. 4. Wind and air temperature fields visualization for Baltic Sea on 15/07/21.

In figures 5 and 6, there are presented current field and wave fields visualization.

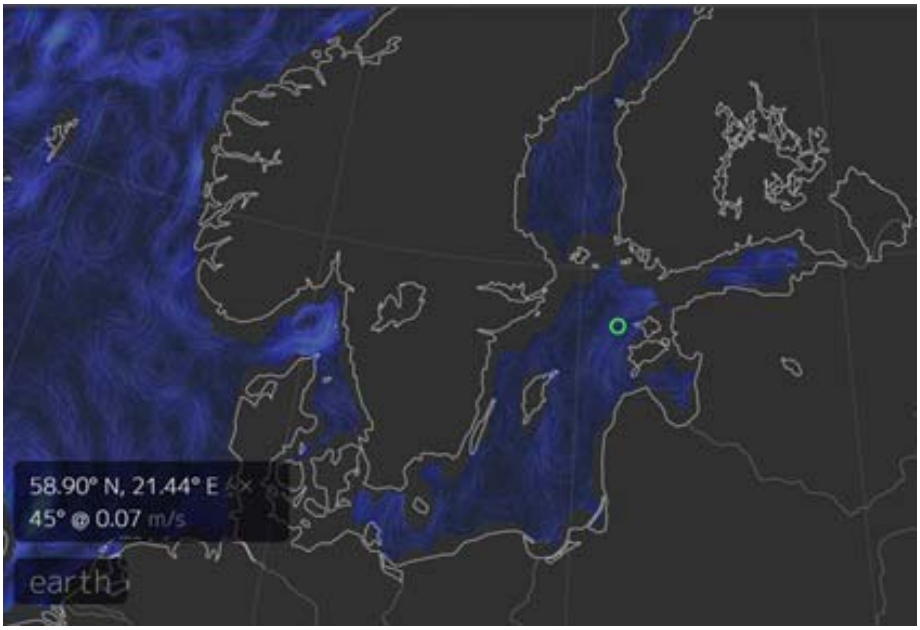

Fig. 5. Currents field visualization for Baltic Sea on 15/07/21.

Fig. 6. Currents and wave fields mutual visualization for Baltic Sea on 15/07/21.

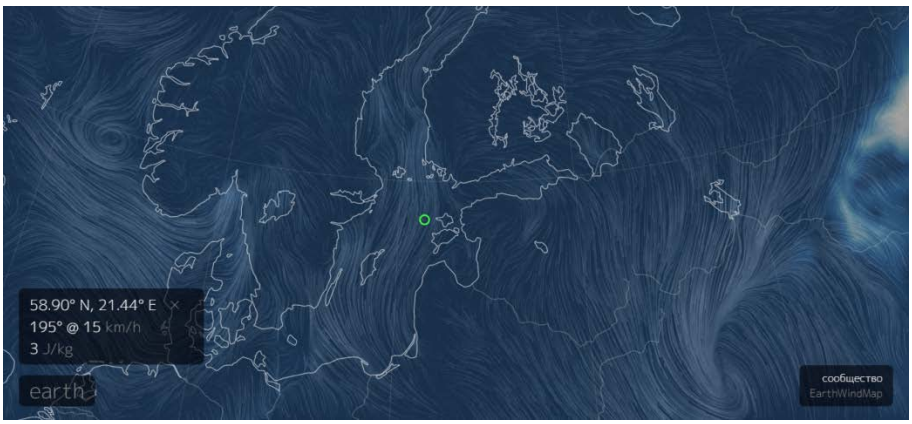

Fig. 7. Available convective potential energy visualization for Baltic Sea on 15/07/21.

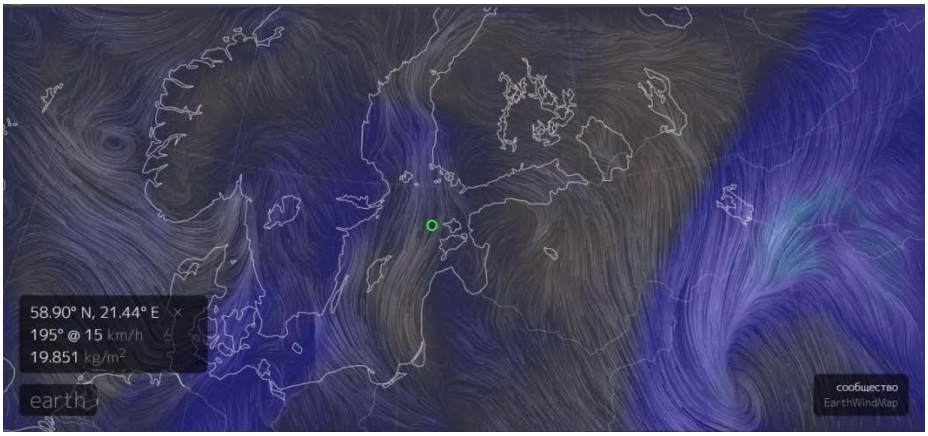

Fig. 8. The moisture content of the clouds visualization for Baltic Sea on 15/07/21.

