

Target indicators for the development of the forest complex in the context of the Altai Republic municipalities

Olga Zhuravleva¹, Maria Sukhova^{1,2,*}, Andrey Karanin¹, Evgenia Chernova², Yuliya Gazukina³

¹ Department of Geography and Environmental Management, Gorno-Altai State University

² Laboratory of Landscape Water and Ecological Researches and Environmental Management, Institute of Water and Environmental Problems of the Siberian Branch of the Russian Academy of Science

³ Faculty of Economics and Law, Gorno-Altai State University

ABSTRACT

Forest resources play an important role in shaping the natural-territorial complex sustainability. The degradation processes taking place on the territory of the forest resources fund make it necessary to assess the condition, use of forests and develop a set of measures to improve the rational use of the forest resources. The article discusses the reasons for the loss of forest stand in the forestry of the Altai Republic. The main reasons for the degradation of forest resources are identified, among which the most significant are forest fires and the spread of insect pests. Insufficient volumes of sanitary-improving measures also contribute to the increase in the area of weakened stands. It has been shown that since 2007 there has been a steady increase in the area of plantations with impaired and lost stability in the Republic of Altai. And in 2015, the maximum area of forests with impaired stability due to existing of pest harborage area was noted. The target indicators of the development of the forest complex for each forestry are given. The system of balanced indicators is evaluated as a tool for assessing and managing the forest complex.

Keywords: Altai, Causes of loss of forest stand, Forest fires, Forest diseases

Corresponding Author:

Maria Sukhova

Department of Geography and Environmental Management,
Gorno-Altai State University,
649000, 1 Lenkin Str., Gorno-Altai, Russian Federation;

Laboratory of Landscape Water and Ecological Researches and Environmental Management,
Institute of Water and Environmental Problems of the Siberian Branch of the Russian Academy of Science,
656038, 1 Molodezhnaya Str., Barnaul, Russian Federation

E-mail: sukhova5515@unesp.co.uk

1. Introduction

Forest resources play an important role in shaping the natural-territorial complex sustainability. The degradation processes taking place on the territory of the forest resources fund make it necessary to assess the condition, use of forests and develop a set of measures to improve the rational use of the forest resources [1-7]. The lack of understanding of the relationship between the forest sector, on the one hand, and strategic management, on the other hand, leads to the fact that it is often not possible to realize the development potential of the forest strategy [8-14].

According to the authors of the concept of a system of balanced indicators D. Norton and R. Kaplan, there is no single correct way to manage performance. The choice of development indicators should depend on specific conditions [15-21]. The targets for the development of the forest complex for municipalities as a whole coincide with the targets for the entire republic. However, those indicators that can illustrate the most significant achievements for a particular area should be given priority. The conditions for the development of the forest complex of municipalities are significantly different. It depends on many factors and, first of all, on the climatic conditions [22].

2. Materials and methods

Territorial units of forest management are 10 forestry's, the largest of which is Turochak. It includes three branches: Turochak, Teletsk and Baigol (Figure 1).

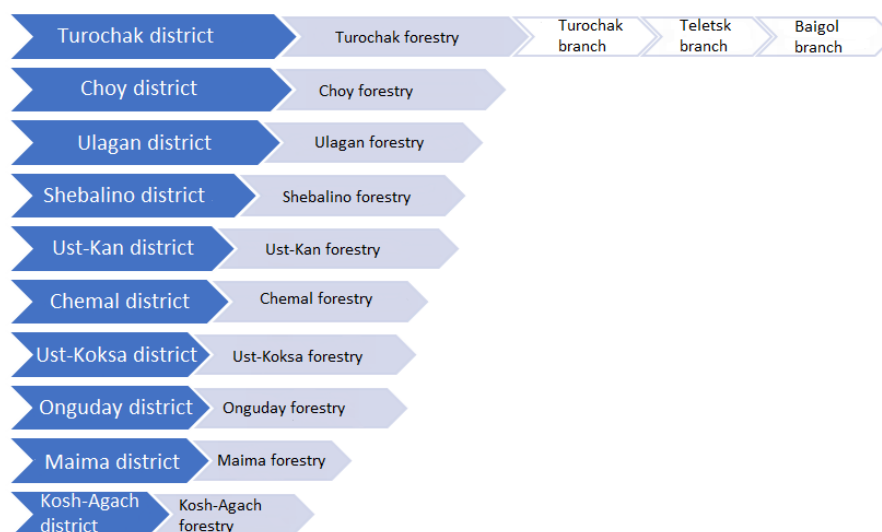


Figure 1. Forestry structure of the Altai Republic (forestry's are located top to bottom in terms of the estimated cutting area)

Forestry's are engaged in state control, organize the formation of forest plots, collect data for the state forest register, conduct industry-specific statistical reporting and ensure the implementation of forestry regulations [23-29]. The territory of the Altai Republic is predominantly mountainous, which is precisely what caused the great pattern structure of nature and climatic conditions. Accordingly, the conditions for forest growth vary greatly depending on the geographical location. They try to take into account this specificity at the level of legal regulation and in accordance with the order of the Federal Forestry Agency dated 09.03.2011 No. 61 "On approval of the list of forest growing zones of the Russian Federation and the list of forest regions of the Russian Federation" [30-32] forests of the Altai Republic are assigned to the South Siberian Mountain zone and occupy two forest areas: Altai-Sayan Mountain taiga and Altai-Sayan Mountain forest-steppe.

Within the Altai-Sayan mountain-forest-steppe region, there are the Kosh-Agach forestry, the southern part of the Ulagan and Ust-Koksa forestries. This most elevated southern part of the republic includes a system of high ridges interspersed by plateaus and intermountain basins. The vertical zoning is as follows: desert steppes (1500-2000 m above sea level), forest belt (1200-2400-2600 m), tundra-nival (2400-4000 m). The dominant formation is larch (Siberian larch – *Larix sibirica*), rising from the steppes to the upper border of the forest. Siberian spruce (*Picea obovata*) is constantly present in the lower forest belt, Siberian cedar pine (*Pinus sibirica*) is in the upper. The rest of the territory of the republic is occupied by the Altai-Sayan Mountain taiga forest region. Deciduous forests, black and coniferous taiga are located here. The belt vegetation scheme is as follows: birch-pine belt of the forest-steppe, belt of dark coniferous forests, taiga-larch and subalpine and alpine tundra [33-38]. Altitudes range from 350 to 2000 meters above sea level.

From north to south and from the tops of the mountains to the foothills in the living ground cover, the participation of mosses and shrubs decreases and the role of herbaceous plants increases. The closeness and height of the tree layer increases, the growth rate of trees in height and in diameter increases, and as a result the productivity of forest stands increases. With advancement from the peaks to the foothills of the mountains, the bonitet class, completeness, growth and timber reserve per 1 hectare increase. A more diverse composition of forests and higher average taxation indicators of the Altai-Sayan Mountain taiga forest region are due to a more favorable climate and better soils [39].

3. Results and discussion

The key to successful forest management is a correct understanding of the growth processes of the stand and its death [40-47]. As a basic principle of choosing priority indicators for municipalities, it is necessary to focus on the causes of the death of forest stands [48-55]. As already noted, forest conditions differ significantly and, accordingly, the causes of death of forest vegetation are also very different. There are enough studies in

Russian and foreign literature on methods for identifying the causes of forest stand loss, from local ones such as windfalls and ravines to the effects of climate change [56-62]. Based on an analysis of the situation from 2012 to 2016, it was revealed that the greatest loss of forests due to fires was observed in three areas: Ulagan, Kosh-Agach and Onguday (Figure 2-4).

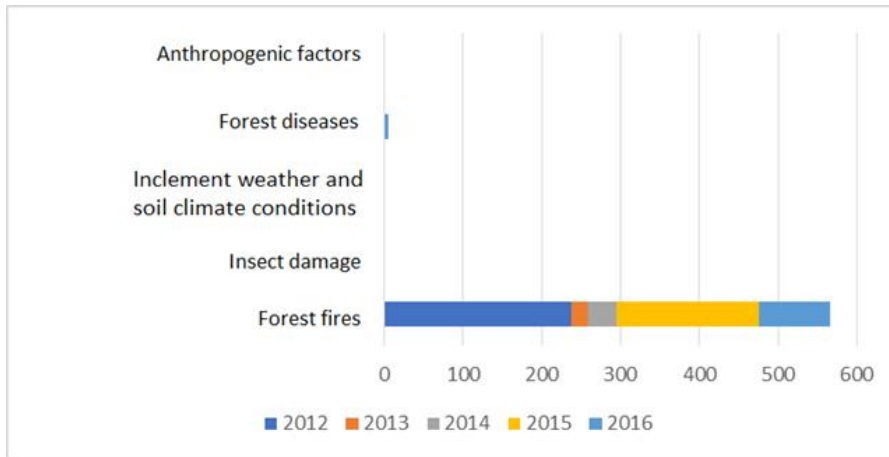


Figure 2. The area of forest plantations of the Ulagan forestry (hect) that died as a result of various reasons from 2012 to 2016

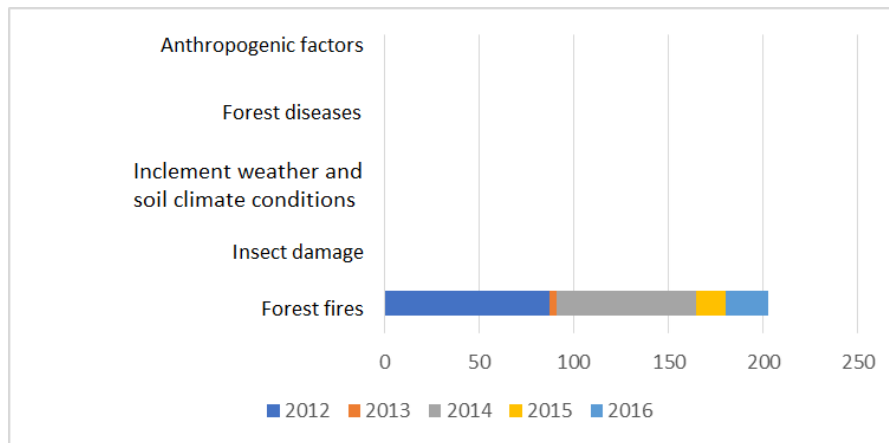


Figure 3. The area of forest plantations of the Onguday forestry (hect) that died as a result of various reasons from 2012 to 2016

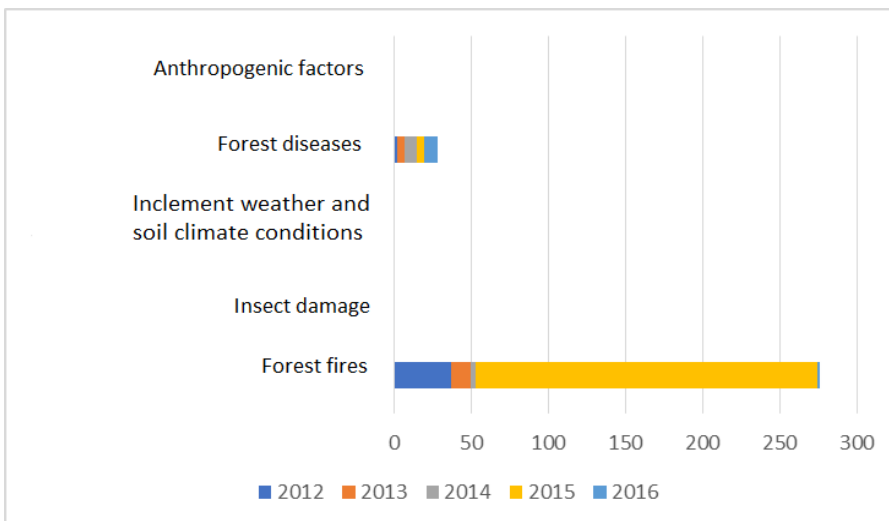


Figure 4. The area of forest plantations of the Kosh-Agach forestry (hect) that died as a result of various reasons from 2012 to 2016

Thus, the priority indicators for these areas should be: the number of forest fires, the amount of damage from forest fires, the area of forest lands killed by fires and the costs of protecting forests from fires per 1 hectare of forest fund. The indicators characterizing the work on forest reproduction are equally important in all regions of the republic [63-70]. For the Onguday district, monitoring of the forest disease situation is also necessary. This reason for the death of the forest was recorded here each of the five analyzed years. As an indicator, we can use the area of forests that died as a result of forest diseases, and the proportion of forests covered by the forest pathological monitoring system. Ulagan forestry also recorded forest diseases, but only in 2016 and on a small area [71-76]. For Ust-Koksa and Shebalino forestries, two main causes of the destruction of forest stands were identified: fires and forest diseases [77-84] (Figure 5-6).

In the Ust-Koksa forestry, the forest stand was most affected in 2012. Moreover, both from fires and from diseases. Shebalino forestry lost most of the area in 2012 as a result of fires, and in 2015 from forest diseases. In both forestries, along with indicators to track the effectiveness of fire prevention, significant attention should be paid to indicators to track the effectiveness of measures to combat forest diseases [85-92].

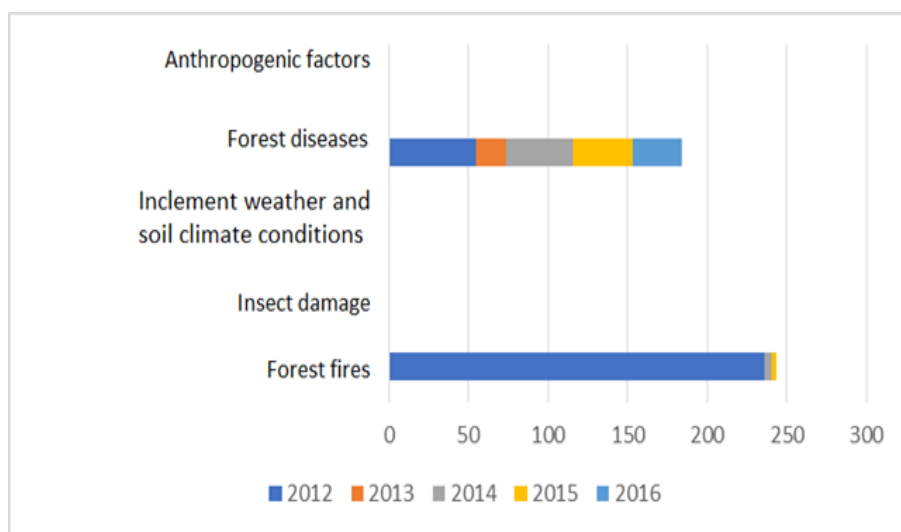


Figure 5. The area of forest plantations of the Ust-Koksa forestry (hect) that died as a result of various reasons from 2012 to 2016