Note, that decoding of above mentioned images 3 - 8 was not goal of this article. As essential result, authors propose the usage of GIDOP Earth tools as DEP at UL for data mining within geo-information management disciplines when while climate change and Covid-19 pandemic.

4 Discussion

It is obvious that with the help of the technology proposed in the article, students get access to a huge amount of complex data and learn to work with such data in solving practical problems in various areas of geo-information management at the global, regional and local levels.

As examples, figures 9 - 11 shows the results of training operations for visualizing the spatial distribution of particulate matter of different diameters (PM10, PM2.5, and PM1) in the surface layer of air using the DOP Earth. These substances are of crucial importance in studying the influence of black carbon (BC) on the Arctic climate change [30]. It is necessary to have simultaneously information about the concentration of the PM10, PM2.5, PM1 with information about the wind speed and direction at the same point of space for a long time. To date, only proposed in this article GIDOP Earth allows you to obtain such information anywhere in the world for years' periods. Note, presented in figures 9 - 11 information is visualized in such a way that you can see the directions of PM transport from middle latitudes

wildfires zones into the Arctic, including Arctic ocean. Have to say, full decoding of above mentioned images 9 - 11 was not goal of this article.

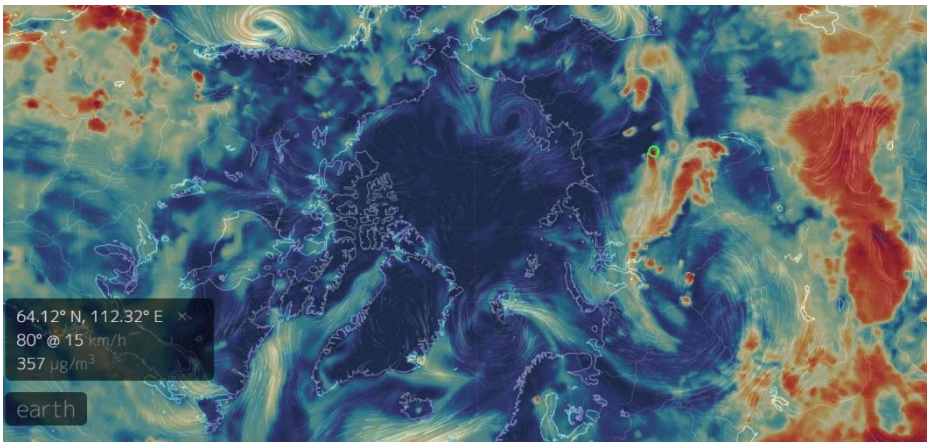

Fig. 9. PM10 19/08/2020.

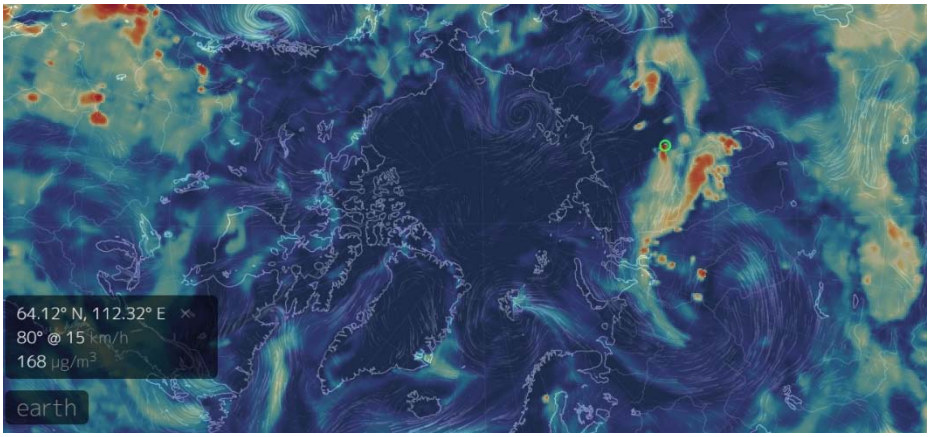

Fig. 10. PM2.5 19/08/2020.