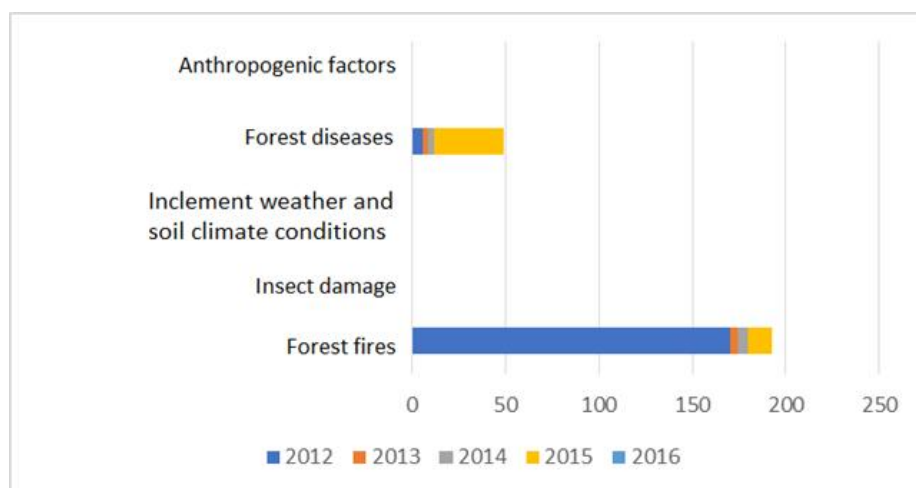


Figure 6. The area of forest plantations of the Shebalino forestry (hect) that died as a result of various reasons from 2012 to 2016.

The situation in the Chermal and Ust-Kan forestry's (Figure 7-8) is similar to the Ust-Koksa and Shebalino, however, forest diseases come first in the list of causes of death and priorities must be set accordingly [93-97]. In Chermal forestry, the greatest damage was done in 2012 and 2013. In Ust-Kan, the largest areas of forest stand were affected by fires in 2012, but the damage from diseases was observed for almost five years on almost the same scale every year [98-103].

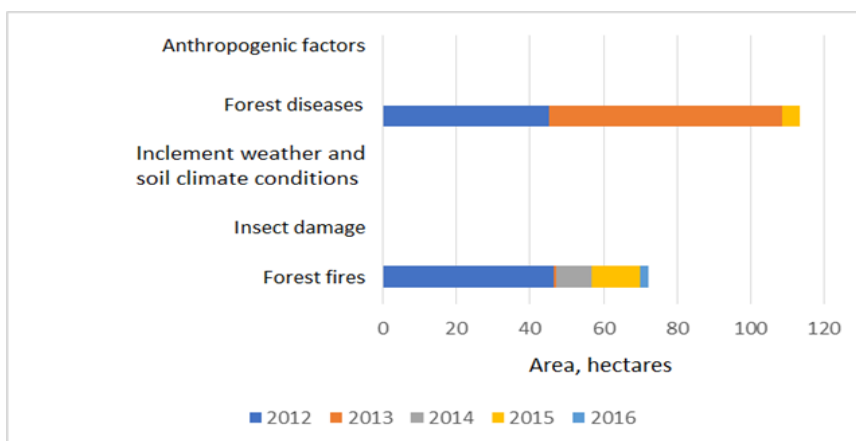


Figure 7. The area of forest plantations of the Chemal forestry (hect) that died as a result of various reasons from 2012 to 2016.

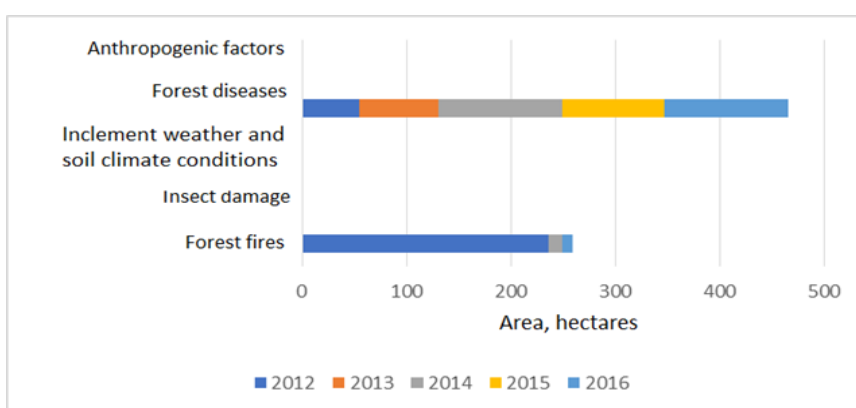


Figure 8. The area of forest plantations of the Ust-Kan forestry (hect) that died as a result of various reasons from 2012 to 2016.

All forestry's in the northern part of the republic demonstrate a difficult situation with the causes of death of forest stands (Figure 9-11). So, for example, in the Turochak forestry, the cause of death that comes first – damage by insects, in second place – forest diseases. In this case, the death from forest fires is negligible. In the Maima forestry, the influence of fires is also negligible, and forest diseases and insect damage take on significance [104].

The most difficult picture is observed in the Choy forestry, where all the causes of death are noted, including anthropogenic factors that were not recorded for other forestry's. Here the reason lies in the complexity of accounting and fixing this factor. Air pollution, soil acidification, changes in the composition of nutrients – all this contributes to a decrease in the viability of trees [14]. But in this forestry for five years, forest fires were not recorded.

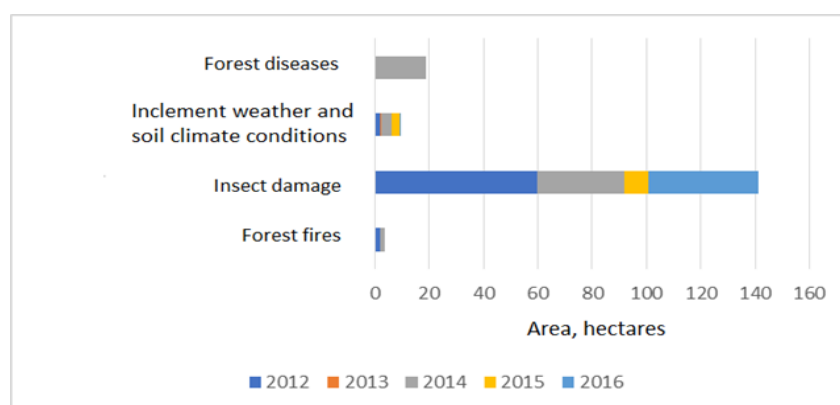


Figure 9. The area of forest plantations of the Turochak forestry (hect) that died as a result of various reasons from 2012 to 2016

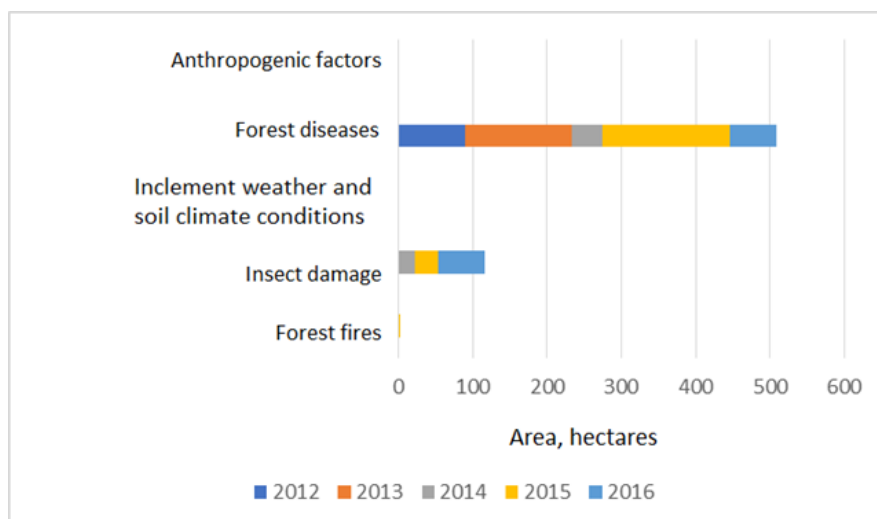


Figure 10. The area of forest plantations of the Maima forestry (hect) that died as a result of various reasons from 2012 to 2016

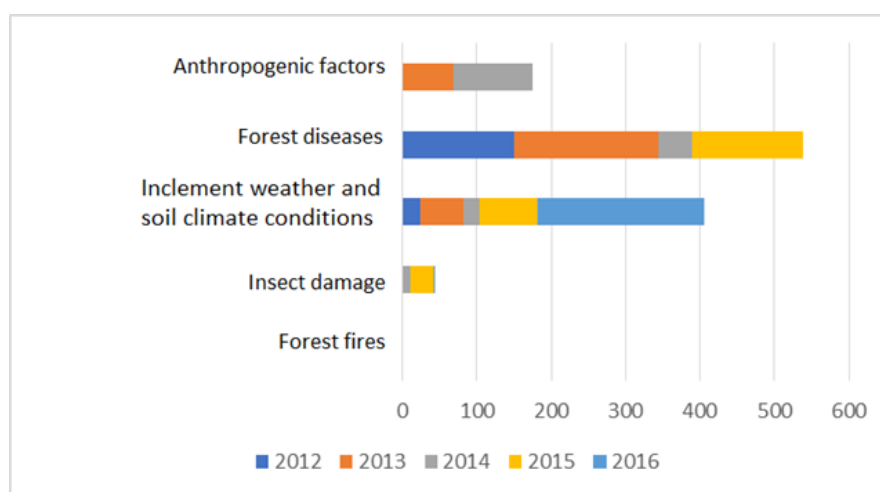


Figure 11. The area of forest plantations of the Choy forestry (hect) that died as a result of various reasons from 2012 to 2016

For all these forestry's, it is possible to reduce target indicators for protecting forests from fires, and instead introduce an indicator such as the ratio of the area of sanitary and recreational measures to the area of dead and damaged forests (%) [104-110].

4. Conclusions

It should be noted that since 2007 in the territory of the Republic of Altai there has been a steady increase in the area of plantations with impaired and lost stability. In 2015, the maximum area of forests with impaired stability was noted due to the spread of insect pests, the area of which was 137 thousand hectares, including insect pests – 134.3 thousand hectares, forest diseases – 2.7 thousand hectares. In addition, the formation of the total area of weakened stands is affected by the chronically insufficient volumes of sanitary and recreational activities carried out in the republic.

The following forest protection measures are very relevant: conducting forest pathological monitoring, fire hazard monitoring, assessing the effectiveness of forest protection measures; sanitary and health measures (sanitary felling, cleaning the forest from clutter) and a number of measures for reforestation. In the future, it will be timely to study the dependence of the identified causes of forest reduction on the observed climate changes. Since in a number of forestry's (Choy, Turochak) one of the reasons for the degradation of the forest stand is adverse weather and soil climate conditions. In foreign publications significant attention is paid to this matter.

Acknowledgements

The research was funded by RFBR and Republic of Altai, project number 20-45-040016.

References

- [1] M. Gane, *Forest Strategy. Strategic Management and Sustainable Development for the Forest Sector*, Amsterdam: Springer Netherlands, 2007.
- [2] V. K. Rezanov, *Adaptive Management of Transformation and Development of Forest Management*, Vladivostok: Dalnauka, 2001.
- [3] R. S. Kaplan, and D. P. Norton, *The Balanced Scorecard: Translating Strategy into Action*, Boston: Harvard Business School Press, 1996.
- [4] Forest Code of the Russian Federation, 2006, Available from: http://www.consultant.ru/document/cons_doc_LAW_64299/.
- [5] Order of the Federal Forestry Agency No. 61 “On approval of the List of forest growing zones of the Russian Federation and the List of forest regions of the Russian Federation”, 2011, Available from: <https://www.garant.ru/products/ipo/prime/doc/2074564/>.
- [6] K. von Gadow, and G. Hui, *Modelling Forest Development*, Amsterdam: Springer Netherlands, 1999.
- [7] A. Angelsen, E. F. K. Shitindi, and J. Aaarrestad, “Why do Farmers Expand Their Land into Forests? Theories and Evidence from Tanzania,” *Environment and Development Economics*, vol. 4, pp. 31-313, 1999.
- [8] C. Bouget, and P. Duelli, “The Effects of Windthrow on Forest Insect Communities: A Literature Review,” *Biological Conservation*, vol. 118, pp. 281-299, 2004.
- [9] S. Cheng, Z. Xu, and Y. Su Zhen, “Spatial and Temporal Flows of China’s Forest Resources: Development of a Framework for Evaluating Resource Efficiency,” *Ecological Economics*, vol. 69, pp. 1405-1415, 2010.
- [10] G. Msilimba, “A Comparative Study of Landslides and Geohazard Mitigation in Northern and Central Malawi,” *Geography*, 2007, Available from: <https://www.semanticscholar.org/paper/A-comparative-study-of-landslides-and-geohazard-in-Msilimba/3a29749af7ec8e43f14e47cda240936c3a729169#paper-header>.
- [11] C. B. K. Rathgeber, P. Fonti, and V. V. Shishov, “Wood Formation and Tree Adaptation to Climate,” *Annals of Forest Science*, vol. 76, article number 109, 2019.
- [12] K. Tempfli, N. Kerle, L.F. Janssen, and G. Huurneman, *Principles of Remote Sensing*, Enschede: The International Institute for Geo-Information Science and Earth Observation, 2008.
- [13] M. D. Abrams, and G. J. Nowacki, “Global Change Impacts on Forest and Fire Dynamics Using Paleoecology and Tree Census Data for Eastern North America,” *Annals of Forest Science*, vol. 76, Article number 8, 2019.
- [14] A. Dohrenbusch, and N. Bartsch, *Forest Development. Succession, Environmental Stress and Forest Management Case Studies*, Berlin: Springer-Verlag Berlin Heidelberg, 2002.
- [15] V. P. Privalko, R. V. Dinzhos, and E. G Privalko, “Melting Behavior of the Nonisothermally Crystallized Polypropylene/Organosilica Nanocomposite,” *Journal of Macromolecular Science – Physics*, vol. 43B, no. 5, pp. 979-988, 2004.
- [16] N. M. Fialko, R. O. Navrodska, G. O. Gnedash, G. O. Presich, and S. I. Shevchuk, “Study of Heat-Recovery Systems of or Heating and Moisturing Combustion Air of Boiler Units,” *Science and Innovation*, vol. 16, no. 3, pp. 43-49, 2020.
- [17] R. Dinzhos, N. Fialko, V. Prokopov, Y. Sherenkovskiy, N. Meranova, N. Koseva, V. Korzhik, O. Parkhomenko, and N. Zhuravskaya, “Identifying the Influence of the Polymer Matrix Type on the