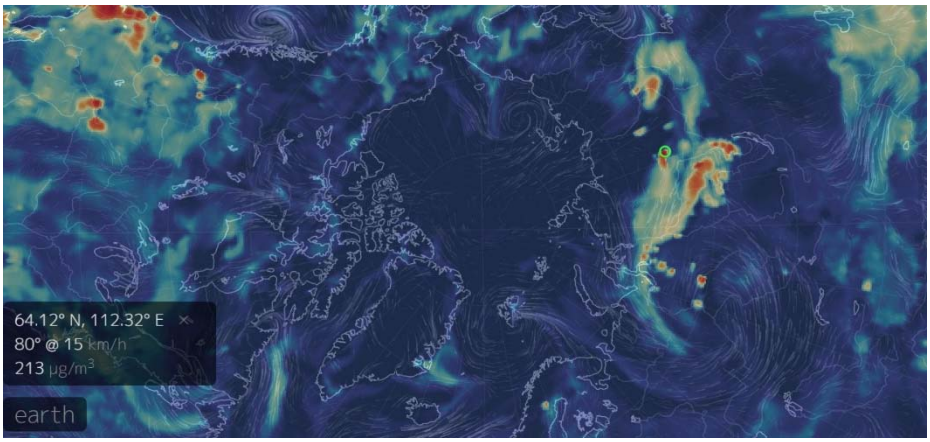

Fig. 11. PM1 19/08/2020.

It is important to say, that all the results of data search and visualization made with GODOP Earth can be reproduced by other researchers, which eliminates the need for additional archiving of the data itself when publishing the results of studies performed using them.

Proposed in paper DLT can be used in educational and training purposes at UL. Note, tasks of training will require a developed learning base within special geo-information systems (GIS) laboratory. It can be undergoing with virtual reality (VR) technologies [18]), that can reduce total cost of learning process arise effectiveness pf the educational process.

5 Conclusions

In article, there are described the development results of digital learning technologies (DLT) adapted to Covid-19 pandemic conditions while Industry 4.0. When Covid-19, it is necessary to work on the digital transformation of university education, including the creation of new concepts for receiving and presenting didactic materials. In studies, there are used methods of data bases constructing, web-technologies and virtual reality tools. In paper, there is proposed to use digital educational platforms (DEPs), which integrate heterogeneous hardware and software resources with the use of web-technologies in distributed networks and wide application of cloud services. As essential DEP, there is proposed to use Google Classroom. Here considered the issues of digital content creation within university education, essentially for practical training. There are presented the enlarged groups of didactical works in this area. As essential result, there is shown the usage of geo-information digital online platform (GIDOP) Earth https://earth.nullschool.net/ for data mining within geo-information management disciplines learning when while climate change and Covid-19 pandemic. Now, learning technologies are especially important in the area of black carbon (BC) transportation as climate change factor in the Arctic. It is easy and coast effective way to deal with PM transportation from wildfires zones to Arctic. Presented in article results of study have a significant scientific novelty and can be used in educational and training purposes, including the preparation of Master's programs in geo-information management at global, regional and local levels. All results of data search and visualization made with GODOP Earth can be fully reproduced by other researchers, that eliminates the need for additional archiving of the data itself. In paper, all graphical materials are original and produced by authors from open sources with GIDOP Earth tools.

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References

1. I. Ilin, S. Maydanova, A. Lepekhin et al, Lecture Notes in Networks and Systems **157**, 179-188 (2021)
2. A.A. Lepekhin, A.I., Levina, A.S. Dubgorn et al, IOP Conference Series: Materials Science and Engineering **940(1)**, 012023 (2020)
3. A. Dubgorn, M.N. Abdelwahab, A. Borremans, I. Zaychenko, *Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019:*

Education Excellence and Innovation Management through Vision 2020, 9677-9682 (2019)