- Structure Formation of Microcomposites When They Are Filled with Copper Particles,” *Eastern-European Journal of Enterprise Technologies*, vol. 5, no. 6-107, pp. 49-57, 2020.
- [18] N. M. Fialko, R. O. Navrodska, S. I. Shevchuk, and G. O. Gnedash, “The Environmental Reliability of Gas-Fired Boiler Units by Applying Modern Heat-Recovery Technologies,” *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, vol. 2020, no. 2, pp. 96-100, 2020.
- [19] S. V. Grazion, M. V. Mukomela, M. N. Erofeev, V. V. Spiriyagin, and S. S. Amelin, “Experimental Estimation of the Waveguide Effect on the Acoustic Emission Signal Parameters in Monitoring Facilities with a Long Surface Radius of Curvature,” *Journal of Machinery Manufacture and Reliability*, vol. 49, no. 11, pp. 971-979, 2020.
- [20] R. Navrodska, N. Fialko, G. Presich, G. Gnedash, S. Alioshko, and S. Shevcuk, “Reducing Nitrogen Oxide Emissions in Boilers at Moistening of Blowing Air in Heat Recovery Systems,” *E3S Web of Conferences*, no. 100, Article number 00055, 2019.
- [21] A. Zvorykin, N. Fialko, S. Julii, S. Aleshko, N. Meranova, M. Hanzha, I. Bashkir, S. Stryzheus, A. Voitenko, and I. Pioro, “CFD Study on Specifics of Flow and Heat Transfer in Vertical Bare Tubes Cooled with Water at Supercritical Pressures,” *International Conference on Nuclear Engineering, Proceedings, ICONE*, no. 9, pp. 1-13, 2017.
- [22] A. Zvorykin, S. Aleshko, N. Fialko, N. Maison, N. Meranova, A. Voitenko, and I. Pioro, “Computer Simulation of Flow and Heat Transfer in Bare Tubes at Supercritical Parameters,” *International Conference on Nuclear Engineering, Proceedings, ICONE*, no. 5, pp. 1-12, 2016.
- [23] D.V. Dinzhos, E.A. Lysenkov, and N.M. Fialko, “Influence of Fabrication Method and Type of the Filler on the Thermal Properties of Nanocomposites Based on Polypropylene,” *Voprosy Khimii i Khimicheskoi Tekhnologii*, vol. 2015, no. 5, pp. 56-62, 2015.
- [24] R. Dinzhos, E. Lysenkov, and N. Fialko, “Simulation of Thermal Conductivity of Polymer Composites Based on Poly (Methyl Methacrylate) with Different Types of Fillers,” *Eastern-European Journal of Enterprise Technologies*, vol. 6, no. 11, pp. 21-24, 2015.
- [25] R. V. Dinzhos, E. A. Lysenkov, and N. M. Fialko, “Features of Thermal Conductivity of Composites Based on Thermoplastic Polymers and Aluminum Particles,” *Journal of Nano- and Electronic Physics*, vol. 7, no. 3, 03022, 2015.
- [26] R. V. Dinzhos, N. M. Fialko, and E. A. Lysenkov, “Analysis of the Thermal Conductivity of Polymer Nanocomposites Filled with Carbonnanotubes and Carbon Black,” *Journal of Nano- and Electronic Physics*, vol. 6, no. 1, 01015, 2014.
- [27] A. Zvorykina, S. Gupta, W. Peiman, I. Pioro, and N. Fialko, “Current Status and Future Applications of Supercritical Pressures in Power Engineering,” *International Conference on Nuclear Engineering, Proceedings, ICONE*, vol. 5, no. 1, pp. 285-300, 2012.
- [28] D. G. Blinov, V. G. Prokopov, Yu. V. Sherenkovskii, N. M. Fialko, and V. L. Yurchuk, “Effective Method for Construction of Low-Dimensional Models for Heat Transfer Process,” *International Journal of Heat and Mass Transfer*, vol. 47, no. 26, pp. 5823-5828, 2004.
- [29] D. G. Blinov, V. G. Prokopov, Yu. V. Sherenkovskii, N. M. Fialko, and V. L. Yurchuk, “Simulation of Natural Convection Problems Based on Low-Dimensional Model,” *International Communications in Heat and Mass Transfer*, vol. 29, no. 6, pp. 741-747, 2002.
- [30] N. M. Fialko, V. G. Prokopov, N. O. Meranova, Yu. S. Borisov, V. N. Korzhik, and G. P. Sherenkovskaya, “Heat Transport Processes in Coating-Substrate Systems under Gas-Thermal Deposition,” *Fizika i Khimiya Obrabotki Materialov*, no. 2, pp. 68-75, 1994.
- [31] N. M. Fialko, V. G. Prokopov, N. O. Meranova, Yu. S. Borisov, V. N. Korzhik, and G. P. Sherenkovskaya, “Single Particle-Substrate Thermal Interaction During Gas-Thermal Coatings Fabrication,” *Fizika i Khimiya Obrabotki Materialov*, no. 1, pp. 70-78, 1994.

- [32] V. G. Prokopov, N. M. Fialko, G. P. Sherenkovskaya, V. L. Yurchuk, Yu. S. Borisov, A. P. Murashov and V. N. Korzhik, "Effect of Coating Porosity on the Process of Heat Transfer with Gas-Thermal Deposition," *Powder Metallurgy and Metal Ceramics*, vol. 32, no. 2, pp. 118-121, 1993.
- [33] N. I. Kobasko, N. M. Fialko, and N. O. Meranova, "Numerical Determination of the Duration of the Nucleate-Boiling Phase in the Course of Steel-Plate Hardening. Heat Transfer," *Soviet Research*, vol. 16, no. 2, pp. 130-135, 1984.
- [34] N. K. Bulatov, A. E. Toilybayev, N. Z. Suleyeva, and D. K. Sarzhanov, "Development of the Model (Algorithm) of the Efficient Transportation Logistics with the Purpose of Collection and Transportation of the Solid Municipal Waste to the Places of Their Recycling," *Environment, Development and Sustainability*, vol. 23, no. 2, pp. 2015-2037, 2021.
- [35] V. V. Ling, and A. V. Yumashev, "Estimation of Worker Encouragement System at Industrial Enterprise," *Espacios*, vol. 39, no. 28, pp. 1-9, 2018.
- [36] N. V. Zakharchenko, S. L. Hasanov, A. V. Yumashev, O. I. Admakin, S. A. Lintser, and M. I. Antipina, "Legal Rationale of Biodiversity Regulation as a Basis of Stable Ecological Policy," *Journal of Environmental Management and Tourism*, vol. 9, no. 3, pp. 510-523, 2018.
- [37] E. Y. Sidorova, and L. I. Goncharenko, "Tax Regulation of Customs Payments in the State Policy of Russia," *Lecture Notes in Networks and Systems*, no. 115, pp. 636-642, 2020.
- [38] E. Y. Sidorova, Y. Kostyukhin, and V. Shtanskiy, "Creation of Conditions for the Development of Production of Science-Intensive Products Based on the Potential of Russian Applied Scientific Organizations," *Smart Innovation, Systems and Technologies*, no. 139, pp. 584-591, 2019.
- [39] L. I. Goncharenko, E. Y. Sidorova, A. A. Artemev, and N. A. Nazarova, "Dividend-Based and Interest-Based Schemes of Minimization of Customs Value of Goods in Deals Between Related Parties: Russian Practice," *Espacios*, vol. 39, no. 16, pp. 1-10, 2018.
- [40] I. Sultangaliyeva, R. Beisenova, R. Tazitdinova, A. Abzhalelov, and M. Khanturin, "The Influence of Electromagnetic Radiation of Cell Phones on the Behavior of Animals," *Veterinary World*, vol. 13, no. 3, pp. 549-555, 2020.
- [41] Y. Parkhomenko, L. B. Tsymbulov, K. P. Zlotnikov, and E. Y. Sidorova, "Application of Swot Analysis to Select Pyrometallurgical Techniques for Copper-Nickel Sulphide Concentrates," *Tsvetnye Metally*, vol. 2020, no. 12, pp. 9-16, 2020.
- [42] R. Beisenova, Z. Rakhymzhan, R. Tazitdinova, A. Auyelbekova, and M. Khussainov, "Comparative Characteristics of Germination of Some Halophyte Plants in Saline Soils of Pavlodar Region," *Journal of Environmental Management and Tourism*, vol. 11, no. 5, pp. 1132-1142, 2020.
- [43] R. Tazitdinova, R. Beisenova, G. Saspugayeva, B. Aubakirova, Z. Nurgalieva, A. Zandybai, I. Fakhrudanova, and A. Kurmanbayeva, "Changes in the Biochemical Parameters of Rat Blood Under the Combined Effect of Chronic Intoxication with Such Heavy Metals as Copper, Zinc, Arsenic," *Advances in Animal and Veterinary Sciences*, vol. 6, no. 11, pp. 492-498, 2018.
- [44] R. Beisenova, S. Tulegenova, R. Tazitdinova, O. Kovalenko, and G. Turlybekova, "Purification by Ketoconazole Adsorption from Sewage," *Systematic Reviews in Pharmacy*, vol. 11, no. 6, pp. 550-554, 2020.
- [45] P. A. Gurianov, "Small Business in Russian Federation: State, Potential Threats, Barriers and Medium-Term Development Perspectives," *World Applied Sciences Journal*, vol. 30, no. 9, pp. 1166-1169, 2014.
- [46] V. D. Nazarova, N. S. Salikova, A. U. Bektemissova, B. E. Begenova, and G. B. Aubakirova, "Isolation of Miricetine-Containing Fractions from *Linostyris villosa* Plant and Their Application as Antianemic Agent," *Periodico Tche Quimica*, vol. 17, no. 35, pp. 998-1012, 2020.
- [47] N. S. Salikova, A. U. Bektemissova, V. D. Nazarova, B. E. Begenova, and N. V. Ostafeichuk, "Preparation of Mixed Hydrogels Based on Biopolymers and the Study of Their Rheological Properties," *Periodico Tche Quimica*, vol. 17, no. 35, pp. 23-40, 2020.

- [48] D. S. Ushakov, O. I. Khamzina, R. A. Karabassov, I. A. Zaiarnaia, and V. A. Gnevasheva, "Countries' Competitiveness as A Factor of MNCs' Global Expansion," *Journal of Advanced Research in Law and Economics*, vol. 9, no. 6, pp. 2169-2175, 2018.
- [49] D. Ushakov, and L. Kharchenko, "Environmental Factors of National Competitiveness in Modern MNCs' Development," *International Journal of Ecological Economics and Statistics*, vol. 38, no. 2, pp. 1-10, 2017.
- [50] D. Topchiy, and A. Tokarskiy, "Formation of Hierarchies in the Organization System of the State Construction Supervision During Reshaping of City Territories," *International Journal of Engineering and Advanced Technology*, vol. 8, no. 4C, pp. 44-46, 2019.
- [51] M. I. Ermilova, D. Ushakov, and S. V. Laptev, "Financing the Russian Housing Market: Problems and the Role of the State," *Opción*, vol. 34, no. Special Issue 17, pp. 1074-1087, 2018.
- [52] A. Lapidus, and T. Dmitry, "Formation of Methods for Assessing the Effectiveness of Industrial Areas' Renovation Projects," *IOP Conference Series: Materials Science and Engineering*, vol. 471, no. 2, 022034, 2019.
- [53] M. L. Belonozhko, L. N. Belonozhko, and S. S. Siteva, "Digital Tourism in the Development of the Arctic Region," *Journal of Environmental Management and Tourism*, vol. 9, no. 6, pp. 1154-1164, 2018.
- [54] L. M. Gaisina, M. L. Belonozhko, V. V. Maier, N. K. Abdrakhmanov, and E. A. Sultanova, "Deliberate Reorganization of the System of Social Relations in Oil and Gas Companies in the Period of Changes in Economics," *Espacios*, vol. 38, no. 48, pp. 1-12, 2017.
- [55] E. Nagyzbekkyzy, G. Abitayeva, S. Anuarbekova, D. Shaikhina, K. Li, S. Shaikhin, K. Almagambetov, A. Abzhalelov, S. Saduakhassova, A. Kushugulova, and F. Marotta, "Investigation of Acid and Bile Tolerance, Antimicrobial Activity and Antibiotic Resistance of Lactobacillus Strains Isolated from Kazakh Dairy Foods," *Asian Journal of Applied Sciences*, vol. 9, no. 4, pp. 143-158, 2016.
- [56] A. Shoman, A. Serikbayeva, L. Mamayeva, B. Faye, and T. Tultabayeva, "A Biological Analysis of Endocrine-Disturbing Chemicals in Camel Meat Sector in Kazakhstan," *EurAsian Journal of BioSciences*, vol. 12, no. 2, pp. 473-479, 2018.
- [57] I. A. Kapitonov, "Low-Carbon Economy as the Main Factor of Sustainable Development of Energy Security," *Industrial Engineering and Management Systems*, vol. 19, no. 1, pp. 3-13, 2020.
- [58] L. Metelytsia, D. Hodyna, I. Dobrodub, I. Semenyuta, M. Zavhorodnii, V. Blagodatny, V. Kovalishyn, and O. Brazhko, "Design of (Quinolin-4-Ylthio) Carboxylic Acids as New Escherichia Coli DNA Gyrase B Inhibitors: Machine Learning Studies, Molecular Docking, Synthesis and Biological Testing," *Computational Biology and Chemistry*, no. 85, 107224, 2020.
- [59] A. Lapidus, and Y. Shesterikova, "Mathematical model for assessing the high-rise apartment buildings complex quality," *E3S Web of Conferences*, no. 91, 02025, 2019.
- [60] R. A. Baizholova, Y. D. Orynassarova, A. N. Ramashova, and Z. A. Abylkassimova, "Interactions Between Human Capital and Innovation," *International Journal of Economic Perspectives*, vol. 11, no. 2, pp. 36-39, 2017.
- [61] V. I. Gencheva, L. A. Omelyanchik, D. M. Fedoryak, A. A. Brazhko, and M. P. Zavgorodny, "Study of Biological Activity of Some 4-S-Derivatives of Quinoline," *Biopolymers and Cell*, vol. 22, no. 6, pp. 475-479, 2006.
- [62] D. V. Topchy, "Formation of Organizational and Technological Systems for Renovation of Production Facilities Located on the Territory of Megacities," *International Journal of Civil Engineering and Technology*, vol. 9, no. 8, pp. 1452-1457, 2018.
- [63] D. A. Saribayeva, K. B. Biyashev, A. Valdovska, A. R. Sansyzbai, and B. K. Biyashev, "Study Antagonistic Activity, the Level of Resistance to Hydrochloric Acid and Bile Probiotic Strain Escherichia Coli," *Journal of Pure and Applied Microbiology*, vol. 9, no. 1, pp. 573-578, 2015.