4. T.V. Alesinskaya, D.V. Arutyunova, V.G. Orlovaet al, Academy of Strategic Management Journal **16(1)**, 10-20 (2017)
5. I.V. Ilin, A.V. Izotov, S.V. Shirokova et al, *Proceedings of 2017 20th IEEE International Conference on Soft Computing and Measurements, SCM 2017* **7970732**, 812-814 (2017).
6. I.V. Ilin, O.Yu. Iliashenko, A.D. Borremans, *Proceedings of the 30th International Business Information Management Association Conference, IBIMA 2017 - Vision 2020: Sustainable Economic development, Innovation Management, and Global Growth*, 2729-2739 (2017)
7. O.Y. Iliashenko, A.I. Levina, A. Dubgorn, *Proceedings of the 30th International Business Information Management Association Conference, IBIMA 2017 - Vision 2020: Sustainable Economic development, Innovation Management, and Global Growth*, 2144-2155 (2017)
8. A. Poljanskihh, A. Levina, A. Dubgorn, MATEC Web of Conferences **193**, 05065 (2018)
9. I.V. Ilin, A.V. Izotov, S.V. Shirokova et al, *Proceedings of 2017 20th IEEE International Conference on Soft Computing and Measurements, SCM 2017* **7970732**, 812-814 (2017)
10. I. Ilin, V. Vasilenok, R. Marchenko, E3S Web of Conferences **110**, 0210 (2019)
11. R.S. Marchenko, A.E. Cherepovitsyn, *Proceedings of the 2017 International Conference "Quality Management, Transport and Information Security, Information Technologies"* **8085805**, 247-251 (2017)
12. E. Zotova, A. Tebekin, O. Yastrebov, B. Alexandra, E3S Web of Conferences **110**, 02053 (2019)
13. A.G. Sokolov, E.P. Istomin, V.M. Abramov, et al, *Proceedings of 34th IBIMA Conference. Vision 2025: Education Excellence and Management of Innovations Through Sustainable Economic Competitive Advantage*, 9878-9885 (2019)
14. A. Sokolov, V. Abramov, E. Istomin et al, IOP Conference Series: Materials Science and Engineering **940(1)**, 012003 (2020)
15. S.I. Bidenko, E.P. Istomin, V.G. Burlov et al, *19th International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM Bulgaria* **19(5.3)**, 139-145 (2019)
16. N.S. Frolova, V.M. Abramov, E.P. Istomin, et al, *Proceedings of 34th IBIMA Conference. Vision 2025: Education Excellence and Management of Innovations Through Sustainable Economic Competitive Advantage*, 10132-10141 (2019)
17. S.V. Lukyanov, V.M. Abramov, A.S. Averkiev, et al, *Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019: Education Excellence and Innovation Management through Vision 2020*, 7112-7122 (2019)
18. N.N. Popov, V.M. Abramov, E.M. Korinets et al, *Proceedings of 34th IBIMA Conference. Vision 2025: Education Excellence and Management of Innovations Through Sustainable Economic Competitive Advantage*, 9409-9417 (2019)
19. N. Popov, V. Abramov, E. Istomin, et al, IOP Conference Series: Materials Science and Engineering **940(1)**, 012013 (2020)
20. N.N. Popov, V.M. Abramov, E.M. Korinets et al, *Proceedings of 34th IBIMA Conference. Vision 2025: Education Excellence and Management of Innovations Through Sustainable Economic Competitive Advantage*, 9409-9417 (2019)

21. T. Tatarnikova, E. Istomin, N. Popov et al, IOP Conference Series: Materials Science and Engineering **940(1)**, 012013 (2020)
22. E.P. Istomin, A.G. Sokolov, V.M. Abramov et al, *International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management SGEM* **1**, 607-614 (2015)
23. M.B. Shilin, V.M. Abramov, I.V. Aleshin, et al, *Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019: Education Excellence and Innovation Management through Vision 2020*, 7053-7061 (2019)
24. S.V. Trunin, S.V. Lukyanov, E.A. Baikov, et al, *Proceedings of 34th IBIMA Conference. Vision 2025: Education Excellence and Management of Innovations Through Sustainable Economic Competitive Advantage*, 10763-10771 (2019)
25. O.N. Mandryka, V.M. Abramov, M.B. Shilin, et al, *Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019: Education Excellence and Innovation Management through Vision 2020*, 7173-7183 (2019)
26. O. Khaimina, L. Karlin, G. Gogoberidze, J. Lednova, V.M. Abramov, A. Isaev, *14th International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM Bulgaria* **2(3)**, 645-652 (2014)
27. S. Krasnov, S. Sergeev, E. Zotova, N. Grashchenko, E3S Web of Conferences **110**, 02052 (2019)
28. A.N. Popova, V.M. Abramov, E.P. Istomin, A.G. Sokolov, N.N. Popov, A.I. Levina, *Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019: Education Excellence and Innovation Management through Vision 2020*, 8575-8579 (2019)
29. A.A. Fokicheva, E.P. Golosovskaya, V.M. Abramov, E.P. Istomin, A.G. Sokolov, A.I. Levina, *Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019: Education Excellence and Innovation Management through Vision 2020*, 8638-8642 (2019)
30. E.A. Yaily, V.M. Abramov, E.P. Istomin, S.I. Bidenko, V.V. Novikov, *19th International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM Bulgaria* **19(2.1)**, 793-799 (2019)