- [64] Z. Sarmurzina, G. Bissenova, K. Zakarya, R. Dospaeva, S. Shaikhin, and A. Abzhalelov, "Characterization of Probiotic Strains of Lactobacillus Candidates for Development of Synbiotic Product for Kazakh Population," *Journal of Pure and Applied Microbiology*, vol. 11, no. 1, pp. 151-161, 2017.
- [65] A. Zh. Khastayeva, A. K. Smagulov, V. S. Zhamurova, A. T. Kozhabergenov, M. K. Kozhakhmetov, and K. M. Muratbekova, "Fatty Acid Composition and Biological Value of Milk of Holstein Cows at Different Lactation Seasons," *Journal of Physics: Conference Series*, vol. 1362, no. 1, Article number 012162, 2019.
- [66] A. Tokarskiy, and D. Topchiy, "State Construction Supervision During Repurposing Project Implementation in the Urban Areas," *IOP Conference Series: Materials Science and Engineering*, vol. 698, no. 6, Article number 066061, 2019.
- [67] A. B. Maydirova, R. A. Baizholova, L. K. Sanalieva, G. T. Akhmetova, and A. A. Kocherbaeva, "Strategic Priorities of Kazakhstan Innovative Economy Development," *Opción*, vol. 36, no. Special Edition 27, pp. 779-793, 2020.
- [68] A. Jurgaitis, D. Topchiy, A. Kravchuk, and D. Shevchuk, "Controlling Methods of Buildings' Energy Performance Characteristics," *E3S Web of Conferences*, no. 91, Article number 02026, 2019.
- [69] A. A. Lapidus, and A. N. Makarov, "Model for the Potential Manufacture of Roof Structures for Residential Multi-Storey Buildings," *Procedia Engineering*, no. 153, pp. 378-383, 2016.
- [70] A. Z. Khastayeva, V. S. Zhamurova, L. A. Mamayeva, A. T. Kozhabergenov, N. Z. Karimov, and K. M. Muratbekova, "Qualitative Indicators of Milk of Simmental and Holstein Cows in Different Seasons of Lactation," *Veterinary World*, vol. 14, no. 4, pp. 956-963, 2021.
- [71] D. V. Topchiy, and A. S. Bolotova, "The Monolithic Buildings Complex Renovation's Organizational and Technological Model Creation," *IOP Conference Series: Materials Science and Engineering*, vol. 913, no. 4, Article number 042016, 2020.
- [72] R. S. Zhussupov, R. A. Baizholova, I. N. Dubina, and G. T. Sadykova, "Methodology for Assessing the Competitive Advantages of Agriculture in the Northern Regions of Kazakhstan," *Espacios*, vol. 39, no. 16, pp. 1-10, 2018.
- [73] S. Shaikhin, A. Sobkiewicz, J. Barciszewski, and T. Twardowski, "Evidence for Plant Ribosomal 5S RNA Involvement in Elongation of Polypeptide Chain Biosynthesis," *Acta biochimica Polonica*, vol. 41, no. 1, pp. 57-62, 1994.
- [74] O. Sobol, V. Domatskiy, Y. Koneva, K. Nifontov, and M. Savvinova, "Review of Basic Trends in Cryotherapy Applications for Horse Injuries," *Arquivo Brasileiro de Medicina Veterinaria e Zootecnia*, vol. 72, no. 3, pp. 688-694, 2020.
- [75] I. D. Bobruskin, S. M. Shaikhin, M. V. Muratova, L. A. Baranova, and E. S. Severin, "Allosteric Regulation of Ca²⁺-Calmodulin-Dependent Phosphodiesterase Activity from the Bovine Brain," *Biokhimiya*, vol. 52, no. 8, pp. 1344-1352, 1987.
- [76] M. Bulegenova, K. Biyashev, Z. Kirkimbaeva, B. Biyashev, S. Ermagambetova, K. Oryntayev, and A. Altenov, "The Effect of the Drug Enterocol on the Humoral Factors of Calf Body Resistance," *Advances in Animal and Veterinary Sciences*, vol. 7, no. 8, pp. 674-680, 2019.
- [77] N. I. Dorogov, I. A. Kapitonov, and N. T. Batyrova, "The Role of National Plans in Developing the Competitiveness of the State Economy," *Entrepreneurship and Sustainability Issues*, vol. 8, no. 1, pp. 672-686, 2020.
- [78] K. B. Biyashev, A. Z. Makbuz, and B. K. Biyashev, "Occurrence of Enteroinfectious Pathogens in Agricultural Animals and Poultry," *Biology and Medicine*, vol. 8, no. 2, BM-170-16, 2016.
- [79] V. S. Pashtetsky, V. V. Khomenko, N. P. Demchenko, N. Y. Poliakova, and R. V. Kashbrasiev, "Sustainable and Competitive Agricultural Development of a Water-Deficient Region (Case of the Crimean Peninsula)," *Geography, Environment, Sustainability*, vol. 13, no. 2, pp. 65-72, 2020.

-
- [80] A. B. Tastulekova, R. K. Satova, and U. Zh. Shalbolova, "Business Valuation and Equity Management When Entering the IPO Market," *European Research Studies Journal*, vol. 21, no. 4, pp. 875-886, 2018.
- [81] K. B. Biyashev, Z. S. Kirkimbaeva, B. K. Biyashev, A. Z. Makbuz, and M. D. Bulegenova, "Determination of the Level of Resistance of Probiotic Strain Escherichia Coli 64g to Hydrochloric Acid, Bile and Antimicrobial Agents," *Ecology, Environment and Conservation*, vol. 25, no. 4, pp. 1930-1933, 2019.
- [82] A. Zholdasbekova, K. B. Biyashev, B. K. Biyashev, D. A. Sarybaeva, and K.T. Zhumanov, "Method for Producing Attenuated Salmonella Strain," *Journal of Pharmaceutical Sciences and Research*, vol. 10, no. 1, pp. 162-163, 2018.
- [83] Z. Tulemisova, K. Biyashev, B. Biyashev, G. Kasenova, Z. Kozhakhmetova, and D. Sarybaeva, "Prophylaxy of Gasstro-Intestinal Diseases of Young Animals," *Journal of Animal and Veterinary Advances*, vol. 12 no. 22, pp. 1645-1650, 2013.
- [84] A. Issimov, D. B. Taylor, K. Zhugunissov, L. Kutumbetov, A. Zhanabayev, N. Kazhgaliyev, A. Akhmetaliyeva, B. Nurgaliyev, M. Shalmenov, G. Absatirov, L. Dushayeva and P. J. White, "The Combined Effects of Temperature and Relative Humidity Parameters on the Reproduction of Stomoxys Species in a Laboratory Setting," *PLoS ONE*, vol. 15, no. 12 December, e0242794, 2021.
- [85] K. T. Zhumanov, K. B. Biyashev, B. K. Biyashev, A. R. Sansyzbai, and A. Valdovska, "Application of Polyvalent Hyperimmune Serum Against Mastitis in Beef Cattle," *Biology and Medicine*, vol. 7, no. 5, Article number BM-154-15, 2015.
- [86] A. Issimov, D. B. Taylor, M. Shalmenov, B. Nurgaliyev, I. Zhubantayev, N. Abekeshev, K. Kushaliyev, A. Kereyev, L. Kutumbetov, A. Zhanabayev, Y. Zhakiyanova, and P.J. White, "Retention of Lumpy Skin Disease Virus in Stomoxys SPP (Stomoxys Calcitrans, Stomoxys Sitiens, Stomoxys Indica) Following Intrathoracic Inoculation," *PLoS ONE*, vol. 16, no. 2, Article number e0238210, 2021.
- [87] Y. Li, A. M. Arutiunian, E. L. Kuznetsova, and G. V. Fedotenkov, "Method for Solving Plane Unsteady Contact Problems for Rigid Stamp and Elastic Half-Space with A Cavity of Arbitrary Geometry and Location," *INCAS Bulletin*, vol. 12, no. Special Issue, pp. 99-113, 2020.
- [88] R. Baizholova, Z. Abylkassimova, and A. Ramashova, "Problems of Staffing for Innovation Sector," *Actual Problems of Economics*, vol. 178, no. 4, pp. 232-245, 2016.
- [89] I. A. Kapitonov, V. I. Voloshin, and V. G. Korolev, "Eastern Vector of Russian State Policy Development for Ensuring Energy Security," *International Journal of Energy Economics and Policy*, vol. 8, no. 5, pp. 335-341, 2018.
- [90] A. Lapidus, N. Cherednichenko, and V. Smotrov, "The Impact of Technology Installation of Injection Mortar Systems for a Long Term Behavior of Anchor Connections," *Procedia Engineering*, no. 153, pp. 371-377, 2016.
- [91] I. A. Kapitonov, "Legal Support for Integration of Renewable Energy Sources in the Energy Law of the Countries from the International Legal Position," *Kuwait Journal of Science*, vol. 46, no. 1, pp. 68-75, 2019.
- [92] G. Golub, S. Kukharets, J. Česna, O. Skydan, Y. Yarosh, and M. Kukharets, "Research on Changes in Biomass During Gasification," *INMATEH - Agricultural Engineering*, vol. 61, no. 2, pp. 17-24, 2020.
- [93] A. A. Zhakupova, K. B. Biyashev, B. K. Biyashev, S. E. Ermagambetova, and G. M. Nurgozhayeva, "Performance Test of the Drug Enterocol," *Journal of Pharmaceutical Sciences and Research*, vol. 9, no. 10, pp. 1941-1942, 2017.
- [94] M. D. Bulegenova, K. B. Biyashev, B. K. Biyashev, Z. S. Kirkimbayeva, and S. E. Ermagambetova, "The Prevalence of Pathogens of Intestinal Zoonoses in Animals and in Environmental Objects," *Journal of Pharmaceutical Sciences and Research*, vol. 10, no. 9, pp. 2373-2375, 2018.
-

- [95] G. A. Golub, O. V. Skydan, S. M. Kukharets, and O. A. Marus, "Substantiation of Motion Parameters of the Substrate Particles in the Rotating Digesters," *INMATEH - Agricultural Engineering*, vol. 57, no. 1, pp. 179-186, 2019.
- [96] A. Lapidus, and I. Abramov, "An Assessment Tool for Impacts of Construction Performance Indicators on the Targeted Sustainability of a Company," *IOP Conference Series: Materials Science and Engineering*, vol. 753, no. 4, 042089, 2020.
- [97] Y. Sun, M. Y. Kuprikov, and E. L. Kuznetsova, "Effect of Flight Range on the Dimension of the Main Aircraft," *INCAS Bulletin*, vol. 12, no. Special Issue, pp. 201-209, 2020.
- [98] D. V. Topchy, "Organisational, and Technological Measures for Converting Industrial Areas Within Existing Urban Construction Environments," *International Journal of Civil Engineering and Technology*, vol. 9, no. 7, pp. 1975-1986, 2018.
- [99] E. L. Kuznetsova, G. V. Fedotenkov, and E. I. Starovoitov, "Methods of Diagnostic of Pipe Mechanical Damage Using Functional Analysis, Neural Networks and Method of Finite Elements," *INCAS Bulletin*, vol. 12, no. Special Issue, pp. 79-90, 2020.
- [100] I. A. Kapitonov, "Transformation of Social Environment in the Application of Alternative Energy Sources," *Environment, Development and Sustainability*, vol. 22, no. 8, pp. 7683-7700, 2020.
- [101] K. A. Bissenov, S. S. Uderbayev, and U. Z. Shalbolova, "Environmental and Economic Efficiency of Using Insulated Wood Concrete in Building Based on Agricultural and Industrial Wastes," *Actual Problems of Economics*, vol. 151, no. 1, pp. 304-311, 2014.
- [102] K. B. Biyashev, B. K. Biyashev, and D. A. Saribayeva, "Persistence of the Escherichia Coli 64G-Probiotic Strain in the Intestine of Calves," *Biology and Medicine*, vol. 8, no. 2, pp. 2-3, 2016.
- [103] A. B. Abzhaliyeva, K. B. Biyashev, B. K. Biyashev, D. M. Orazaliev, M. R. Turabekov, and A. A. Taipova, "Prevalence of Intestinal Pathogens in Animals, Food Products of Animal Origin and in the Environmental Objects," *Journal of Pharmaceutical Sciences and Research*, vol. 10, no. 2, pp. 246-247, 2018.
- [104] I. A. Kapitonov, V. I. Voloshin, and V. G. Korolev, "Energy Security of Territories as a Factor of Sustainable Development Under the Conditions of Economic Changes," *International Journal of Energy Economics and Policy*, vol. 9, no. 6, pp. 210-221, 2019.
- [105] I. A. Kapitonov, T. G. Filosofova, and V. G. Korolev, "Development of Digital Economy in the Energy Industry-Specific Modernization," *International Journal of Energy Economics and Policy*, vol. 9, no. 4, pp. 273-282, 2019.
- [106] K. B. Biyashev, B. K. Biyashev, and A. Z. Makbuz, "Prevalence of Causative Agents of Emergent Food Zoonotic Diseases in Animals, Animal Origin Products and Environmental Objects," *Biology and Medicine*, vol. 8, no. 2, Article number BM-169-16, 2016.
- [107] A. A. Zhakupova, A. Z. Maulanov, B. K. Biyashev, K. B. Biyashev, and N. B. Sarsembaeva, "Histological Study of the Interaction of the Escherichia with Epithelium of the Small Intestine of Rats," *Advances in Environmental Biology*, vol. 8, no. 10, pp. 553-555, 2014.
- [108] I. A. Kapitonov, "International Regulation of the Restriction of the Use of Environment," *Periodicals of Engineering and Natural Sciences*, vol. 7, no. 4, pp. 1681-1697, 2019.
- [109] I. A. Kapitonov, "Development of Low-Carbon Economy as the Base of Sustainable Improvement of Energy Security," *Environment, Development and Sustainability*, vol. 23, no. 3, pp. 3077-3096, 2021.
- [110] D. Topchiy, V. Skakalau, and A. Yurgaytis, "Comprehensive Verification Construction Compliance Control as the Developer's Project Risk Reduction Tool," *International Journal of Civil Engineering and Technology*, vol. 9, no. 1, pp. 985-993, 2018.